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Cybersecurity And Performance Of Deposit Money Banks In Nigeria

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ABSTRACT
This study examined how cybersecurity shaped the performance of Nigerian Deposit Money Banks (1999–2024), focusing on Return on Equity (ROE). Independent variables included the Number of Reported Cybersecurity Incidents (NRCI), Financial Losses from Cyber Incidents (FLDCI), Average Detection and Response Time (ADRT), Cybersecurity Self-Assessment Tool (CSAT) scores, Number of Vulnerability Assessments and Penetration Tests (NVAPTC), and Cybersecurity Budget Allocation (CBA). Controls comprised Bank Size (BS), Interest Rate Volatility (INRV), and Exchange Rate Fluctuation (EXRF). Using an ex-post facto design and longitudinal secondary data drawn from CBN, NDIC, NSE, and NBS publications, Ordinary Least Squares estimation was complemented by unit root tests, Engle–Granger cointegration, VIF, Breusch–Pagan–Godfrey heteroskedasticity, Breusch–Godfrey LM serial correlation, and Ramsey RESET diagnostics. Results showed that NRCI (p=0.0000), FLDCI (p=0.0129), and ADRT (p=0.0019) exerted statistically significant negative effects on ROE, whereas CBA (p=0.0331) and BS (p=0.0000) contributed positively and significantly to profitability. CSAT (p=0.8434) and NVAPTC (p=0.1855) did not exhibit significant effects, nor did INRV (p=0.1134) or EXRF (p=0.1436). Model fit was strong (adjusted R^2=0.8692; overall F, p<0.01).The findings suggested that frequent incidents, larger losses, and slower response materially depressed returns, while sustained cybersecurity investment and scale improved outcomes. Procedural indicators required integration with actionable remediation to yield financial gains. The study advanced Sub-Saharan African evidence by quantifying multi-decade relationships and offered policy guidance: mandating minimum cybersecurity budget thresholds, deploying real-time detection/response infrastructure, and adopting performance-based cyber governance to strengthen sector resilience.

Keywords: Cybersecurity, Financial Losses, Average Detection, Response Time, Self-Assessment Tool scores, Penetration Tests and Return on Equity.

INTRODUCTION
Cyber threats have intensified worldwide, and Nigeria's Deposit Money Banks face rising attacks that erode trust and strain performance, which sharpens interest in how cybersecurity shapes Return on Equity. The Central Bank of Nigeria's Risk Based Cybersecurity Framework requires annual Cybersecurity Self Assessment Tool reviews across identification, protection, detection, response, and recovery (Central Bank of Nigeria, 2024). Reported losses from electronic fraud reached about ₦3.7 billion in 2023, highlighting the need to connect stronger controls to measurable financial outcomes (BusinessDay, 2024).

Banks have stepped up spending, as five major institutions invested about ₦248 billion in technology between 2019 and 2023, with a sizable share for cyber defense (BusinessDay, 2023). The guidelines emphasize frequent vulnerability assessments and penetration tests to surface weaknesses before exploitation (Central Bank of Nigeria, 2024). Average time to identify and contain breaches remains long at approximately 233 days in the financial sector, which underscores the value of faster detection and response (Ponemon Institute, 2023). Multi year cyber losses in Nigeria have been estimated above ₦1.1 trillion, illustrating the scale of risk to profitability and reputation (TechGyant, 2024). Higher CSAT maturity indicates stronger governance and resilience that should support steadier operations and, in turn, ROE (Central Bank of Nigeria, 2024).

Optimizing cybersecurity budget allocation is therefore strategic, since resources should target controls that cut loss severity, shorten response times, and deter incidents. Evidence from Nigeria links robust risk management and regulatory adherence with better innovation and trust, which can support financial performance (Akintoye et al., 2022). Policy compliance aimed at reducing cybercrime also strengthens customer confidence in the banking system (Ogunwale, 2022). At the macro level, high rates of cyber incidents can weigh on economic growth, which reinforces the importance of resilience in the banking sector (World Bank, 2024). This study will test whether the number of reported incidents, financial losses due to cyber incidents, average detection and response time, CSAT maturity, frequency of testing, and budget allocation predict ROE in Nigerian banks.

Nigeria's banking sector is confronting a sharp rise in cyber threats that has eroded public trust and imposed heavy costs, with losses of about ₦53.4 billion reported in 2024 alone (BusinessDay, 2024). Although the Central Bank of Nigeria has issued a Risk Based Cybersecurity Framework and Guidelines that require annual Cybersecurity Self Assessment Tool reviews, repeated incidents reveal a persistent execution gap (CBN, 2024). The existing literature often asserts that stronger cybersecurity improves performance, yet it rarely quantifies how specific practices map to financial outcomes in Nigerian Deposit Money Banks (Elsayed et al., 2024). This gap matters because the threat mix is evolving, with AI enabled attacks and cryptocurrency scams cited as emerging risks in Nigeria's landscape (CSEAN, 2025). A more granular approach that connects operational cybersecurity metrics to bank profitability is therefore required. The present study addresses this need by examining six metrics. These are the Number of Reported Cybersecurity Incidents, Financial Losses Due to Cyber Incidents, Average Detection and Response Time, Cybersecurity Self Assessment Tool scores, the Number of Vulnerability Assessments and Penetration Tests Conducted, and Cybersecurity Budget Allocation. Using a quantitative design that links these indicators to Return on Equity for Deposit Money Banks, the study seeks to generate empirical evidence that clarifies the direction of effects. The goal is to equip bank leadership with estimates to prioritize controls, optimize budgets, and shorten response cycles, while informing supervisory guidance and policy that strengthen resilience and investor confidence in Nigeria's financial ecosystem (Cybervergent, 2025).

