



Capital Structure and Financial Performance of Listed Insurance Firms in Nigeria:

A Multi-Estimator Panel Analysis with Threshold, Dynamic and Distributional Evidence

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Abstract

This study examines the relationship between capital structure and the financial performance of insurers listed on the Nigerian Exchange Group (NGX), accounting for small-panel limitations, potential reverse causality and non-linearity. Using an unbalanced panel for 2015–2025, the study employs pooled, fixed-effects, random-effects and Mundlak models, complemented by robust inference procedures, panel-threshold regression, method-of-moments quantile regression (MMQR), dynamic instrumental-variable estimators and Monte Carlo simulations. Leverage is measured using total-liabilities (TDR), debt-to-equity (DER), long-term (LTDR) and short-term (STDR) ratios, with financing debt (FDR), excluding policyholder liabilities, used for robustness analysis. The random-effects results indicate that a 0.10 increase in TDR is associated with a 0.62-percentage-point reduction in return on assets (ROA); however, this relationship is not robust across alternative estimators and inference procedures. Findings for return on equity, leverage maturity, non-linearity and interaction effects are inconclusive, while weak instruments preclude credible causal inference. The results underscore the importance of distinguishing financing debt from insurance-contract liabilities in assessing insurers' performance and strengthening disclosure of borrowings, maturities and refinancing risks. The study contributes by integrating alternative leverage measures and rigorous sensitivity analyses to clarify the limits of associational and causal inference in Nigeria's insurance sector.

Keywords: Capital structure; insurance companies; financial performance; panel threshold regression; quantile regression; dynamic panel; Nigeria.

1. Introduction

1.1 Background

Capital structure decisions determine how a firm combines equity, retained earnings, reserves and borrowed funds, and therefore how risk and return are shared between shareholders and creditors

(Modigliani & Miller, 1958; Myers, 1984). For insurers the question is distinctive. The balance sheet is dominated by technical liabilities owed to policyholders, which arise from underwriting rather than from a financing choice, while equity capital doubles as a regulatory solvency buffer. The mix of shareholders' funds, retained earnings and genuine financial debt (bank loans, bonds, debentures) therefore bears jointly on profitability, solvency and sustainability.

The Nigerian insurance sector has just passed through its most consequential capital reform in a generation. The Nigerian Insurance Industry Reform Act (NIIRA) 2025 (Federal Republic of Nigeria, 2025) set higher minimum capital of ₦10 billion for life insurers, ₦15 billion for non-life insurers and ₦35 billion for reinsurers (allAfrica, 2025), up from ₦3 billion for general insurers, and introduced a risk-based capital regime. NAICOM fixed end-July 2026 as the compliance deadline and said it would not be extended (Voice of Nigeria, 2025); in August 2026 it reported that 43 insurers and reinsurers had been verified as compliant (P.M. News, 2026). Sources differ on exact assent and deadline dates, so the Act's primary text should be consulted. Financial-statement comparability has also shifted: IFRS 17 *Insurance Contracts* applies to annual periods beginning on or after 1 January 2023 (International Accounting Standards Board [IASB], 2017), changing the measurement of insurance liabilities and equity inside the study window.

The reform forces insurers to raise equity, retain earnings or, less commonly, borrow, so financing mixes are being shaped by regulation as well as markets. Whether leverage helps or harms insurer performance under these conditions matters to boards, investors and the regulator, and it is an empirical question because competing theories predict opposite signs.

1.2 Problem statement and research gap

Evidence on insurers is mixed. Studies of general insurers in Sub-Saharan Africa report a negative but negligible leverage–ROA link (Msomi, 2022) and, in a later sample, examine capital structure alongside intellectual capital (Msomi et al., 2025). Ghanaian studies report both a significant negative debt–profitability relationship (Abudu et al., 2023) and significantly positive leverage effects under an unearned-premium-based definition (Agyapong, 2022). Kenyan evidence links larger, more leveraged insurers to superior performance (Morara & Sibindi, 2021). Recent Nigerian panel's report significant effects of debt-to-equity, total debt and equity on return on capital employed (Odufisan et al., 2025) and study risk-based capital and performance (Olushola & Ajike, 2025).

Four problems limit what can be concluded for Nigeria. (G1) Measurement: leverage definitions vary, and few studies separate financing debt from insurance-contract liabilities, so a high “debt ratio” may reflect a large underwriting book. (G2) Time: the 2015–2025 window spans IFRS 17 and the NIIRA 2025 reform, which earlier samples could not cover. (G3) Inference: with few listed insurers, conventional standard errors are unreliable and many dynamic estimators are infeasible. (G4) Identification: leverage and performance are plausibly jointly determined, yet most studies treat leverage as exogenous and test only linear effects.

1.3 Objectives, research questions and hypotheses

General objective. To examine the effect of capital structure on the financial performance of insurers listed on the NGX over 2015–2025. Each hypothesis is stated in null form and tested for ROA (a) and ROE (b).

Table 1. Objectives, research questions and hypotheses

No.	Specific objective	Research question	Null hypothesis
1	Effect of the total debt ratio (TDR)	RQ1: Does TDR affect ROA and ROE?	H1a/b: TDR has no effect
2	Effect of the debt-to-equity ratio (DER)	RQ2: Does DER affect ROA and ROE?	H2a/b: DER has no effect
3	Effect of the long-term debt ratio (LTDR)	RQ3: Does LTDR affect ROA and ROE?	H3a/b: LTDR has no effect
4	Effect of the short-term debt ratio (STDR)	RQ4: Does STDR affect ROA and ROE?	H4a/b: STDR has no effect
5	Test for non-linearity (quadratic and threshold)	RQ5: Is the relationship non-linear?	H5a/b: no curvature and no threshold
6	Test whether effects differ across the performance distribution	RQ6: Does the TDR effect vary by quantile?	H6a/b: TDR effect is constant across quantiles
7	Test robustness to endogeneity, inference method and moderators (IFRS 17 period, size)	RQ7: Are findings robust and conditional on period or size?	H7a/b: no moderation by IFRS 17 period or size

1.4 Contribution, significance and scope

The study contributes (i) an insurer-relevant approach to leverage measurement; (ii) evidence covering the IFRS 17 transition and the 2025 capital reform; (iii) a multi-estimator strategy that distinguishes conditional associations from causal claims; and (iv) inference procedures suited to a small panel. The findings are relevant to insurer boards, investors and NAICOM. The study covers insurers listed on the NGX during 2015–2025; unlisted insurers and non-insurance firms are excluded.

2. Literature Review

This section critically reviews 22 empirical studies, moving from foundational capital-structure research to insurer-specific and Nigerian evidence. The discussion distinguishes reported findings from limitations that affect their interpretation, including cases where the available publication information does not permit a full assessment of identification and robustness. Table 2 summarises the studies, their settings, principal findings and relevance to the present research.

2.1 Foundational evidence on what drives capital structure

Titman and Wessels (1988) were among the first to take measurement error seriously, using a factor-analytic approach to handle unobservable attributes such as collateral value and growth. Their results supported a negative relation between the uniqueness of a firm's product and its leverage and a size effect on short-term debt, but several other attributes predicted by theory showed little relation to debt. The study is informative about method, since measurement error in proxies attenuates coefficients, but it treats leverage as the outcome and covers US industrial firms, so it cannot tell us whether leverage affects performance or whether its findings extend to a regulated insurer whose liabilities are largely operating in nature.

Rajan and Zingales (1995) moved the question across borders by comparing G-7 countries. They found that leverage was broadly similar across the countries, that size and tangibility tended to raise

leverage and that profitability and market-to-book ratios tended to lower it, although institutional differences, such as the treatment of bankruptcy and the role of banks, blurred the interpretation of some coefficients. Booth et al. (2001) extended the exercise to ten developing countries and concluded that the variables that explain leverage in developed markets are also relevant in developing ones, while country-level factors such as financial-market development matter for debt maturity. Frank and Goyal (2009) later distilled a large US literature into a small set of reliably important determinants, namely industry median leverage, tangibility, profits, size, market-to-book and expected inflation, and found that profits and leverage were negatively related. Taken together, these four studies make two points that bear directly on this paper. First, a negative profit–leverage correlation is the most robust empirical regularity, which means that a negative leverage–performance coefficient in a regression cannot by itself be read as a causal effect of leverage; it may simply reflect the feedback from profits to financing. Second, institutions shape the results, so findings from developed markets should not be transplanted to Nigeria without testing. None of the four, however, includes insurers, and none treats the financing choice as a driver of accounting performance.

2.2 Testing the competing theories

The theory tests are pivotal because trade-off and pecking order theories make opposing predictions about the sign of the leverage–profit relation. Shyam-Sunder and Myers (1999) tested a static trade-off model against a pecking order model for 157 US firms with continuous data over 1971–1989 and found that the pecking order explained net debt issues better than a target-adjustment model. Frank and Goyal (2003) replicated the test on a much broader sample and obtained a different result: net equity issues track the financing deficit poorly, and the pecking order performs better only for large firms, which implies that the earlier result may reflect sample selection. Fama and French (2002) tested both theories against dividend and leverage data. They found that more profitable firms have lower book leverage, as the pecking order predicts, but noted that the pecking order cannot explain why many small, growing firms issue equity heavily, while the trade-off model struggled with the persistence of low-leverage firms.

For the present study the lesson is methodological. Shyam-Sunder and Myers worked with large, continuously listed firms, Frank and Goyal showed that such a sample favours the pecking order, and Fama and French showed that neither theory dominates. The sample of Nigerian listed insurers is likewise small and survivorship-selected (firms need several consecutive years of audited statements), so the same bias may favour a negative profit–leverage pattern. That is a further reason to treat leverage–performance coefficients as conditional associations, and to use estimators that make the feedback explicit.