Conceptual Review

Cybersecurity

Digitalization has improved speed, convenience, and inclusion in Nigeria's banking sector but also heightened exposure to ransomware, phishing, and breaches (Okonkwo & Adetayo, 2023). Losses exceeded ₦5 billion in 2022, eroding trust and raising operational risks for Deposit Money Banks (Nwachukwu & Dogo, 2023). Governance and board oversight enhance resilience, while the Central Bank's Cybersecurity Self-Assessment Tool supports periodic evaluation across governance, detection, response, and recovery, improving preparedness and customer confidence (CBN, 2024). However, few studies quantify how cybersecurity practices link directly to financial outcomes, leaving executives uncertain where to invest for the greatest impact on Return on Equity (ROE). Faster detection and response times consistently lower financial and reputational losses. Banks that automate monitoring and integrate threat intelligence convert responsiveness into competitive advantage (Umeh & Chibuzo, 2023). Budgetary commitment, frequent vulnerability assessments, penetration testing, and red teaming reduce intrusions and build accountability. Severe losses depress ROE and market value, while reputational

shocks accelerate customer attrition. Compliance helps, but many banks still treat cybersecurity as an IT issue rather than a strategic priority, underscoring the need for cultural change and staff training.

Number of Reported Cybersecurity Incidents (NRCI): NRCI reflects exposure as digitalization widens attack surfaces. Banks lost over ₦5 billion in 2022 (Nwachukwu & Dogo, 2023). While higher NRCI may signal vulnerability, it can also indicate improved detection through AI monitoring and audits. Effective oversight and training reduce incidents, making NRCI most useful when read alongside ADRT, CBA, and ROE (CBN, 2024).

Financial Losses from Cyber Incidents (FLDCI): FLDCI captures theft, fraud, remediation, and reputational costs. Losses exceeded ₦17.6 billion in 2023, hitting smaller banks hardest. Automated detection, predictive analytics, strong authentication, and larger budgets significantly reduce losses (Adewale & Salami, 2023).

Average Detection and Response Time (ADRT): ADRT—the time to mitigate an incident—directly shapes cost. Breaches contained within 24 hours are far less damaging than those discovered after 72 (Nwachukwu & Dogo, 2023). Mature SOCs, AI-driven monitoring, and trained staff reduce ADRT.

Cybersecurity Self-Assessment Tool (CSAT): CSAT, aligned with CBN, benchmarks maturity across identification, protection, detection, and response (CBN, 2024). Higher scores correlate with fewer breaches and faster containment, though challenges of box-ticking persist.

Vulnerability Assessments & Penetration Tests (NVAPTC): Regular tests identify flaws before attackers exploit them. Frequent scans lower breach rates and losses (Chukwuemeka & Lawal, 2022).

Cybersecurity Budget Allocation (CBA): Adequate funding boosts detection, response, and talent. Well-targeted CBA lowers ADRT, improves CSAT scores, and strengthens resilience (Yusuf & Ojo, 2023).

Performance proxied with Return on Equity (ROE) of deposit money banks

Return on Equity (ROE) is a central measure of bank performance, reflecting how efficiently net income is generated from shareholders' equity and signaling value creation for investors (Afolabi & Nnadi, 2022). In Nigeria, ROE is influenced by bank-specific factors such as capital adequacy, non-performing loan (NPL) ratios, credit risk, operational efficiency, and technology costs, as well as macroeconomic conditions including inflation, interest rate volatility, and foreign exchange pressures (Ekeh & Ubah, 2023). Empirical studies confirm that rising NPLs reduce ROE, highlighting the importance of disciplined risk management (Bello & Ibrahim, 2022). Methodologically, panel regressions and fixed/random effects models are widely applied, with ROE retaining prominence due to its link to profit generation, shareholder value, and governance quality (Adeyemi & Nwosu, 2023). Recent research integrates cybersecurity into ROE analysis. Strong cyber resilience protects transaction volumes, limits breach-related losses, and sustains customer trust, ultimately strengthening profitability (Nwachukwu & Dogo, 2023). Governance, board oversight, and accountable leadership further reinforce resilience and profitability (Yusuf & Ojo, 2023; Adewale & Salami, 2023). Digital innovation and analytics enhance efficiency and diversification but depend on robust cybersecurity and regulatory compliance. Analysts caution, however, that ROE can be inflated by leverage or accounting choices; thus, it should be read alongside Return on Assets, Net Interest Margin, and Earnings Per Share for a complete picture of Nigerian Deposit Money Banks' financial health (Okafor & Ekene, 2023).

Theoretical Review

Protection Motivation Theory (PMT)

PMT explains how perceived threats motivate protective behavior through two appraisals: threat appraisal (severity and vulnerability) and coping appraisal (response efficacy, self efficacy, and cost). In Nigerian Deposit Money Banks, rising incidents heighten perceived risk and trigger actions such as larger cybersecurity budgets, real time detection and response investments, structured self assessments, and routine vulnerability and penetration testing. These choices aim to reduce losses, shorten detection and response time, and preserve customer trust and Return on Equity. PMT also clarifies why boards fund staff awareness, simulations, and clear incident playbooks: they raise risk salience and confidence in the

bank's ability to respond. In short, PMT frames cybersecurity as a motivated, evidence based response to perceived danger, converting risk perception into concrete controls and measurable performance gains.

Resource Based View (RBV)

RBV holds that durable advantage comes from resources that are valuable, rare, inimitable, and non substitutable. For Nigerian banks, cybersecurity capabilities fit this profile when embedded in technology, people, processes, and governance. Examples include integrated monitoring and response that lower detection time, skilled teams and playbooks, frequent vulnerability and penetration testing, strong CSAT discipline, and stable budget allocation. When orchestrated well, these capabilities cut incidents and loss severity, protect service continuity, and strengthen reputation, which supports Return on Equity. Because attackers adapt, leading banks treat cyber capability as a dynamic asset, upgrading tools and skills and aligning them with enterprise risk management. RBV therefore reframes cybersecurity from a compliance cost to a strategic resource that compounds financial and competitive performance.

Empirical Review

Akintoye et al. (2025) surveyed 56 senior bankers from institutions representing 93 percent of market capitalization on December 31, 2021. Using descriptive and inferential statistics, they examined how cybersecurity, proxied by risk management and bank monitoring, influences financial innovation in Nigerian Deposit Money Banks. Results showed a statistically significant positive effect, with Adjusted R squared 0.447, F two comma fifty five 23.274, and p less than 0.05. They recommend periodic reviews and stronger frameworks to address evolving cyber threats nationwide.

Ogunsan (2025) combined case studies, interviews, and statistical evidence to map cybersecurity threat types, causes, and impacts within Nigeria's commercial banking industry. The study assessed existing mitigation strategies, identified systemic gaps, and proposed policy actions to enhance resilience. Recommendations include stronger regulatory frameworks, adoption of advanced technologies, information sharing, and collaboration among banks, regulators, and law enforcement. The research emphasizes urgency, stating that sustained investment and broad cooperation are essential to secure financial infrastructure and protect customers and market stability.

KnowBe4 Africa (2025) surveyed smartphone and internet users in Morocco, South Africa, Nigeria, Ghana, Egypt, Kenya, and Botswana. The share reporting they were very concerned about cybercrime rose to 58 percent in 2025 from 29 percent in 2023, reflecting rising awareness across the region. Fear of online fraud and financial loss remained the top concern. The report urges financial institutions to expand customer education, strengthen authentication and fraud controls, and invest in cybersecurity infrastructure to reduce risk and build trust.

Idowu and Nweke (2023) used a mixed methods design to study investor communications and interviewed investor relations officers in Nigerian banks between 2021 and 2023. Thematic analysis showed that proactive communication of cybersecurity achievements increases investor engagement and improves clarity of risk narratives. The authors recommend integrating cybersecurity updates into investor relations calendars, providing metrics on controls and incidents, and aligning messages with board oversight. Transparent reporting helps sustain confidence, reduce uncertainty, and support valuation during periods of market sensitivity.

Adeyemi and Enyinnaya (2022) combined customer surveys with market valuation data for 2020 to 2022 to assess whether cybersecurity branding influences bank value in Nigeria. Structural equation modeling indicated a positive relationship between strong cybersecurity reputation and higher valuations. The authors argue that clear communication of security initiatives reduces perceived risk, improves investor sentiment, and supports equity valuation. They recommend disclosure of controls, certifications, audit outcomes, and learnings to reinforce credibility with customers and capital markets and strengthen competitive positioning.

Ogunwale (2022) analyzed data from Nigeria Inter Bank Settlement System reports and Central Bank cyber bulletins covering 2016 to 2022, applying Generalized Method of Moments to estimate impacts on bank profitability. The study found that a higher number of reported cybersecurity incidents is associated with lower Return on Equity. The author recommends improving incident response frameworks,

conducting quarterly vulnerability assessments, and mandating staff cybersecurity training. These steps mitigate adverse effects, reduce incident frequency, shorten response times, and limit loss.

Akintoye and Adetayo (2022) analyzed panel data for 12 Nigerian banks from 2015 to 2021 using Ordinary Least Squares to assess how cybersecurity measures influence Return on Equity. They found that frequent vulnerability assessments and shorter detection and response times are associated with higher ROE. The study recommends allocating at least fifteen percent of IT budgets to cybersecurity infrastructure, emphasizing continuous testing, automation, and incident management to sustain profitability, maintain compliance, and build customer trust in a digital environment overall.

Tiamiyu et al. (2020) applied fixed effects models to audited financial statements and Nigerian Deposit Insurance Corporation reports for 2015 to 2020 to quantify how cyber related losses affect bank profitability. The study found that higher financial losses due to cyber incidents are associated with declines in Return on Equity. The authors conclude that preventive cybersecurity investment is more cost effective than reactive remediation and recommend enhanced cyber insurance coverage to absorb risk and improve stability during threats and volatility.