2.3 Leverage and firm performance

A smaller body of work asks the question this paper asks, namely whether leverage affects performance. Abor (2005) examined firms listed on the Ghana Stock Exchange over a short panel, using ROE and separate short-term, long-term and total debt ratios. He reported positive associations for short-term debt and total debt and a negative association for long-term debt, and attributed the pattern to the dominance of short-term finance in Ghana. The study is valuable because it was among the first to separate maturities in an African context, but its panel is short, its coefficients rest on conventional standard errors, it does not address the possibility that profitable

firms choose their debt mix, and it covers non-financial firms for which the whole liability side is financing. Margaritis and Psillaki (2010) improved on this by measuring performance as technical efficiency for French manufacturing firms, and found that leverage was positively related to efficiency and that the causality ran in both directions, which they interpreted as support for the disciplinary role of leverage and for a role of efficiency in raising debt capacity. Their contribution is to take simultaneity seriously, but efficiency scores from distance functions are not comparable with accounting ROA or ROE, and manufacturing firms face a different regulatory and balance-sheet environment.

2.4 Banks and other regulated financial firms

Banks are the closest regulated analogue. Berger and Udell (2006) tested the agency-cost hypothesis on US banks using profit efficiency as the outcome and reported that higher leverage, or a lower equity ratio, was associated with higher profit efficiency over most of the observed range, with results that were not reversed when they allowed for the possibility that efficiency affects capital structure. This is one of the few studies to couple a performance outcome with an explicit attempt to separate the direction of effect. Gropp and Heider (2010) studied large listed banks in the US and Europe and argued that the standard determinants of leverage from the industrial-firm literature (size, profits, collateral, market-to-book and dividends) work in the same direction for banks, that unobserved bank-specific fixed effects explain a large share of the variation in leverage, and that capital regulation appears to be of second-order importance for most banks. Two lessons follow. Firm fixed effects absorb much of the explainable variation, which supports the use of FE and Mundlak models here; and regulation matters less than might be expected for banks above the minimum, whereas for Nigerian insurers the 2025 reform makes the floor visibly binding for many firms, which may weaken the transferability of the bank evidence.

2.5 Insurers: capital, financial health and performance

Evidence on insurers outside Africa shows how insurer capital differs from industrial capital. Cummins and Nini (2002) studied US property-liability insurers and documented that many held capitals well above regulatory minima, and examined whether the extra capital was used efficiently; the implication is that insurer equity is not simply a regulatory residual, and that cross-sectional differences in capital reflect choices. Chen and Wong (2004) modelled the financial health of Asian insurers as a function of firm characteristics such as size, liquidity and underwriting activity, which is the design precedent for the control set used here. Adams and Buckle (2003) estimated a performance equation for the Bermuda insurance market with leverage among the explanatory variables.

2.6 Insurer evidence from Africa

The African insurer literature has expanded since 2014 but the findings diverge. Shala et al. (2014) † analysed the determinants of the debt ratio of 11 Kosovo insurers over 2009–2012 with a random-effects model, which makes capital structure the outcome and, with four years, offers little scope for dynamics or fixed effects. Morara and Sibindi (2021) † studied the determinants of financial performance of Kenyan insurers and reported that larger, more leveraged insurers with more tangible assets performed better. The result is interesting for Nigeria, but the study is a determinants regression in which leverage is one regressor among many, and the leverage measure is not insurer-specific. Msomi (2022) † studied 113 general insurers in Sub-Saharan Africa over 2008–2019 using

pooled, fixed- and random-effects models and found a negative but negligible leverage–ROA link alongside a positive liquidity effect. Agyapong (2022) † examined 29 general insurers in Ghana over the same years and concluded that leverage, underwriting risk and inflation were significant for profitability and that highly levered insurers were more profitable. Abudu et al. (2023) † analysed 24 Ghanaian insurers over 2014–2018 and reported a significantly negative effect of debt-to-equity on ROA, together with cointegration and threshold analyses. Msomi et al. (2025) † extended the capital-structure question by studying how capital structure and intellectual capital jointly relate to the performance of insurers in the region.

These six studies reach different conclusions about the sign of the leverage effect: negligible and negative (Msomi, 2022), positive (Agyapong, 2022; Morara & Sibindi, 2021) and significantly negative (Abudu et al., 2023). Three explanations are plausible and none requires the studies to be mutually inconsistent. The first is definition: Agyapong's leverage is built from unearned premiums and outstanding claims, which are operating liabilities and a different construct from the debt-to-equity ratio in Abudu et al. The second is the market and period: the Ghanaian studies cover different five-to-twelve-year windows, and the Sub-Saharan sample pools heterogeneous regulatory regimes. The third is estimation: the studies differ in whether they report cluster-robust errors, whether they test for non-linearity and whether they consider reverse causality. The Abudu et al. threshold analysis is the only one among these to examine non-linearity directly, but its sample is only five years long.

2.7 Evidence from Nigeria

Nigerian studies are fewer and more concentrated in regional outlets. Odufisan et al. (2025) † analysed insurers listed on the NGX, with return on capital employed as the outcome and with debt-to-equity, total debt and total equity as explanatory variables, and reported that all three were significant. Two features of the published article limit its interpretation: the table reports a negative equity coefficient while the narrative describes equity as positively related to performance, and the equation appears to combine a ratio with log-transformed levels of debt and equity, which makes the leverage effect hard to interpret. Olushola and Ajike (2025) † studied risk-based capital and the performance of Nigerian insurers (ROE, ROA and EPS) in a small panel of five insurers over 2010–2023 with a random-effects model; the topic is closely related, because the risk-based regime is changing how capital maps into performance, but five firms provide very little information for estimating firm effects or for any inference with clustered errors. Neither study, on the evidence retrieved, separates financing debt from technical liabilities, tests for non-linearity, addresses reverse causality, or reports few-cluster-robust inference.

2.8 Critical synthesis and research gap

Reading the 22 studies together, four patterns stand out. First, the evidence on the sign of the leverage–performance relationship is genuinely mixed, and this is not mainly a matter of sampling noise: it follows from how leverage is defined (financing debt, total liabilities, or insurance operating liabilities), what outcome is used (ROA, ROE, ROCE, or efficiency) and which estimator is applied. Second, the strongest foundational result, the negative profit–leverage correlation (Rajan & Zingales, 1995; Fama & French, 2002; Frank & Goyal, 2009), is exactly what a negative leverage coefficient in a performance regression would also reproduce if profits drive financing, so the insurer studies that report negative coefficients do not discriminate between causal and feedback

interpretations. Third, studies with small panels (Shala et al., 2014; Olushola & Ajike, 2025; Abudu et al., 2023) rely on asymptotic inference that is unreliable with so few clusters. Fourth, only Margaritis and Psillaki (2010) and Berger and Bonaccorsi di Patti (2006) address direction of causality, and neither concern insurers.

These patterns define the gaps that the present study addresses: (G1) a leverage measure that separates financing debt from technical liabilities; (G2) Nigerian listed-insurer evidence covering IFRS 17 and the 2025 reform; (G3) inference suited to a small panel; and (G4) explicit treatment of feedback and non-linearity. The study also adds a design feature that none of the 22 studies reports, namely a Monte Carlo check of how each estimator behaves in a panel of this size (Section 6.11).

Table 2. Overview of the empirical studies reviewed

Study	Setting and design	Reported finding	Limitation for present purpose
Titman & Wessels (1988)	US firms; determinants of leverage	Tests the effect of firm attributes on debt choice; limited support for several theoretical predictors	Non-financial; leverage as outcome, not performance driver
Rajan & Zingales (1995)	G-7 firms; cross-country	Leverage broadly similar across countries; size and tangibility positive, profitability and growth opportunities negative	Excludes financials; developed markets
Booth et al. (2001)	Ten developing countries	Determinants resemble those in developed markets, with country-specific differences	Non-financial; leverage determinants
Shyam-Sunder & Myers (1999)	157 US firms, 1971–1989	Pecking order fits better than static trade-off	Large listed US firms; no performance outcome
Fama & French (2002)	US firms; dividends and debt	Both theories receive partial support; more profitable firms hold less debt	Dividend-focused; non-financial
Frank & Goyal (2003)	US firms; pecking order test	Financing deficit explains net debt issues poorly	Does not address insurers
Frank & Goyal (2009)	US firms; determinants	Industry median leverage, tangibility, profits, size, market-to-book and inflation reliably important	Leverage as outcome

Abor (2005)	Listed firms, Ghana	Short-term and total debt positively and long-term debt negatively related to ROE	Non-insurance; short panel
Margaritis & Psillaki (2010)	French manufacturing firms	Leverage positively related to efficiency; two-way causality	Efficiency, not accounting return; non-financial
Berger & Bonaccorsi di Patti (2006)	US banks	Higher leverage linked to higher profit efficiency (agency-cost view)	Bank regulation differs from insurance
Gropp & Heider (2010)	Large banks, US and Europe	Standard cross-sectional leverage determinants also matter for banks, alongside regulation	Leverage as outcome; banks
Cummins & Nini (2002)	US property-liability insurers	Insurers hold capital above regulatory requirements	Capital utilisation, not profitability
Chen & Wong (2004)	Asian insurers	Firm characteristics such as size and liquidity relate to insurer financial health	Financial-health score, not ROA/ROE
Adams & Buckle (2003)	Bermuda insurers	Firm-level determinants of insurer performance, with leverage among them	Offshore market; unlike listed Nigerian insurers
Shala et al. (2014) †	11 Kosovo insurers, 2009–2012	Determinants of the debt ratio estimated with random effects	Capital structure as outcome; 4 years
Morara & Sibindi (2021) †	Kenyan insurers	Larger, more leveraged insurers with more tangible assets report superior performance	Determinants study; leverage definition not insurer-specific
Msomi (2022) †	113 general insurers, Sub-Saharan Africa, 2008–2019	Negative but negligible leverage–ROA link; liquidity positive	Cross-country pooling; general insurers only
Agyapong (2022) †	29 Ghanaian general insurers, 2008–2019	Leverage significant; highly levered insurers more profitable	Leverage built from operating liabilities

Abudu et al. (2023) †	24 Ghanaian insurers, 2014–2018	Debt-to-equity significantly negative for ROA; cointegration and threshold tests reported	Five-year panel; single-regressor model
Msomi et al. (2025) †	Sub-Saharan African insurers	Examines capital structure, intellectual capital and performance jointly	Regional pooling; not Nigeria-specific
Odufisan et al. (2025) †	Insurers listed on the NGX	Debt-to-equity, total debt and equity significant for return on capital employed	Ratio and levels mixed; one outcome; table–text sign inconsistency
Olushola & Ajike (2025) †	Five Nigerian insurers, 2010–2023	Risk-based capital and ROE, ROA and EPS; random effects	Five firms; abstract-level verification

Note. Findings are paraphrased from the cited publications and available publication records; the depth of methodological appraisal is limited where full text was not available.