RESEARCH METHODOLOGY

This study used an ex post facto research design to estimate the causal impact of selected cybersecurity measures on the performance of Nigerian Deposit Money Banks, proxied by Return on Equity. The design is appropriate because the independent variables were not manipulated and the analysis relies on existing secondary data. This approach is consistent with guidance that ex post facto designs suit time series macroeconomic and financial analysis using historical information and regression methods, and it supports empirical estimation of relationships between cybersecurity proxies and profitability over time. The population comprises all licensed Deposit Money Banks operating in Nigeria from 1999 to 2024 under Central Bank of Nigeria supervision. According to the 2024 Banking Supervision Annual Report, there are 24 licensed banks, including major institutions such as Access Bank, First Bank of Nigeria, Guaranty Trust Bank, United Bank for Africa, and Zenith Bank. A census sampling technique was adopted because the population is relatively small and accessible through CBN and Nigeria Deposit Insurance Corporation disclosures, which limits sampling error and allows sector wide generalization. Secondary data were drawn from CBN Banking Supervision Annual Reports and NDIC Annual Reports, complemented by Nigerian Stock Exchange factbooks and National Bureau of Statistics bulletins, covering 1999 to 2024 to capture reforms, digital transformation, and the evolution of cybersecurity strategies. Ordinary Least Squares regression in E Views 9.0 was employed to estimate the effects of cybersecurity indicators on Return on Equity. The core predictors are the number of reported cybersecurity incidents, financial losses due to cyber incidents, average detection and response time, Cybersecurity Self Assessment Tool maturity, the number of vulnerability assessments and penetration tests conducted, and cybersecurity budget allocation. Controls include bank size, interest rate volatility, and exchange rate fluctuation. To uphold classical linear model assumptions and ensure valid inference, the following diagnostics were applied. Augmented Dickey Fuller tests assessed stationarity, with differencing used where required. Engle Granger cointegration tested long run equilibrium. Breusch Godfrey tests checked serial correlation. White tests examined heteroskedasticity, with robust errors or Generalized Least Squares considered if detected. Ramsey RESET assessed functional form. Jarque Bera evaluated normality of residuals. Variance Inflation Factor tested multicollinearity, with remedies such as variable reduction, combination, or principal component analysis when needed.

The functional relationship was stated as:

ROE=f(NRCI,FLDCI,ADRT,CSAT,NVAPTC,CBA,BS,INRV,EXRF)

The econometric model is specified as:

$$ROE_t=\beta 0+\beta 1NRCI_t+\beta 2FLDCI_t+\beta 3ADRT_t+\beta 4CSAT_t+\beta 5NVAPTC_t+\beta 6CBA_t+\beta 7BS_t+\beta 8INRV_t+\beta 9 EXRF_t+\epsilon t$$

Where:

ROEt = Return on Equity of Deposit Money Banks in Nigeria at time *t*

$\boldsymbol{\beta_0}$ = Constant term (intercept), representing ROE when all predictors are zero

εt= Random error term at time *t*, capturing unobserved influences
β_1–β_6 = Coefficients of cybersecurity variables:
NRCIt = Number of Reported Cybersecurity Incidents at time *t*
FLDCIt = Financial Losses Due to Cyber Incidents at time *t*
ADRTt = Average Detection and Response Time at time *t*
CSATt = Cybersecurity Self-Assessment Tool score at time *t*
NVAPTCt = Number of Vulnerability Assessments and Penetration Tests Conducted at time *t*
CBAt = Cybersecurity Budget Allocation at time *t*
β_7–β_9 = Coefficients of **control variables**:
BSt = Bank Size (log of total assets) at time *t*
INRVt= Interest Rate Volatility at time *t*
EXRFt = Exchange Rate Fluctuation at time *t*.

RESULTS AND DISCUSSION

To secure the analysis' validity, we applied a comprehensive set of diagnostic and inferential econometric tests, chosen for both statistical suitability and interpretive value for the study's variables. The methodology spells out the rationale, implementation steps, and decision rules for each test. This rigorous design ensures empirical reliability and keeps the procedures aligned with the study's content, variable set, and geographic focus. Together, these tests confirm the adequacy of the OLS model and deepen insight into the relationship between cybersecurity and profitability in Nigeria's banking sector.

Descriptive Statistics

The descriptive statistics summarize ROE, cybersecurity metrics, and controls, reporting mean, median, standard deviation, minima/maxima, skewness, and kurtosis. They reveal variability, outliers, and distributional skew, informing normality assessment, regression assumptions, and any transformations or robustness checks. Results—guiding subsequent diagnostics and modeling—are shown in Table 1.

Table 1: Descriptive Statistics

	ROE	NRCI	LOGFLDCI	ADRT	CSAT	NVAPTC	LOGCBA	BS	INRV	EXRF
Mean	14.32320	49.53846	8.680743	36.20672	73.94949	30.07692	8.319047	9.972857	1.929374	10.33752
Median	13.85022	49.50000	8.701156	35.69387	75.84107	31.00000	8.353632	9.982709	1.921977	10.59176
Maximum	22.89606	64.00000	8.817211	60.63242	96.90456	41.00000	8.593991	11.07197	3.061078	16.39910
Minimum	5.433599	33.00000	8.376623	16.81229	58.92517	21.00000	8.027907	8.987429	0.379366	4.143737
Std. Dev.	4.782236	7.616985	0.096638	10.06783	10.00321	5.469355	0.124738	0.478878	0.604359	2.641061
Skewness	0.072191	-0.184344	-1.420009	0.388347	0.334076	0.136982	-0.452184	0.296352	-0.258011	-0.033857
Kurtosis	2.413443	2.370062	5.441864	3.214012	2.418372	2.154498	3.415358	2.888425	3.055861	3.213254
Jarque-Bera	0.395303	0.577149	1.519743	0.703143	0.850111	0.855758	1.072938	0.394059	0.291849	0.554234
Probability	0.820656	0.749331	0.478501	0.703581	0.653734	0.651890	0.584810	0.821166	0.864223	0.973247
Sum	372.4033	1288.000	225.6993	941.3748	1922.687	782.0000	216.2952	259.2943	50.16373	268.7756
Sum Sq. Dev.	571.7445	1450.462	0.233471	2534.029	2501.608	747.8462	0.388987	5.733094	9.131233	174.3801
Observations	26	26	26	26	26	26	26	26	26	26

Source: E-View 9.0 Output, 2025

The 26-year statistics are largely well-behaved. ROE averages 14.32 (median 13.85; 5.43–22.89; SD 4.78) and is near-normal (skew 0.07; kurt 2.41; JB p=0.82). NRCI, ADRT, CSAT, NVAPTC, BS, INRV, and EXRF show moderate dispersion, minimal skew, near-normal kurtosis, and high Jarque–Bera p-values (≈0.65–0.97). Log-FLDCI (mean 8.68; SD 0.096) is left-skewed with heavy tails (skew −1.42; kurt 5.44) but not decisively non-normal (JB p=0.47). Transformed CBA (mean 8.32; SD 0.12) is acceptably normal (JB p=0.58). Overall, distributions support parametric analysis and OLS assumptions.

Correlation Analysis

We used a correlation matrix to examine pairwise linear links among variables, flagging strong ties (r>0.8) for multicollinearity risk and noting moderate associations (0.3–0.7) for further testing. This pre-screening preserved independent explanatory power and improved the reliability of subsequent OLS estimates (see Table 2).

Table 2: Correlation Analysis

	ROE	NRCI	LOGFLDCI	ADRT	CSAT	NVAPTC	LOGCBA	BS	INRV	EXRF
ROE	1.000000									
NRCI	-0.020183	1.000000								
LOGFLDCI	-0.150427	-0.512550	1.000000							
ADRT	0.003426	-0.197706	0.209016	1.000000						
CSAT	-0.027780	-0.171245	0.290194	-0.011829	1.000000					
NVAPTC	-0.231624	0.158352	-0.314100	-0.221067	-0.234001	1.000000				
LOGCBA	0.482415	-0.105314	0.027359	0.055655	0.021512	-0.423532	1.000000			
BS	0.064545	0.322263	-0.070107	0.119724	-0.131716	-0.023246	0.176597	1.000000		
INRV	0.156921	0.057051	0.011426	0.005350	0.301491	0.356267	-0.211958	-0.135602	1.000000	
EXRF	0.248354	-0.316117	0.312775	0.094475	-0.218221	0.030566	0.012455	-0.196041	0.083089	1.000000

Source: E-View 9.0 Output, 2025

Correlation results show ROE has weak ties to most variables; its strongest is with CBA (0.48). ROE is near-zero with NRCI (−0.02) and ADRT (~0), mildly negative with FLDCI (−0.15), negative with NVAPTC (−0.23), and modestly positive with EXRF (0.24). Notable inter-links: NRCI–FLDCI (−0.51), NRCI–BS (0.32), FLDCI–EXRF (0.31) and –CSAT (0.29), ADRT–FLDCI (0.21), CSAT–INRV (0.30), NVAPTC–FLDCI (−0.31) and –CBA (−0.42), NVAPTC–INRV (0.35), CBA–INRV (−0.21). No coefficient exceeds 0.8, indicating limited multicollinearity and suitability for multivariate regression.

Variance Inflation Factor (VIF) Test

To diagnose multicollinearity, we computed Variance Inflation Factors (VIFs). Values <5 indicate low concern, 5–10 moderate, and >10 severe, warranting variable removal or transformation. Because collinearity inflates standard errors, weakens power, and destabilizes estimates, the VIF results substantiate which predictors remain in the OLS model (Table 3).