3. Theoretical Framework

The framework draws on trade-off theory and pecking order theory. Together, they explain the potential benefits and costs of borrowing and the possibility that profitability influences financing choices.

3.1 Trade-off theory

Firms balance tax and discipline benefits of debt against expected distress costs (Kraus & Litzenberger, 1973). For insurers, distress costs are amplified by policyholder confidence and regulatory intervention, so optimal debt is low and the relationship is expected to be non-linear. This motivates the quadratic and threshold tests (H5). Minimum-capital floors also bind equity from below.

3.2 Pecking order theory

Under information asymmetry firms prefer internal funds, then debt, then equity (Myers, 1984; Myers & Majluf, 1984). Profitable insurers accumulate retained earnings and need less external debt, producing a negative association and feedback from lagged performance to leverage. This feedback is why the study includes dynamic instrumental-variable estimators. The 2025 recapitalisation, which forces equity issuance, is a case where regulation overrides the equity-last ordering.

3.3 Theoretical synthesis and predictions

Trade-off theory motivates tests for a potentially non-linear relationship between leverage and performance, while pecking order theory predicts a negative association when profitable insurers rely more heavily on retained earnings. The theories also imply possible feedback from

performance to leverage. Accordingly, the hypotheses are tested without presuming a single direction of association.

Table 3. Theoretical predictions for the leverage–performance relationship

Variable	Trade-off	Pecking order	Working expectation
TDR / DER	Positive at low, negative at high leverage	Negative	Negative linear; inverted-U or threshold as alternative (H5)
LTDR	Positive if matching long-duration assets; negative near distress	Negative	Open; two-sided
STDR	Negative (refinancing and liquidity risk)	Negative	Negative; two-sided
Dynamics	Gradual adjustment to target	Leverage responds to lagged profits	Lagged ROA affects leverage; tested via IV

Note. These are theoretical expectations to be tested, not empirical findings. Evidence from Ghana (Abor, 2005) motivates a two-sided test for short-term debt.

3.4 A stylised model of insurer leverage and performance

To make the predictions precise, consider an insurer with assets normalised to one. Technical liabilities l is determined by underwriting scale and are not a financing choice; financing debt is $d \geq 0$; equity is $e = 1 - l - d$ and must satisfy a regulatory floor $e \geq k$. Before financing costs, the assets earn r . Debt-funded investment earns $\rho(d) = \rho_0 - \rho_1 d$ per unit of debt (diminishing returns), debt costs $i(d) = i_0 + i_1 d$ (a rising spread), $\tau \in [0,1]$ is the tax shield, and expected distress cost is $\kappa h(d)$ with h convex and $h'(0) = 0$. Return on assets is

$$\Pi(d) = r + [\rho(d) - (1 - \tau) i(d)] d - \kappa h(d) \quad (5)$$

Proposition 1 (sign and shape). $\Pi'(0) = \rho_0 - (1 - \tau)i_0$. If this spread is positive, Π is strictly concave with an interior maximum d defined by $\Pi'(d) = 0$: performance rises with leverage at low levels and falls at high levels. If the spread is non-positive, Π is decreasing throughout and the relationship is monotonically negative. The sign of the initial spread is therefore the crux: where borrowing is costly relative to the return on additional investment, as may be the case in high-interest-rate environments, trade-off-type curvature should be absent. This yields H1–H5.

Proposition 2 (feedback bias). Suppose performance is persistent, $\pi_t = \rho\pi_{t-1} + \beta d_t + \varepsilon_t$ with $\rho > 0$, and leverage responds to retained profits, $d_t = \bar{d} - \phi\pi_{t-1} + v_t$ with $\phi > 0$ (pecking order). A static regression of π_t on d_t omits π_{t-1} , so its probability limit is $\beta + \rho\delta$, where $\delta = \text{Cov}(d_t, \pi_{t-1})/\text{Var}(d_t) < 0$. The estimator is biased toward more negative values, and the bias grows with persistence and feedback. Controlling for lagged performance removes the omitted-variable bias but introduces the Nickell bias, and instruments are then required; this is the rationale for the dynamic estimators in Section 6.7 and for the Monte Carlo evidence in Section 6.11.

Proposition 3 (measurement). If ROA depends on financing debt with coefficient β and on technical liabilities with coefficient γ , a regression on $TDR = 1 + d$ estimates a variance-weighted average of β and γ . When financing debt is rare and has small variance relative to 1, the TDR coefficient mainly reflects γ , the association between underwriting scale and profit, rather than β . Moreover, since $ROE = ROA/(1 - TDR)$, ROE rises convexly in TDR even when ROA is unaffected. Hence TDR and DER can behave differently from FDR, and ROE can have the opposite sign from ROA.

Proposition 4 (regulatory floor and identification). The floor implies $d \leq 1 - 1 - k$. Raising k to $k' > k$ truncates the feasible leverage range, so any interior optimum d^* above $1 - 1 - k'$ becomes unobservable and the variance of leverage falls. The 2025 recapitalisation therefore reduces power to detect curvature or thresholds in the post-reform period and affects comparability across IFRS 17 and pre-IFRS 17 years.

Table 4. Propositions and their empirical counterparts

Proposition	Testable implication	Where tested
P1: spread sign and curvature	Negative linear if spread ≤ 0 ; hump if > 0	H1–H5; Models 1–8; threshold (Section 6.6)
P2: feedback bias	Static estimates more negative than dynamic; lagged ROA lowers next-period leverage	Feedback test and IV estimators (Section 6.7); Monte Carlo (Section 6.11)
P3: measurement	FDR effects differ from TDR effects; ROE opposite sign to ROA	Robustness (Section 6.10); Tables of ROA and ROE
P4: regulatory floor	Reduced leverage variance and power after reform; moderation by period	H7; moderation (Section 6.9)

Note. The model is stylised; the propositions follow from the stated assumptions and are not themselves empirical findings.

4. Conceptual Framework and Hypothesis Development

Figure 1 shows capital structure as the explanatory construct and financial performance as the outcome, conditional on firm controls and firm and year effects, with feedback from performance to financing acknowledged as a threat to causal interpretation.

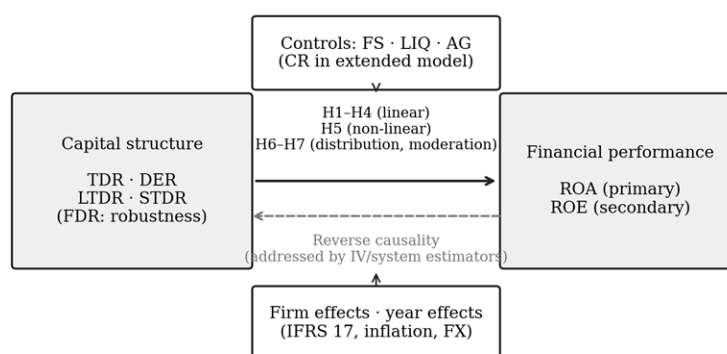


Figure 1. Conceptual framework. Solid arrow = hypothesised effect; dashed arrow = reverse causality addressed by instrumental-variable estimators.

ROA is primary because it is least distorted by the equity base, which recapitalisation is changing quickly; ROE is secondary and estimated only for firm-years with positive equity. TDR and DER follow conventional definitions using total liabilities as “total debt” for comparability with the Nigerian literature; because insurance-contract liabilities are not financing debt, a financing-debt ratio (FDR: borrowings, bonds, debentures and lease liabilities over total assets) is a core robustness measure. LTDR and STDR are retained only if borrowings are disclosed by maturity. Firm size (FS), liquidity (LIQ) and asset growth (AG); the claims ratio (CR) is added in an extended model because it is mechanically related to profit. Firm age is excluded from fixed-effects models because with firm and year effects it is perfectly collinear.

Hypotheses H1–H4 test linear effects of each leverage measure; H5 non-linearity; H6 heterogeneity across the performance distribution, to assess whether the relationship differs across performance levels; and H7 moderation by the IFRS 17 period (2023–2025) and by firm size, motivated by accounting-basis changes and by larger insurers’ better access to financing.

5. Data and Methodology

5.1 Research design and analytical sample

The study adopts a quantitative, explanatory ex-post-facto panel design using an unbalanced firm-year panel for 2015–2025. The reported models apply the stated inclusion criteria consistently across the analytical sample.

The inclusion criteria are: (i) primary business in life, non-life or composite underwriting; (ii) at least five consecutive years within the 2015–2025 study period; and (iii) availability of annual financial statements for the relevant years. The exclusion criteria are: (i) fewer than five usable years; (ii) holding companies whose consolidated accounts are dominated by non-insurance activities; and (iii) firm-years with non-positive equity, excluded from ROE and DER estimation only. The panel is unbalanced, with a maximum of 11 annual observations per firm.

5.2 Study period and data treatment

The study period is 2015–2025, spanning the periods before and after IFRS 17 became effective on 1 January 2023 (IASB, 2017) and the period preceding the recapitalisation compliance deadline. The analysis applies the stated variable definitions and treatment rules consistently across the panel. Continuous variables are winsorised at the 1st and 99th percentiles; estimates using unwinsorised variables provide a robustness check.

5.3 Variable definitions

Table 6. Variable measurement and expected relationships

Variable	Symbol	Measurement	Role	Expected sign
Return on assets	ROA	Profit after tax / total assets	Dependent (primary)	
Return on equity	ROE	Profit after tax / equity (positive equity only)	Dependent (secondary)	
Total debt ratio	TDR	Total liabilities / total assets	Independent	– / non-linear
Debt-to-equity ratio	DER	Total liabilities / equity	Independent	–

Long-term debt ratio	LTDR	Borrowings > 1 year / total assets	Independent	Open
Short-term debt ratio	STDR	Borrowings ≤ 1 year / total assets	Independent	– (open)
Financing-debt ratio	FDR	(Borrowings + bonds + debentures + leases) / total assets	Robustness	–
Firm size	FS	ln(total assets, ₦ million)	Control	+ (open)
Liquidity	LIQ	(Cash + short-term deposits) / total assets	Control	+
Asset growth	AG	(TA _t – TA _{t–1}) / TA _{t–1}	Control	+ (open)
Claims ratio	CR	Claims incurred / net premium earned (extended model)	Control	–

Note. TA = total assets. Firm age is excluded from fixed-effects models (collinear with firm and year effects). TDR and DER are never entered together, nor TDR with LTDR and STDR, because they are mechanically related.

5.4 Models

For firm i in year t , with firm effects μ_i , year effects λ_t and error ε_{it} , the baseline models are:

$$Y_{it} = \beta_0 + \beta_1 TDR_{it} + \beta_2 FS_{it} + \beta_3 LIQ_{it} + \beta_4 AG_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

with $Y \in \{ROA, ROE\}$. Model (2) replaces TDR with DER and Model (3) with LTDR and STDR (jointly), giving Models 1–6 across the two outcomes. Non-linearity is tested by adding TDR^2 (Models 7–8) and by Hansen’s (1999) single-threshold model:

$$Y_{it} = \mu_i + \lambda_t + \theta_1 TDR_{it} \cdot 1(TDR_{it} \leq \gamma) + \theta_2 TDR_{it} \cdot 1(TDR_{it} > \gamma) + \delta' Z_{it} + \varepsilon_{it} \quad (2)$$

Dynamic and endogeneity-robust specifications use the first-difference and level equations:

$$\Delta ROA_{it} = \rho \Delta ROA_{i,t-1} + \beta \Delta TDR_{it} + \delta' \Delta Z_{it} + \Delta \lambda_t + \Delta \varepsilon_{it} \quad (3)$$

estimated by Anderson–Hsiao IV (Anderson & Hsiao, 1981; instruments $ROA_{i,t-2}$, $TDR_{i,t-2}$), difference-IV with collapsed lags 2–3 in the spirit of Arellano and Bond (1991), and a system-IV estimator that stacks (3) with the level equation instrumented by lagged differences. Distributional heterogeneity is estimated with the method-of-moments quantile regression of Machado and Santos Silva (2019):

$$Q_Y(\tau | X_{it}) = (\alpha_i + \delta_i q(\tau)) + X_{it}'(\beta + \gamma q(\tau)) \quad (4)$$

where α_i and δ_i are firm location and scale effects and $q(\tau)$ is the τ -th quantile of the standardised residual. Moderation is tested by adding $TDR \times POST$ ($POST = 1$ for 2023–2025) and $TDR \times FS$ (FS centred).

5.5 Estimator strategy, diagnostics and inference

Table 7. Estimators, purpose and key assumptions

Estimator	Purpose	Key assumption / caveat
Pooled OLS, FE, RE, Mundlak	Baseline comparison; separate within and between variation	FE removes time-invariant heterogeneity only; RE needs orthogonality
F, Breusch–Pagan LM (Breusch & Pagan, 1980), Hausman (Hausman, 1978), Mundlak (Mundlak, 1978) tests	Select among estimators	Hausman invalid under clustering; Mundlak is cluster-robust
Wild cluster bootstrap (Cameron et al., 2008; 4,999 draws)	Few-cluster p-values (16 firms)	Null imposed; Rademacher weights
Two-way clustering (firm, year)	Common shocks and firm dependence	Only 11-year clusters; approximate
Randomization inference	Exact-style test of within-firm leverage effect	Permutes TDR within firm; tests sharp null
Hansen (1999) threshold regression	Non-linearity with endogenous regimes	Bootstrap F test (399 draws); 15% trimming
MMQR (Machado & Santos Silva, 2019)	Effects across performance quantiles	Location–scale structure; bootstrap CI (300 firm resamples)
Anderson–Hsiao, difference-IV, system-IV	Reverse causality and dynamics	Instrument strength and exogeneity; levels instruments need stationarity
Holm (1979) adjustment	Multiplicity across eight leverage tests	Controls family-wise error

Diagnostics are variance inflation factors and correlations (multicollinearity); the modified Wald test (Greene, 2018) for heteroskedasticity; the Wooldridge test, implemented as in Drukker (2003), for serial correlation; the Pesaran (2015) CD test (cross-sectional dependence); and Fisher-type panel unit-root tests used descriptively because $T \leq 11$. Driscoll–Kraay errors are not used as primary because they require large T ; system GMM with full instrument sets is not used because it is unreliable with 16 firms (Roodman, 2009), so instrument sets are collapsed and the number of excluded instruments is kept below the number of firms. Lagged dependent variables are not added to FE models without correction because of Nickell (1981) bias; the dynamic LSDV estimate is reported only as a biased benchmark. The study does not claim to have solved endogeneity: estimates are conditional associations, and the IV results are interpreted in light of their first-stage strength.

6. Results

The empirical estimates and the Monte Carlo exercise address different questions. The panel estimates describe the relationships observed in the insurer sample, whereas the Monte Carlo exercise evaluates estimator behaviour under specified parameter values.

6.1 Sample and descriptive statistics

The analysis panel contains 17 firm labels and 164 firm-year records over 2015–2025. The inclusion rule of at least five years removes 1 firm (3 firm-years), leaving 16 firms and 161 firm-years (Table 8). Asset growth requires a prior-year observation, so the estimation sample is 145 firm-years (161 less one first-year observation for each firm). No firm-year has negative equity, so the ROE sample equals the ROA sample.

Table 8. Sample construction

Step	Firms	Firm-years
Panel firm labels, 2015–2025	17	164
Less: fewer than five years (inclusion criterion)	1	3
Analysis sample	16	161
Less: first firm-year lacks lagged assets for AG	0	16
Estimation sample (Models 1–8)	16	145
Of which usable for ROE (positive equity)	16	145

Table 9. Descriptive statistics (winsorised at the 1st and 99th percentiles)

Variable	N	Mean	SD	Min	P25	Median	P75	Max
ROA	161	0.0476	0.02	0.0011	0.035	0.0497	0.0596	0.0886
ROE	161	0.0893	0.04	0.0027	0.0671	0.0879	0.1078	0.2076
TDR	161	0.463	0.101	0.25	0.395	0.4438	0.5366	0.6607
DER	161	0.936	0.402	0.3333	0.653	0.798	1.1581	1.9474
LTDR	161	0.004	0.008	0	0	0	0.0053	0.0358
STDR	161	0.0064	0.011	0	0	0	0.0083	0.0482
FDR	161	0.0105	0.018	0	0	0	0.0146	0.0699
FS	161	11.723	1.061	9.1859	11.037	11.764	12.445	13.838
LIQ	161	0.1504	0.06	0.03	0.107	0.1522	0.197	0.2685
AG	145	0.1955	0.11	−0.0316	0.1291	0.1823	0.2691	0.4632
CR	161	0.5506	0.081	0.426	0.4848	0.5473	0.5981	0.7288

Note. FS = ln of total assets in ₺ million. N for AG is lower because each firm's first year has no lagged assets.

Mean ROA is 4.76% (SD 2.01 pp) and mean ROE 8.93%. Total liabilities average 0.463 of assets, with mean DER of 0.94, which reflects a balance sheet dominated by technical liabilities. Financing debt is rare: 62.7% of firm-years report no borrowings and only 8 of 16 firms ever do, so maturity ratios are identified from few firms. Figure 2 shows the cross-sectional distribution of ROA and TDR by year, with the 2022/2023 IFRS 17 transition marked.

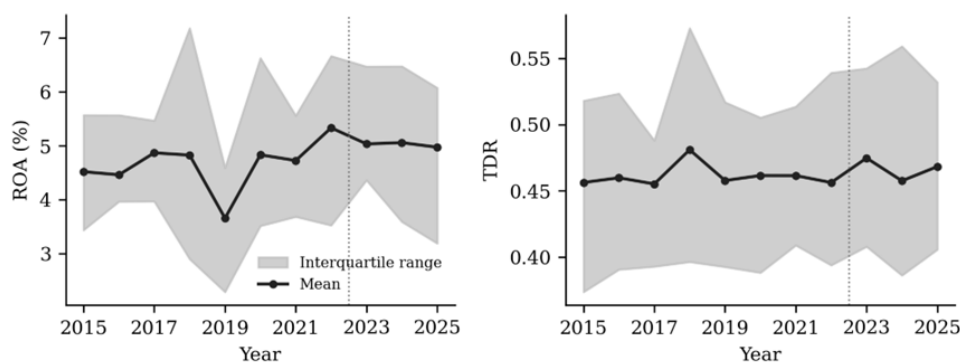


Figure 2. Mean and interquartile range of ROA and TDR by year. Dotted line marks the IFRS 17 transition.

6.2 Correlation and multicollinearity

Table 10. Pairwise correlations

	ROA	ROE	TDR	DER	LTDR	STDR	FS	LIQ	AG
ROA	1								
ROE	0.88***	1							
TDR	-0.38***	0.07	1						
DER	-0.37***	0.06	0.98***	1					
LTDR	-0.09	-0.08	-0.03	-0.06	1				
STDR	-0.10	-0.11	-0.07	-0.10	0.80***	1			
FS	0.37***	0.41***	-0.05	-0.08	0.30***	0.28***	1		
LIQ	-0.13*	-0.05	0.28***	0.31***	-0.11	-0.17**	0.03	1	
AG	0.05	0.03	0.00	0.03	-0.05	-0.06	0.03	0.06	1

Note. Lower triangle. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Figure 3 visualises the matrix.

TDR and DER correlate at 0.98, as expected for monotonic transformations of one ratio, which confirms they must not enter one equation. LTDR and STDR correlate at 0.80, just under the 0.80 threshold set in advance, so they are retained jointly and checked with VIFs (Table 11); all VIFs in Models 1–3 is below 5.