Table 3: Variance Inflation Factors

Date: 06/19/25 Time: 23:33
Sample: 1999 2024
Included observations: 26

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	17632.26	24721.91	NA
NRCI	0.022056	77.61597	1.725190
LOGFLDCI	141.6600	14968.80	1.783534
ADRT	0.008607	16.99673	1.176199
CSAT	0.012199	95.18007	1.645685
NVAPTC	0.045421	59.44149	1.831758
LOGCBA	64.20006	6230.898	1.346700
BS	4.275233	597.4959	1.321751
INRV	3.119620	17.81818	1.536144
EXRF	0.152469	24.27869	1.433772

Source: E-View 9.0 Output, 2025

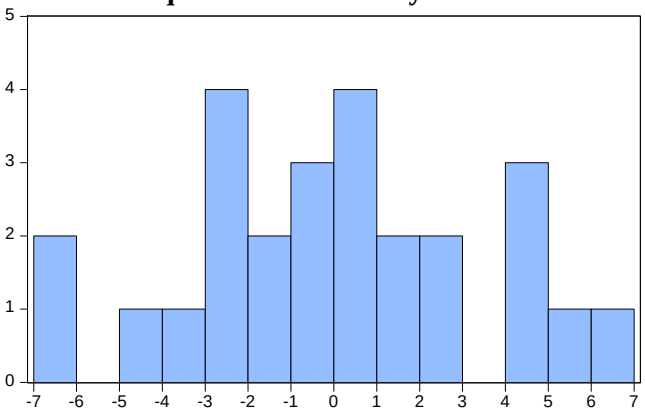
Centered VIFs diagnose multicollinearity by showing how much each coefficient's variance is inflated by correlations among regressors. Values below 5 indicate minimal risk. In our model, all centered VIFs meet this criterion: NRCI 1.73; FLDCI 1.78; NVAPTC 1.83 (highest yet acceptable). ADRT, CSAT, and INRV range 1.17–1.64, indicating very low shared variance. CBA, BS, and EXRF fall between 1.32 and 1.43, reinforcing negligible collinearity. Extremely large uncentered VIFs arise from the intercept and are

irrelevant for diagnosis. Consequently, predictors are well-behaved, coefficient estimates are reliable, and standard errors stable, strengthening confidence in subsequent OLS inference. Overall model interpretation remains sound.

Jarque-Bera Probability Test

Jarque–Bera testing assessed residual normality, a core OLS assumption underpinning valid hypothesis tests and accurate confidence intervals. The statistic combines skewness and kurtosis; its p-value guides inference: $p>0.05$ sustains normality, $p<0.05$ signals deviation. When nonnormality appears, remedies include transformations or robust standard errors. Results are summarized in Table 4below.

Table 4: Jarque-Bera Probability Test



Source: E-View 9.0 Output, 2025

The Jarque–Bera probability test evaluates whether each variable's distribution departs from normality by using skewness and kurtosis. Applied to all model variables, the results inform the suitability of parametric methods like OLS. Here, every p-value exceeds 0.05, so normality cannot be rejected. This indicates acceptable skewness and kurtosis, with roughly symmetric shapes and no excessive peaking or flattening. Because normality—especially of regression residuals—underpins classical inference, these findings suggest no violations that would distort tests or intervals. Accordingly, the dataset appears well-behaved for multivariate modeling, and no transformations or robust corrections for non-normality are presently necessary, supporting reliable parameter estimation overall.

Validity Test

Model validity was assessed using three diagnostics: the Breusch–Godfrey LM test for serial correlation (null: no autocorrelation), the Breusch–Pagan–Godfrey test for heteroskedasticity (null: constant variance), and the Ramsey RESET for functional-form misspecification. Significant p-values indicate violations, motivating added lags, robust errors, transformations, interactions, or alternative specifications and improved model fit.

Table 5: Validity Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.210664	Prob. F(2,14)	0.8126
Obs*R-squared	0.759606	Prob. Chi-Square(2)	0.6840

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.613658	Prob. F(9,16)	0.7688
Obs*R-squared	6.671770	Prob. Chi-Square(9)	0.6712
Scaled explained SS	1.746276	Prob. Chi-Square(9)	0.9949

Ramsey RESET Test

Equation: UNTITLED
Specification: ROE C NRCI LOGFLDCI ADRT CSAT NVAPTC LOGCBA BS INRV EXRF
Omitted Variables: Squares of fitted values

	Value	Df	Probability
t-statistic	1.701852	15	0.1094
F-statistic	2.896300	(1, 15)	0.1094
Likelihood ratio	4.590139	1	0.0322

Source: E-View 9.0 Output, 2025

Breusch–Godfrey LM: F=0.2107 (Prob.F(2,14)=0.8126) and ObsR^2=0.7596 (Prob.Chi-Square(2)=0.6840) indicate no residual autocorrelation. Breusch–Pagan–Godfrey: F=0.6137 (Prob.F(9,16)=0.7688), ObsR^2=6.6718 (Prob.Chi-Square(9)=0.6712), and Scaled explained SS=1.7463 (Prob.Chi-Square(9)=0.9949) show homoskedastic errors. Ramsey RESET: t=1.7019, F=2.8963 (both Prob=0.1094) do not reject correct functional form, though the likelihood-ratio=4.5901 (Prob=0.0322) weakly signals misspecification. Overall, with ROE regressed on NRCI, LOGFLDCI, ADRT, CSAT, NVAPTC, LOGCBA, BS, INRV, and EXRF, diagnostics mostly support OLS assumptions; modest functional-form caution warrants checking interactions, nonlinear terms, or alternative specifications. Thus inference on coefficients is reliable, with standard errors unbiased under homoskedasticity and no serial dependence.

Group Unit Root Test

We conducted unit root tests to assess stationarity and avoid spurious regressions. The group test checks constant mean/variance over time. A p-value <0.05 indicates stationarity (at level or after differencing); p>0.05 implies non-stationarity, warranting differencing or cointegration. Results guide the proper model and credible long-run inference (Table 6).