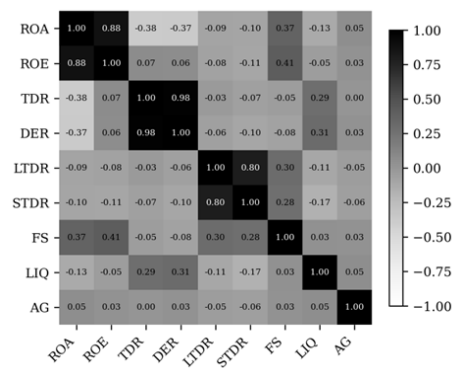


Figure 3. Correlation heatmap.

Table 11. Variance inflation factors

Variable	Model 1 (TDR)	Model 2 (DER)	Model 3 (LTDR, STDR)
TDR	1.09	—	—
DER	—	1.1	—
LTDR	—	—	2.71
STDR	—	—	2.76
FS	1	1.01	1.11
LIQ	1.09	1.1	1.04
AG	1	1	1.01
Maximum	1.09	1.1	2.76

Note. VIFs computed without year dummies.

6.3 Panel specification tests

Table 12. Panel specification tests: statistic (p-value)

Test	M1 ROA TDR	M2 ROA DER	M3 ROA LTDR/STDR	M4 ROE TDR	M5 ROE DER	M6 ROE LTDR/STDR
F: no firm effects	4.59 (<0.001)	4.64 (<0.001)	5.85 (<0.001)	5.93 (<0.001)	6.18 (<0.001)	5.05 (<0.001)
Breusch–Pagan LM	43.22 (<0.001)	40.75 (<0.001)	61.43 (<0.001)	64.08 (<0.001)	65.79 (<0.001)	47.58 (<0.001)
Hausman	2.67 (0.614)	4.35 (0.360)	8.70 (0.122)	3.20 (0.524)	4.12 (0.390)	7.21 (0.206)
Mundlak (cluster-robust)	2.99 (0.559)	4.76 (0.313)	21.64 (<0.001)	3.11 (0.539)	5.81 (0.214)	20.83 (<0.001)
Preferred estimator	RE	RE	FE	RE	RE	FE

Note. Decision rule fixed in advance: FE if F rejects and Hausman or Mundlak rejects; otherwise RE if LM rejects; otherwise, pooled OLS.

Firm effects are strongly supported (F and LM $p < 0.001$), so pooled OLS is rejected. For Models 1, 2, 4 and 5 neither Hausman ($p = 0.614, 0.360, 0.524, 0.390$) nor Mundlak rejects, so RE is preferred; for the maturity models the Mundlak test rejects ($p = <0.001, <0.001$), so FE is preferred. Because the Hausman test has low power with 16 firms and the tests disagree for Models 3 and 6, every leverage coefficient is also reported under all three estimators (Table 15).

6.4 Baseline regression results

Table 13. Effects of capital structure on ROA

Variable	Coefficient	Std. error	t	p-value	Wild-boot. p
Model 1: TDR — RE					
TDR	−0.0620**	0.0244	−2.54	0.022	0.046
FS	0.0087***	0.0029	3.03	0.008	—
LIQ	−0.0010	0.0318	−0.03	0.975	—
AG	0.0045	0.0102	0.44	0.664	—
Constant	−0.0267	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.126				
Wald F(4, 15) [p]	4.76 [0.011]				
Model 2: DER — RE					
DER	−0.0132*	0.0067	−1.99	0.065	0.08
FS	0.0086***	0.0029	2.97	0.01	—
LIQ	−0.0027	0.0323	−0.08	0.935	—
AG	0.0052	0.0104	0.5	0.625	—
Constant	−0.0420	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.112				
Wald F(4, 15) [p]	4.99 [0.009]				
Model 3: LTDR and STDR — FE					
LTDR	−0.3617	0.3179	−1.14	0.273	0.373
STDR	−0.0424	0.236	−0.18	0.86	0.855

FS	0.0233	0.0163	1.43	0.172	—
LIQ	0.0233	0.0384	0.61	0.554	—
AG	−0.0031	0.0162	−0.19	0.849	—
Constant	−0.2187	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.16				
Wald F(5, 15) [p]	2.95 [0.048]				

Note. Dependent variable: ROA; estimator preferred in Table 12. Standard errors clustered by firm (16 clusters), p-values from t with 15 d.f. Wild-boot. p: wild cluster bootstrap, 4,999 Rademacher draws, null imposed. Year dummies included but not shown. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (cluster-robust).

Table 14. Effects of capital structure on ROE

Variable	Coefficient	Std. error	t	p-value	Wild-boot. p
Model 4: TDR — RE					
TDR	0.0675	0.056	1.21	0.246	0.342
FS	0.0211***	0.0068	3.11	0.007	—
LIQ	−0.0349	0.0682	−0.51	0.616	—
AG	0.0008	0.0188	0.04	0.965	—
Constant	−0.1833	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.143				
Wald F(4, 15) [p]	3.18 [0.044]				
Model 5: DER — RE					
DER	0.0211	0.0141	1.49	0.156	0.256
FS	0.0216***	0.007	3.08	0.008	—
LIQ	−0.0367	0.0671	−0.55	0.592	—
AG	−0.0009	0.0191	−0.05	0.962	—
Constant	−0.1769	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.157				
Wald F(4, 15) [p]	3.41 [0.036]				
Model 6: LTDR and STDR — FE					
LTDR	−0.7550	0.5578	−1.35	0.196	0.326
STDR	−0.1637	0.4622	−0.35	0.728	0.719
FS	0.0398	0.03	1.33	0.204	—
LIQ	−0.0178	0.0934	−0.19	0.851	—
AG	−0.0016	0.0293	−0.05	0.958	—
Constant	−0.3562	—	—	—	—
N / firms	145 / 16				
R ² (within)	0.171				
Wald F(5, 15) [p]	2.42 [0.085]				

Note. Dependent variable: ROE. Notation as in Table 13.

ROA. Under the preferred random-effects estimator, TDR has a negative association with ROA ($\beta = -0.0620$, cluster $p = 0.022$, wild-bootstrap $p = 0.046$); a one-standard-deviation higher TDR (0.101) is associated with ROA about 0.63 pp lower, against a mean of 4.76%. The DER coefficient is negative but not significant at 5% ($\beta = -0.0132$, $p = 0.065$, bootstrap $p = 0.080$). Neither LTDR ($p = 0.273$) nor STDR ($p = 0.860$) is significant; borrowing is rare and the two ratios are highly correlated.

ROE. No leverage coefficient is significant at 5%: TDR ($\beta = 0.0675$, $p = 0.246$), DER ($p = 0.156$), LTDR ($p = 0.196$) and STDR ($p = 0.728$). The positive TDR and DER signs on ROE, against a

negative sign on ROA, are consistent with the identity $ROE = ROA \times (\text{assets/equity})$: higher liabilities raise the equity multiplier even if they lower ROA. Within- R^2 values are modest (0.11–0.17).

Table 15. Leverage coefficients under pooled OLS, fixed effects and random effects

Outcome: leverage	Pooled OLS β (p)	Fixed effects β (p)	Random effects β (p)	Preferred
ROA: TDR	−0.0704 (0.018)	−0.0356 (0.372)	−0.0620 (0.022)	RE
ROA: DER	−0.0172 (0.029)	−0.0040 (0.684)	−0.0132 (0.065)	RE
ROA: LTDR	−0.3970 (0.196)	−0.3617 (0.273)	−0.4058 (0.179)	FE
ROA: STDR	−0.2510 (0.384)	−0.0424 (0.860)	−0.0766 (0.747)	FE
ROE: TDR	0.0425 (0.505)	0.1271 (0.126)	0.0675 (0.246)	RE
ROE: DER	0.0115 (0.495)	0.0381 (0.038)	0.0211 (0.156)	RE
ROE: LTDR	−0.4462 (0.440)	−0.7550 (0.196)	−0.7249 (0.182)	FE
ROE: STDR	−0.8133 (0.152)	−0.1637 (0.728)	−0.3331 (0.471)	FE

Note. Cluster-robust p-values; all models include FS, LIQ, AG and year dummies.

The estimator matters. The TDR coefficient on ROA is −0.0356 under fixed effects ($p = 0.372$) but −0.0620 under random effects ($p = 0.022$). Figure 4 shows why: the cross-firm relationship (panel a) is steeper than the within-firm relationship (panel b), so the preferred specification's significance relies on between-firm variation in leverage, and within-firm evidence alone is weak.

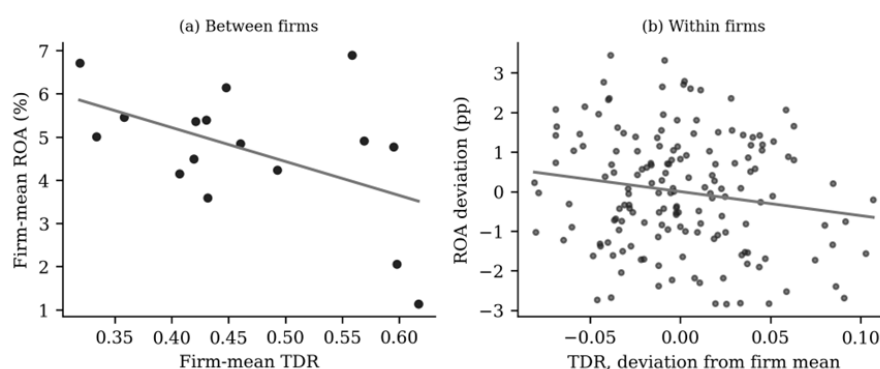


Figure 4. Between-firm and within-firm relationships between TDR and ROA. Panel (a) firm means; panel (b) deviations from firm means.

6.5 Diagnostic tests

Table 16. Residual diagnostics

Model	Modified Wald (p)	Wooldridge F (p); $\hat{\rho}$	Pesaran CD (p)
Model 1	0.007	4.80 (0.045); −0.28	−2.18 (0.029)
Model 2	<0.001	5.62 (0.032); −0.27	−2.17 (0.030)
Model 3	<0.001	3.32 (0.088); −0.32	−2.20 (0.028)
Model 4	<0.001	1.87 (0.192); −0.33	−2.10 (0.036)
Model 5	<0.001	2.94 (0.107); −0.30	−2.10 (0.036)
Model 6	<0.001	0.52 (0.481); −0.41	−2.19 (0.029)
Model 7	<0.001	5.20 (0.038); −0.28	−2.17 (0.030)
Model 8	<0.001	2.77 (0.117); −0.30	−2.15 (0.031)

Note. Modified Wald: H_0 homoskedastic. Wooldridge: H_0 no first-order serial correlation ($H_0: \rho = -0.5$). Pesaran CD: H_0 cross-sectional independence (FE residuals with year effects).

Table 17. Fisher-type panel unit-root tests, ADF without augmentation

Variable	Firms used	Fisher χ^2	p-value	Reading
ROA	15	49.6	0.014	Unit root rejected
TDR	15	80.74	<0.001	Unit root rejected
LIQ	15	106.28	<0.001	Unit root rejected
FS	15	3.91	1	Unit root not rejected

Note. At most 11 observations per firm: low power, descriptive only.

The modified Wald test rejects homoskedasticity (Model 1: p 0.007); the Wooldridge test rejects no serial correlation in Models 1, 2 and 7 at 5% but not in Models 3–6 and 8; and the Pesaran test rejects cross-sectional independence in every model (p from 0.028 to 0.036), consistent with common shocks. These violations justify clustered, bootstrap and two-way inference and year effects. FS is the only variable for which a unit root is not rejected, as expected for log nominal assets, which is a caveat for the size coefficient.

6.6 non-linearity: quadratic and threshold evidence

Table 18. Non-linear specifications

Specification	ROA	ROE
Quadratic: β_1 (TDR), p	−0.1632 (0.121)	−0.2566 (0.245)
Quadratic: β_2 (TDR ²), p	0.1082 (0.362)	0.3473 (0.191)
Implied turning point (TDR)	0.75	0.37
Threshold estimate $\hat{\gamma}$ (TDR)	0.48	0.48
95% LR confidence set for γ	[0.367, 0.588]	[0.367, 0.588]
Regime coefficient, $TDR \leq \hat{\gamma}$ (SE)	0.013 (0.037)	0.218 (0.076)
Regime coefficient, $TDR > \hat{\gamma}$ (SE)	−0.019 (0.035)	0.159 (0.071)
Observations in lower / upper regime	87 / 58	87 / 58
Threshold test F; bootstrap p (399 draws)	5.58; 0.565	5.05; 0.623

Note. Fixed-effects threshold model with FS, LIQ, AG and year dummies; 15% trimming; firm-clustered wild bootstrap under the null of no threshold.

There is no evidence of non-linearity. The squared TDR term is statistically insignificant (ROA: $p = 0.362$; ROE: $p = 0.191$), and the implied ROA turning point (0.75) lies outside the sample maximum of 0.66. The Hansen test locates a candidate threshold near $TDR = 0.48$, but the bootstrap test does not reject linearity (ROA $p = 0.565$; ROE $p = 0.623$). For ROA the regime slopes are individually insignificant; for ROE both regime slopes are positive and exceed their standard errors, matching the linear positive sign, but the test does not show that they differ between regimes. H_5 is therefore not rejected. The 95% likelihood-ratio confidence set for γ covers the whole trimmed search range (Figure 5(b)), which indicates that the threshold is not identified.

6.7 Endogeneity and dynamic panel evidence

Table 19. Dynamic and instrumental-variable estimates of the TDR effect on ROA

Estimator	$\hat{\rho}$ (lagged ROA)	TDR coefficient (SE)	First-stage F (TDR)	Sargan p (d.f.)	AR(1), AR(2) p	N
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Dynamic LSDV (biased benchmark)	0.283 (0.090)	−0.016 (0.032)	—	—	—	145
Anderson–Hsiao IV	1.11 (6.21)	1.08 (9.84)	—	—	—	113
Difference-IV, collapsed lags 2–3	−0.38 (3.99)	−1.09 (5.87)	0.17	0.948 (2)	0.003, 0.908	113
System-IV (difference + levels)	0.237 (0.337)	−0.301 (0.194)	0.49	0.893 (4)	—	113

Note. Firm-clustered SEs. Excluded instruments: 4 (difference-IV) and 6 (system-IV), fewer than the 16 firms. First-stage F is the joint F on excluded instruments; values below 10 indicate weak instruments. Sargan statistics are homoskedastic and are reported for orientation only.

Instruments are weak. The first-stage F for TDR is 0.17 in the difference-IV model and 0.49 in the system-IV model, far below conventional thresholds, so the Anderson–Hsiao and difference-IV estimates (1.08 and −1.09) have standard errors of 9.8 and 5.9 and are uninformative. The system-IV estimate is more precise ($\beta = -0.301$, SE 0.194, $p = 0.142$) and negative, but its first stage remains weak, so it cannot be taken as evidence of a causal effect. The Arellano–Bond-type tests behave as expected for a valid difference specification (AR(1) $p = 0.003$, AR(2) $p = 0.908$), and Sargan tests do not reject overidentifying restrictions, but with weak instruments such tests have little power. The biased dynamic LSDV benchmark gives persistence of 0.28 and a TDR coefficient of −0.016 ($p = 0.636$). The conclusion is that, with 16 firms and at most 11 years, the data cannot separate the effect of leverage on performance from the feedback of performance on leverage, so the endogeneity element of H7 cannot be resolved and the results remain associations.

Table 20. Lead and feedback tests (fixed effects, analysis data)

Test	Coefficient (SE)	p-value	N
ROA on TDR and next-year TDR: current TDR	−0.015 (0.041)	0.716	129
ROA on TDR and next-year TDR: lead TDR	−0.057 (0.041)	0.187	129
Feedback: TDR on lagged ROA	−0.530 (0.240)	0.043	145

Note. Firm and year effects; FS, LIQ and AG included; firm-clustered SEs. The feedback regression has TDR as the dependent variable.

Two further tests probe the direction of the relationship. A significant lead of TDR in the ROA equation would indicate anticipation or reverse causality; the lead coefficient is −0.057 ($p = 0.187$), so the test is inconclusive rather than clean, because its interval is wide. The feedback test, which is the specific implication of the pecking order in Proposition 2, is informative: lagged ROA has a negative and statistically significant coefficient on current TDR ($\beta = -0.53$, $p = 0.043$), so more profitable insurers in the analysis panel reduce leverage in the following year. This is the mechanism that biases static estimates toward more negative values (Proposition 2) and is quantified in Section 6.11.

6.8 Heterogeneity across the performance distribution

Table 21. MMQR estimates of the TDR coefficient across quantiles

Quantile τ	0.1	0.3	0.5	0.7	0.9
ROA: $\beta(\tau)$	−0.0250	−0.0313	−0.0350	−0.0407	−0.0458
ROA: 95% bootstrap CI	[−0.109, 0.053]	[−0.113, 0.047]	[−0.116, 0.037]	[−0.127, 0.030]	[−0.147, 0.031]
ROE: $\beta(\tau)$	0.1034	0.1167	0.1268	0.137	0.1498

ROE: 95% bootstrap CI	[-0.045, 0.281]	[-0.026, 0.265]	[-0.035, 0.258]	[-0.039, 0.265]	[-0.040, 0.280]
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Note. Method of moments quantile regression with firm location and scale effects; FS, LIQ, AG and year dummies included; 300 firm-level bootstrap resamples. Scale coefficient of TDR: ROA -0.0066 (95% CI $[-0.037, 0.018]$, $p = 0.560$); ROE 0.0142 (CI $[-0.047, 0.062]$, $p = 0.820$).

The ROA slope declines from -0.025 at $\tau = 0.1$ to -0.046 at $\tau = 0.9$, which suggests a somewhat larger negative association for high-performing insurers, but every bootstrap interval contains zero and the scale coefficient that governs the slope variation is insignificant ($p = 0.560$). For ROE the slopes are positive at all quantiles (0.103 to 0.150) and likewise insignificant. H6 is therefore not rejected: there is no reliable evidence that the leverage–performance relationship differs across the performance distribution. Figure 5(a) plots the ROA quantile process.

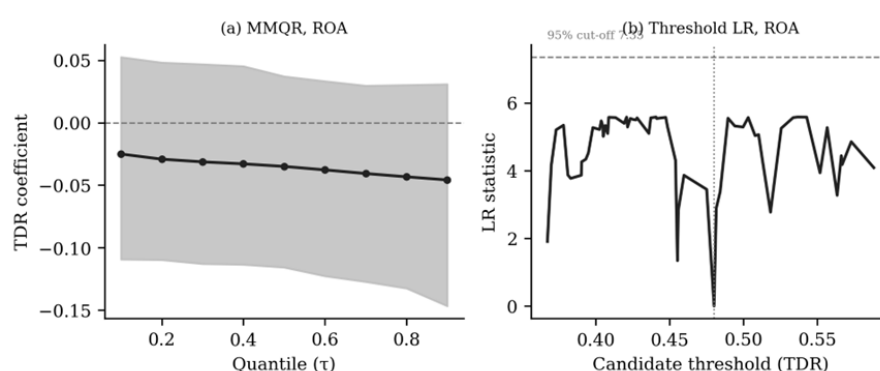


Figure 5. Quantile process and threshold likelihood-ratio plot, ROA. Panel (a): MMQR TDR coefficient with 95% bootstrap band. Panel (b): LR statistic across candidate thresholds; dashed line is the 95% cut-off (7.35).

6.9 Moderation by IFRS 17 period and firm size

Table 22. Moderation tests, fixed effects

Term	ROA β (SE; p)	ROE β (SE; p)
TDR (main), POST model	-0.030 (0.042; 0.485)	0.123 (0.083; 0.158)
TDR $\times$ POST (2023–2025)	-0.014 (0.032; 0.673)	0.010 (0.062; 0.880)
TDR (main), size model	-0.039 (0.044; 0.389)	0.109 (0.087; 0.225)
TDR $\times$ FS (centred)	0.009 (0.030; 0.770)	0.048 (0.055; 0.394)

Note. Firm and year effects; POST main effect absorbed by year effects; firm-clustered SEs; $N = 145$.

Neither interaction is significant (TDR $\times$ POST: $p = 0.673$ for ROA; TDR $\times$ FS: $p = 0.770$), so H7 on moderation is not rejected: the association does not differ detectably between the IFRS 17 period and earlier years or between larger and smaller insurers. With only three post-transition years, power is limited.