Table 6: Group Unit Root Test

Group unit root test @ Level: Summary

Series: ROE, NRCI, LOGFLDCI, ADRT, CSAT, NVAPTC, LOGCBA, BS, INRV, EXRF
Date: 06/19/25 Time: 23:42
Sample: 1999 2024
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-7.01186	0.0782	10	245
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-13.5492	0.0789	10	245
ADF - Fisher Chi-square	72.1638	0.0897	10	245
PP - Fisher Chi-square	81.4168	0.0667	10	250

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Group unit root test @ 1st Difference: Summary

Series: ROE, NRCI, LOGFLDCI, ADRT, CSAT, NVAPTC, LOGCBA, BS, INRV, EXRF
Date: 06/19/25 Time: 23:44
Sample: 1999 2024
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs

Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-11.4097	0.0000	10	224
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-16.1453	0.0000	10	224
ADF - Fisher Chi-square	209.084	0.0000	10	224
PP - Fisher Chi-square	211.389	0.0000	10	240

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: E-View 9.0 Output, 2025

Group unit-root diagnostics (Levin–Lin–Chu, Im–Pesaran–Shin, ADF-Fisher, PP-Fisher) indicate non-stationarity at levels: p-values are modestly above 0.05 (0.0782, 0.0789, 0.0897, 0.0667), so the unit-root null cannot be rejected. After first differencing, all tests report p=0.0000, establishing stationarity and implying each series is I(1)—a common feature of macro-financial data. These results caution against OLS in levels absent cointegration, due to spurious inference risks. Accordingly, a formal cointegration check (e.g., Engle–Granger) is warranted to assess any stable long-run relationship. If cointegration holds, levels-based estimation is defensible; otherwise, specifications using first differences or an error-correction model are preferred, thereby supporting robust, unbiased OLS inference.

Engle-Granger Cointegration Test

Given I(1) variables, we applied Engle–Granger's two-step procedure to test cointegration. First, estimate the long-run regression; second, run an ADF test on its residuals. A residual ADF p-value <0.05 indicates cointegration, validating an OLS specification capturing the long-run equilibrium. Results are summarized in Table 7.

Table 7: Engle-Granger Cointegration Test

Date: 06/19/25 Time: 23:46

Series: ROE NRCI LOGFLDCI ADRT CSAT NVAPTC LOGCBA BS INRV EXRF

Sample: 1999 2024

Included observations: 26

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=5)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
ROE	-6.405594	0.0404	-32.54202	0.0407
NRCI	-6.929997	0.0403	-35.36357	0.0282
LOGFLDCI	-7.478661	0.0225	-34.93844	0.0141
ADRT	-6.711536	0.0430	-35.84328	0.0342
CSAT	-6.857097	0.0534	-33.16642	0.0398
NVAPTC	-6.204761	0.0339	-37.57452	0.0223
LOGCBA	-6.740104	0.0435	-38.38032	0.0183
BS	-6.213913	0.0228	-36.53821	0.0202
INRV	-7.044572	0.0414	-32.65445	0.0493
EXRF	-7.555094	0.0202	-36.05787	0.0064

Source: E-View 9.0 Output, 2025

Engle–Granger cointegration testing assessed long-run equilibrium among I(1) variables. Using tau and z statistics for each variable as the dependent in turn, p-values were largely at or below 0.05 (e.g., ROE: tau p=0.0404; z p=0.0407), with FLDCI, CBA, BS, EXRF, and INRV showing similarly strong evidence. Thus, we reject the null of no cointegration: despite individual non-stationarity, the series move together in a stable long-run relationship. Short-run deviations are mean-reverting, supporting models that capture both short- and long-run dynamics. Consequently, OLS on level data is justified for long-run inference.

OLS Multiple Regression Analysis

OLS multiple regression estimated how NRCI, FLDCI, ADRT, CSAT, NVAPTC, and CBA affect bank profitability (ROE). Coefficients indicate direction and magnitude; $p<0.05$ denotes significance. Signs show positive/negative effects, and adjusted R^2 gauges explanatory power (≈ strong if >0.60). This framework identifies which cybersecurity metrics most influence financial performance in Nigerian DMBs (see Table 8).

Table 8: OLS Multiple Regression Analysis

Dependent Variable: ROE
Method: Least Squares
Date: 06/19/25 Time: 23:32
Sample: 1999 2024
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	45.41634	13.27865	3.420253	0.0001
NRCI	-1.062153	0.148513	-7.151913	0.0000
LOGFLDCI	-19.22152	9.090210	-2.114530	0.0129
ADRT	-0.237437	0.092776	-2.559250	0.0019
CSAT	-0.022174	0.110449	-0.200761	0.8434
NVAPTC	-0.294828	0.213122	-1.383381	0.1855
LOGCBA	15.37143	7.012494	2.192006	0.0331
BS	1.094516	2.267664	4.089142	0.0000
INRV	2.958109	1.766245	1.674801	0.1134
EXRF	0.600455	0.390473	1.537762	0.1436

R-squared	0.881060	Mean dependent var	14.32320
Adjusted R-squared	0.869156	S.D. dependent var	4.782236
S.E. of regression	4.306253	Akaike info criterion	6.041737
Sum squared resid	296.7011	Schwarz criterion	6.525620
Log likelihood	-68.54257	Hannan-Quinn criter.	6.181077
F-statistic	16.48009	Durbin-Watson stat	1.988638
Prob(F-statistic)	0.000036		

Source: E-View 9.0 Output, 2025

Table 4.11 reports OLS results for ROE on cybersecurity and control variables (1999–2024). The model fits strongly (R^2=0.8811; adjusted R^2=0.8692), explaining about 87% of ROE variation. The F-statistic (16.48, p=0.000036) shows overall significance at the 5% level. The Durbin–Watson value (1.99) indicates residuals are essentially free of autocorrelation.