6.10 Robustness and inference

Table 23. Robustness of the TDR–performance association

Check	ROA: β (p; bootstrap p)	ROE: β (p; bootstrap p)
Baseline, RE (ROA), RE (ROE)	-0.0620 (0.022; boot. 0.041)	0.0675 (0.246; boot. 0.339)
One-year lagged TDR	-0.0720 (0.008; boot. 0.015)	-0.0184 (0.723; boot. 0.752)

Financing-debt ratio (FDR)	−0.2014 (0.006; boot. 0.030)	−0.4735 (0.003; boot. 0.026)
Unwinsorised data	−0.0631 (0.019; boot. 0.037)	0.0691 (0.249; boot. 0.350)
Excluding 2022–2023 (n = 113)	−0.0774 (0.006; boot. 0.016)	0.0265 (0.636; boot. 0.658)
Adding claims ratio (CR)	−0.0690 (0.014; boot. 0.027)	0.0550 (0.340; boot. 0.393)
Leave-one-firm-out: range of β ; significant runs	−0.0783 to −0.0515; 13 of 16	0.0277 to 0.0839; 0 of 16
Leave-one-year-out (FE): range of β ; min p	−0.0523 to −0.0236; min p = 0.237	—

Note. Estimator for rows 1–6 is the preferred estimator for each outcome (Table 12). Leave-one-year-out uses fixed effects.

Table 24. Inference robustness for the baseline TDR → ROA coefficient

Inference method	Coefficient	SE / reference	p-value
RE, firm-clustered (t, 15 d.f.)	−0.0620	0.0244	0.022
RE, wild cluster bootstrap	—	4,999 Rademacher draws	0.046
FE, firm-clustered	−0.0356	0.0386	0.372
FE, two-way clustered (firm, year)	−0.0356	0.0289	0.249
FE, within-firm randomization inference	—	permutation SD 0.0325	0.27
RE wild-bootstrap p, Holm-adjusted over 8 tests	—	Family of H1–H4 tests, ROA and ROE	0.368

Note. The eight tests are the leverage coefficients in Models 1–6 (TDR, DER, LTDR, STDR for ROA and ROE) using wild-bootstrap p-values.

The negative TDR–ROA association is stable in sign across all checks (Figure 6) and stronger with lagged leverage ($\beta = -0.0720$, bootstrap $p = 0.015$), without 2022–2023 and with unwinsorised data. Its statistical significance, however, is fragile. It disappears under fixed effects ($p = 0.372$), two-way clustering ($p = 0.249$) and within-firm randomization inference ($p = 0.270$), is significant in 13 of 16 leave-one-firm-out runs, and the Holm-adjusted p-value across eight tests is 0.368. The financing-debt ratio, which excludes policyholder liabilities, is significantly negative for both ROA ($\beta = -0.201$, bootstrap $p = 0.030$) and ROE ($\beta = -0.474$, bootstrap $p = 0.026$) under the preferred estimator; this is an exploratory result outside the Holm family and rests on few borrowing firms. In the Monte Carlo evaluation, the specified TDR effect is -0.050 ; the FE estimate (-0.036) and RE estimate (-0.062) bracket it, but their confidence intervals are wide, showing how little power a 16-

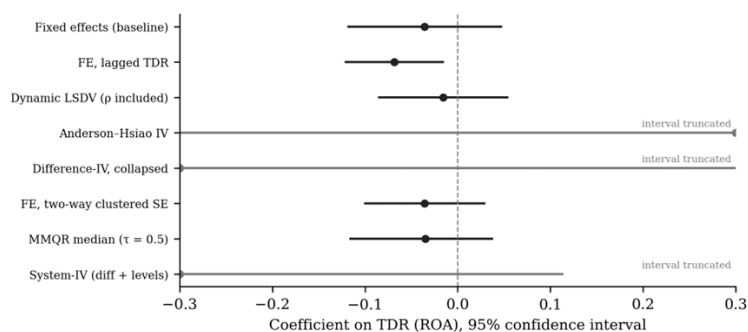


Figure 6. Coefficient on TDR (ROA) across estimators. Points are estimates; lines are 95% intervals. Truncated intervals reflect weak instruments.

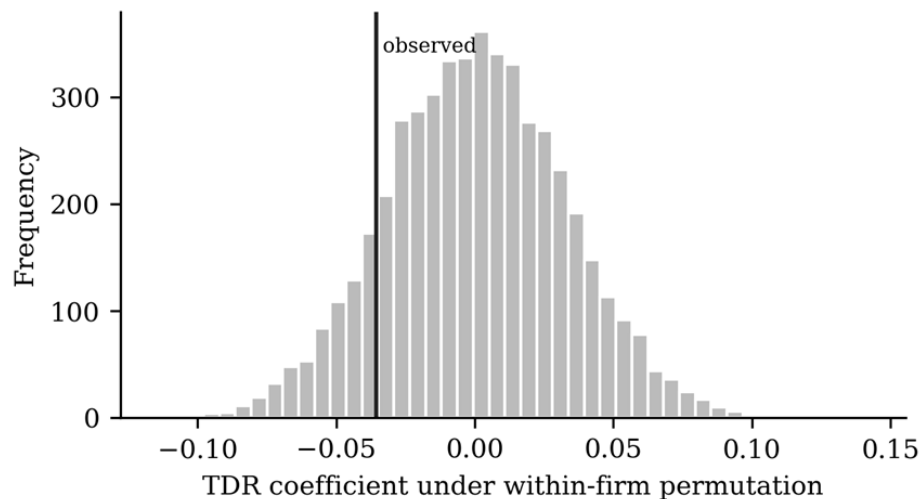


Figure 7. Distribution of the FE TDR coefficient under within-firm permutation. The vertical line is the observed estimate; the permutation p-value is 0.270.

6.11 Monte Carlo evidence on estimator performance and power

The Monte Carlo evaluation assesses estimator performance for a panel of this size across four specified TDR effects (0, -0.025 , -0.050 and -0.100). Pooled OLS, fixed-effects and random-effects estimators with firm-clustered standard errors are evaluated over 300 replications per effect. Table 25 reports mean bias, root-mean-square error (RMSE), the rejection rate of a 5% test and the coverage of 95% confidence intervals.

Table 25. Monte Carlo performance of estimators for the TDR $\rightarrow$ ROA coefficient (300 replications per cell, Monte Carlo design)

True β	Estimator	Mean bias	RMSE	Rejection rate (5%)	95% CI coverage
0	Pooled	-0.0214	0.043	14.30%	85.70%
0	FE	-0.0036	0.032	6.70%	93.30%
0	RE	-0.0126	0.029	8.70%	91.30%
-0.025	Pooled	-0.0274	0.046	40.00%	81.70%
-0.025	FE	-0.0050	0.032	15.30%	93.70%
-0.025	RE	-0.0164	0.031	42.30%	89.70%
-0.050	Pooled	-0.0335	0.049	66.30%	76.30%
-0.050	FE	-0.0067	0.032	39.00%	92.30%
-0.050	RE	-0.0206	0.033	74.00%	84.70%
-0.100	Pooled	-0.0460	0.057	98.70%	62.70%
-0.100	FE	-0.0107	0.034	88.30%	91.00%
-0.100	RE	-0.0297	0.04	99.30%	71.70%

Note. Design: 17 firms (16 retained), 2015–2025, unbalanced, same DGP as the analysed panel, with asset growth proxied by the log change in assets. Cluster-robust t tests with 15 d.f. For true $\beta = 0$ the rejection rate is the empirical size; for other values it is power.

Three results stand out. First, static estimators are biased toward more negative values, as Proposition 2 predicts: at the true effect of -0.050 the mean bias is -0.007 for FE, -0.021 for RE and -0.034 for pooled OLS. Second, the bias has consequences for inference. Random-effects and pooled tests reject a false null more often (74% and 66% at the true effect) but over-reject a true

zero effect (8.7% and 14.3% against the nominal 5%), and their 95% intervals cover the truth only 85% and 76% of the time, whereas FE intervals cover 92%. Third, power is low where it matters: the FE test detects the true effect in only 39% of replications, and in 15% for an effect half as large. The implication for the analysed panel is that the significant random-effects coefficient in Table 13 should be read as an upper bound on the strength of the evidence (partly produced by the feedback bias), while the non-significant fixed-effects coefficient is unsurprising given the test's low power. The credible conclusion is the interval spanned by the FE and RE estimates, and not either point estimate alone.

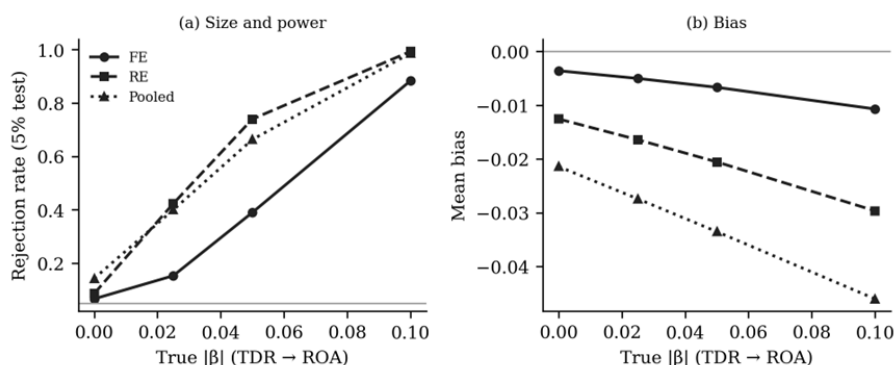


Figure 8. Monte Carlo size, power and bias of the pooled, FE and RE estimators. Each point averages 300 replications.

6.12 Hypothesis decisions

Table 26. Hypothesis decisions at the 5% level

Hypothesis	Evidence	Decision
H1a: TDR → ROA	$\beta = -0.0620$; $p = 0.022$; boot. 0.046; Holm 0.368	Fail to reject
H1b: TDR → ROE	$\beta = 0.0675$; $p = 0.246$; boot. 0.342; Holm 1.000	Fail to reject
H2a: DER → ROA	$\beta = -0.0132$; $p = 0.065$; boot. 0.080; Holm 0.559	Fail to reject
H2b: DER → ROE	$\beta = 0.0211$; $p = 0.156$; boot. 0.256; Holm 1.000	Fail to reject
H3a: LTDR → ROA	$\beta = -0.3617$; $p = 0.273$; boot. 0.373; Holm 1.000	Fail to reject
H3b: LTDR → ROE	$\beta = -0.7550$; $p = 0.196$; boot. 0.326; Holm 1.000	Fail to reject
H4a: STDR → ROA	$\beta = -0.0424$; $p = 0.860$; boot. 0.855; Holm 1.000	Fail to reject
H4b: STDR → ROE	$\beta = -0.1637$; $p = 0.728$; boot. 0.719; Holm 1.000	Fail to reject
H5a/b: non-linearity (TDR ² ; threshold)	TDR ² $p = 0.362 / 0.191$; threshold boot. $p = 0.565 / 0.623$	Fail to reject
H6a/b: constant across quantiles	Scale-coefficient $p = 0.560 / 0.820$	Fail to reject
H7a/b: no moderation (IFRS 17 period; size)	TDR × POST $p = 0.673$; TDR × FS $p = 0.770$	Fail to reject

Note. For H1–H4, rejection requires cluster-robust, wild-bootstrap and Holm-adjusted p-values all below 0.05 under the preferred estimator. “Fail to reject” does not establish absence of an effect.

7. Discussion

This section interprets the estimates in Section 6 as conditional associations and assesses whether their direction, magnitude and statistical significance persist across estimators and inference procedures. The estimates do not, by themselves, establish that capital structure causes changes in profitability.

The principal baseline result is a negative association between the total-debt ratio (TDR, defined here as total liabilities divided by total assets) and return on assets. Under random effects, the coefficient is -0.0620 ($SE = 0.0244$; $t = -2.54$; $p = 0.022$), while the reported wild-cluster-bootstrap p-value is 0.046. At the sample mean, this estimate suggests that a 0.10 increase in TDR is associated with approximately a 0.62-percentage-point decrease in ROA, holding the included covariates and year effects constant. A one-standard-deviation increase in TDR (0.1012) corresponds to an estimated ROA difference of approximately -0.63 percentage points, relative to mean ROA of 4.76%. This association is not estimator-invariant: the fixed-effects coefficient is -0.0356 ($p = 0.372$), two-way-clustered inference gives $p = 0.249$, within-firm randomization inference gives $p = 0.270$, and the Holm-adjusted p-value across the eight leverage tests is 0.368. The appropriate conclusion is therefore not that leverage has a proven harmful causal effect, but that the reported estimates are compatible with a negative between-firm association whose statistical support weakens under stricter within-firm and multiplicity-adjusted inference.

The results for alternative leverage measures reinforce the need to interpret insurer liabilities carefully. The debt-to-equity ratio is negatively associated with ROA in the random-effects model ($\beta = -0.0132$, $p = 0.065$; bootstrap $p = 0.080$), but it does not meet the conventional 5% threshold. Long-term and short-term borrowing ratios are not statistically significant for ROA (LTDR $\beta = -0.3617$, $p = 0.273$; STDR $\beta = -0.0424$, $p = 0.860$) or ROE (LTDR $\beta = -0.7550$, $p = 0.196$; STDR $\beta = -0.1637$, $p = 0.728$). These maturity estimates should be interpreted cautiously because borrowing is sparse in the reported panel. For ROE, none of the baseline leverage coefficients is statistically significant at 5%: TDR $\beta = 0.0675$ ($p = 0.246$) and DER $\beta = 0.0211$ ($p = 0.156$), with LTDR and STDR also insignificant. The positive point estimates for TDR and DER in the ROE equations, alongside the negative TDR estimate for ROA, are consistent with the fact that leverage affects the equity multiplier; they do not establish that leverage improves shareholders' returns.

Sensitivity analysis gives a mixed rather than uniform verdict. The negative TDR–ROA sign remains in the reported lagged-leverage specification ($\beta = -0.0720$; bootstrap $p = 0.015$), the unwinsorised specification ($\beta = -0.0631$; bootstrap $p = 0.037$), the sample excluding 2022–2023 ($\beta = -0.0774$; bootstrap $p = 0.016$), and the specification adding the claims ratio ($\beta = -0.0690$; bootstrap $p = 0.027$). However, the sign's persistence does not resolve the inference problem: fixed-effects and other within-firm tests are not statistically significant, and only 13 of 16 leave-one-firm-out runs retain conventional significance. An exploratory financing-debt ratio (FDR), which excludes insurance-contract liabilities, is negatively associated with ROA ($\beta = -0.2014$; bootstrap $p = 0.030$) and ROE ($\beta = -0.4735$; bootstrap $p = 0.026$). This is substantively important but should not be elevated to a definitive finding because it is exploratory and relies on a limited number of firms with reported borrowings. The 0.98 correlation between TDR and DER also supports estimating them in separate equations rather than treating them as independent regressors.

The tests provide no statistically persuasive evidence of non-linearity or systematic effect heterogeneity. The quadratic TDR-squared term is insignificant for ROA ($\beta_2 = 0.1082$, $p = 0.362$) and ROE ($\beta_2 = 0.3473$, $p = 0.191$). Although the threshold procedure places a candidate split near $TDR = 0.480$, its bootstrap tests do not reject the null of no threshold (ROA $p = 0.565$; ROE $p = 0.623$), and the reported confidence set does not identify a precise threshold. MMQR estimates for ROA range from -0.0250 at the 10th quantile to -0.0458 at the 90th quantile, but every reported 95% bootstrap interval includes zero; the scale-effect test is also insignificant ($p = 0.560$). The TDR interactions with the post-IFRS 17 period (ROA $p = 0.673$) and firm size (ROA $p = 0.770$) are insignificant. These non-rejections do not prove that curvature, quantile heterogeneity or period differences are absent: with a small panel, limited borrowing variation and only three post-transition years, statistical power is constrained.

8. Conclusion

For the reported 2015–2025 analysis panel, the evidence is most consistent with a cautious, non-causal interpretation. Random-effects estimates associate a higher total-liabilities ratio with lower ROA ($\beta = -0.0620$; $p = 0.022$; wild-bootstrap $p = 0.046$), but the association is not robust to fixed effects, two-way clustering, within-firm randomization inference or Holm adjustment. The reported models do not identify a statistically significant leverage relationship with ROE, maturity-specific borrowing effect, quadratic relationship, threshold, quantile variation, or moderation by the IFRS 17 period or firm size. The exploratory financing-debt ratio is negative for both ROA and ROE, suggesting that borrowing itself may carry information different from policyholder liabilities, but this result requires particular caution because borrowing is uncommon in the sample.

9. Recommendations

The practical implications for Nigeria should follow the strength and limits of these estimates. The study does not establish a causal effect of leverage, and its dynamic instrumental-variable estimates are not reliable for causal interpretation: the reported first-stage F statistics are 0.17 for difference-IV and 0.49 for system-IV, both indicating very weak instruments. The feedback regression reports that lagged ROA is negatively associated with current TDR ($\beta = -0.530$, $p = 0.043$), which is consistent with profitable firms relying less on liabilities or external financing. The Monte Carlo exercise is a separate, model-based assessment—not empirical evidence about Nigerian firms—and reports that, when the true TDR effect is -0.050 , mean bias is -0.0067 for FE, -0.0206 for RE and -0.0335 for pooled OLS; FE's rejection rate is 39.0%, compared with 74.0% for RE and 66.3% for pooled OLS.

Stakeholder	Recommendations based on the reported findings
Insurer boards and managers	Do not use the total-liabilities ratio alone as a financing-policy target. Separate policyholder/insurance-contract liabilities from borrowings, bonds, debentures and lease liabilities in internal capital dashboards. Given the exploratory negative FDR estimates, assess borrowing costs, debt maturity, liquidity and solvency headroom before adding financing debt; the current evidence does not prove that equity financing is always superior.

Investors	Distinguish underwriting-related technical liabilities from financing debt when comparing listed insurers. Read ROA and ROE together because leverage changes the equity multiplier, and avoid interpreting a high total-liabilities ratio as direct evidence of excessive borrowing or poor management.
NAICOM and financial-reporting stakeholders	Consider a consistent disclosure template separating insurance-contract liabilities from interest-bearing financing debt, with amounts, rates, maturity, security, lease liabilities and refinancing dates. More consistent disclosure would improve the ability to assess maturity-specific relationships and capital adequacy during implementation of the risk-based capital framework.
Researchers and standard-setters	For small insurer panels, report fixed- and random-effects estimates alongside wild-bootstrap, two-way-clustered, randomization and multiplicity-adjusted inference. Treat dynamic-IV findings as non-causal when first-stage diagnostics show weak instruments.

10. Limitations

Limitation	Methodological implication	Mitigation
Annual-report data quality, late FY2025 filings	Unbalanced panel; survivorship risk	Documented inclusion rules; double-entry extraction; sensitivity to sample
Small number of listed insurers	Low power; unreliable conventional SEs; GMM infeasible	Wild bootstrap; randomization inference; leave-one-out; collapsed instruments
Measurement of leverage and performance	Total liabilities include policyholder liabilities	FDR, separate LTDR/STDR, ROA and ROE
Endogeneity and weak instruments	Associations, not causal effects	Lagged regressors; IV estimators with first-stage diagnostics
IFRS 17 and regulatory change in window	Series break around 2022–2023	Year effects; period exclusion; moderation test
Generalisability	Listed insurers only	Conclusions confined to the listed population

11. Suggestions for Further Research

- Add market-based performance (Tobin's Q) and underwriting performance, and split by life, non-life and composite insurers when sample size permits.
- Use the 2025 recapitalisation deadline as a quasi-natural experiment with unlisted or non-compliant insurers as a comparison group once FY2026 statements are available.
- Combine NAICOM supervisory data with a longer or larger panel (including unlisted insurers) to obtain strong instruments for a causal design.

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Data availability

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable. This study did not involve human or animal subjects.

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Competing interests

The authors declare that they have no competing interests.

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