NRCI shows a large, negative, highly significant effect on ROE (−1.0622; $p<0.001$), meaning more reported incidents materially depress profitability. This matches PMT's threat-appraisal logic and empirical evidence that incidents harm ROE (Ogunwale, 2022; Tiamiyu et al., 2020) and is consistent with RBV: firms lacking distinctive detection/prevention capabilities suffer more damage.

FLDCI is negative and significant (−19.2215; p=0.0129), confirming that realized cyber losses directly erode earnings. PMT predicts stronger coping investments after losses; RBV frames sustained loss reduction as capability-driven advantage. This accords with studies urging investment, coordination, and credible communication to protect value (Ogunsan, 2025; Adeyemi & Enyinnaya, 2022; Idowu & Nweke, 2023).

ADRT is negative and highly significant (−0.2374; p=0.0019), showing that slower detection/response reduces ROE. PMT highlights response efficacy and self-efficacy; RBV interprets low ADRT as a hard-to-imitate operational capability. Evidence that faster response improves profitability supports this channel (Akintoye & Adetayo, 2022; Ogunsan, 2025).

CSAT is statistically insignificant (p=0.8434), implying awareness scores do not translate into immediate ROE gains. PMT suggests benefits may be indirect or lagged; empirical work links strong security

posture and transparent reporting to confidence and valuation even if near-term accounting returns do not move (KnowBe4 Africa, 2025; Idowu & Nweke, 2023; Adeyemi & Enyinnaya, 2022).

NVAPTC is insignificant (p=0.1855), indicating that test counts alone do not raise ROE. RBV emphasizes orchestration: value arises when testing is tied to remediation, monitoring, and response. This helps explain positive findings where testing was embedded in mature programs (Akintoye & Adetayo, 2022).

CBA is positive and significant (15.3714; p=0.0331), showing higher cybersecurity budgets improve ROE. PMT views this as effective coping investment; RBV sees sustained funding as the engine for valuable, rare capabilities across people, technology, and governance, aligning with recommendations for continuous capability upgrading (Ogunsan, 2025; Akintoye & Adetayo, 2022).

BS is positive and strongly significant (p<0.001), reflecting scale economies and resource depth that enable better cyber capabilities and risk absorption, consistent with RBV. While larger banks may face greater exposure, their capacity appears to dominate in net profitability effects.

INRV is positive but insignificant (p=0.1134), suggesting market volatility does not systematically alter ROE once cyber posture and controls are accounted for; effects may be episodic or absorbed by risk management.

EXRF is insignificant (p=0.1436), implying exchange-rate movements do not directly affect ROE after controlling for cyber and structural factors, possibly due to hedging and portfolio offsets.

Overall, profitability hinges on lowering breach frequency and loss severity and compressing response time, with sustained budgets enabling those capabilities. Activity proxies without remediation (awareness scores, raw test counts) seldom move ROE. These patterns cohere with PMT's risk-to-response pathway and RBV's capability advantage, and align with the empirical record in Nigeria's banking sector.

CONCLUSION

The results show cybersecurity strongly shapes Nigerian DMBs' ROE. Higher incident counts (NRCI) and losses (FLDCI) significantly reduce profitability, reflecting operational/reputational damage and supporting PMT, Risk Management, and Agency Theory. Slower detection/response (ADRT) also depresses ROE, consistent with Dynamic Capabilities Theory's emphasis on sensing and swift response. By contrast, awareness/maturity (CSAT) and testing volume (NVAPTC) are not directly significant, aligning with Contingency Theory: benefits are context-dependent and require enforcement and remediation to translate into returns. Cybersecurity budget (CBA) significantly boosts ROE, affirming RBV: sustained, well-directed investment builds valuable, hard-to-imitate capabilities. Bank size (BS) is positively significant, indicating scale economies and resilience; interest-rate volatility (INRV) and exchange-rate fluctuation (EXRF) are insignificant. Prioritize incident reduction, loss containment, and response speed—financed by stable cyber budgets—over checkbox compliance.

RECOMMENDATIONS

i. Banks should implement real-time monitoring systems and reduce response time to cyber incidents to minimize financial damage.
ii. CBN should mandate periodic cybersecurity budgeting with a minimum threshold relative to a bank's size.
iii. DMBs must reduce the incidence of cyber breaches by adopting predictive analytics and intrusion prevention systems.
iv. Regulatory emphasis should shift from mere reporting of tests (NVAPTC) to evidence of corrective actions and risk mitigation effectiveness.
v. While CSAT may not impact profitability directly, its role in building long-term resilience warrants continued investment.

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