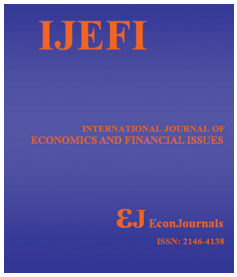

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2026, 16(3), 26-35.

Causality Exploration between Interactions of Competition, Efficiency, and Stability and Capital Structure in African Banks

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Received: 06 January 2026 **Accepted:** 30 March 2026 **DOI:** https://doi.org/10.32479/ijefi.20303

ABSTRACT

This study examines the causal relationship between capital structure, measured by the capital–asset ratio (CAR), and the joint dynamics of competition, efficiency, and stability in African commercial banks. Using panel data from 66 banks across 12 African countries over the period 2010-2021, the study employs the two-step system generalized method of moments (GMM) estimator to address endogeneity and dynamic effects. To capture the combined influence of banking market conditions, a composite competition–efficiency–stability index (CESINDEX) is constructed. The empirical results reveal a bidirectional causal relationship between CESINDEX and CAR, indicating that capital structure both influences and is influenced by the interaction of competition, efficiency, and stability in the banking sector. Robustness checks using an alternative measure of capital structure—the liabilities–asset ratio (LAR)—confirm the consistency of the findings. These results highlight the interdependence between bank capitalization and market dynamics, suggesting that regulatory policies aimed at strengthening bank capital can have broader implications for competitive behavior, operational efficiency, and financial stability. The study contributes to the limited empirical literature on African banking systems and offers valuable insights for policymakers and bank managers seeking to promote a resilient and efficient financial sector.

Keywords: CESINDEX, Competition, Efficiency, Stability, and Capital Structure
JEL Classifications: A10, A12, A13

1. INTRODUCTION

Banks play a central role in financial intermediation by mobilizing savings, allocating credit, managing risk, and supporting economic activity, making their stability critical to broader economic performance (Orebiyi et al., 2025). Competition influences bank stability in two opposing ways: It can enhance stability by improving risk discipline and lowering borrower costs, but it can also undermine stability by compressing margins and encouraging excessive risk-taking. Similarly, competition affects efficiency through dual channels—it can stimulate innovation and cost minimization, yet excessive rivalry may erode scale efficiencies and weaken operational performance. Efficiency itself also has a twofold effect on stability: higher efficiency can strengthen stability through better cost control, profitability, and risk management, while overly aggressive efficiency gains may weaken internal controls and increase fragility. To capture these intertwined dynamics, this study measures the mediating role of efficiency in the competition–stability relationship using a composite index, CESINDEX, which jointly reflects competition, efficiency, and stability and reveals their combined influence on banks' capital structure decisions.

Causality refers to a directional and systematic relationship in which changes in one variable generate observable effects in another (Hage and Meeker, 2025). In this study, causality is examined between capital structure and CESINDEX, a composite measure capturing the interactions of competition, efficiency, and stability. This framework allows for identifying whether institutional dynamics shape banks' leverage decisions, whether

capital structure feeds back into institutional conditions, or whether both processes occur simultaneously. Unidirectional causality implies that changes in institutional interactions precede adjustments in capital structure, while bidirectional causality reflects dynamic feedback over time. Competition influences pricing behavior and risk exposure, efficiency affects internal capital generation and cost discipline, and stability shapes access to external finance through risk perceptions. Conversely, leverage choices alter banks' risk profiles, operational priorities, and competitive positioning (Gupta et al., 2025). These reciprocal dynamics are particularly salient in Africa's volatile and fragmented banking systems, making causality analysis essential for sound inference and policy formulation.

The existing banking literature has largely adopted a pairwise causality approach, examining capital structure in relation to competition, efficiency, or stability separately. Although this evidence confirms that capital structure both influences and responds to each dimension in isolation, it does not address how capital structure interacts with their joint and interdependent dynamics, especially in African banking markets. Neither theory nor empirical work has adequately explored whether the interaction of competition, efficiency, and stability exerts a distinct causal influence on bank capitalization (Yahaya, 2026; Al-Assaf et al., 2026), or whether capital structure simultaneously reshapes these institutional forces (Dogan et al., 2025; Li and Li, 2025). As a result, it remains unclear whether banks' capital decisions are driven by isolated market signals or by their combined institutional environment, limiting the effectiveness of regulatory and managerial frameworks in fragile systems. By explicitly testing causality between capital structure and the interaction of competition, efficiency, and stability, this study fills this gap and offers a more integrated understanding of capitalization dynamics in emerging banking markets.

Guided by the identified gap in literature, this study addresses several interrelated research questions. First, is there a causal relationship between capital structure and the interaction of competition, efficiency, and stability in African commercial banks? Second, what is the direction of this causality—does the combined interaction of competition, efficiency, and stability drive banks' capital structure decisions, does capital structure influence this interaction, or do both effects occur simultaneously? Third, do these causal dynamics differ from those observed in studies that examine competition, efficiency, and stability in isolation? Fourth, how relevant is it to explicitly account for the interaction of these three dimensions when formulating capital structure decisions and regulatory policies in fragile African banking systems? Finally, to what extent does incorporating the joint interaction of competition, efficiency, and stability provide a more comprehensive explanation of capitalization behavior in African banks than traditional pairwise approaches? Together, these questions aim to clarify the role of interactive market dynamics in shaping bank capital structure and to inform more effective policy and managerial decision-making in emerging banking markets.

The causal relationship between capital structure and the interaction of competition, efficiency, and stability in African banks is theoretically underpinned by agency cost theory, which emphasizes conflicts of interest between bank managers, shareholders, and creditors (Sdiq and Abdullah, 2022). According to this theory, capital structure serves as a key governance mechanism that can discipline managerial behavior by reducing free cash flow problems and excessive risk-taking, thereby influencing banks' efficiency and stability, especially in competitive environments (Abdulah and Tursoy, 2023). At the same time, the degree of competition, operational efficiency, and financial stability jointly shapes managerial incentives and risk preferences, which in turn affect optimal capital structure choices. In highly competitive and fragile banking markets, such as those in Africa, managers may adjust capitalization levels to mitigate agency conflicts arising from increased risk exposure, regulatory pressure, and monitoring intensity (Abdullah et al., 2021). The interaction of competition, efficiency, and stability therefore creates a complex incentive structure that both constrains and is influenced by capital structure decisions. Additionally, To, A. T., and Suzuki. (2019) confirm that debt can be a useful tool for reducing the negative impact of agency costs on financial performance because of the pressure on managers to pay back the debts. Thus, managers are less able to concentrate on their own interest and thus the conflict of interest is reduced. By examining the bidirectional causality between capital structure and these interacting dimensions, this study extends agency cost theory beyond isolated relationships and demonstrates how agency considerations operate through their combined effects in shaping capitalization behavior in African banking systems.

This study is relevant because it offers a more comprehensive and policy-useful understanding of bank capital structure by explicitly accounting for the joint dynamics of competition, efficiency, and stability, rather than treating them as isolated factors. By establishing bidirectional causality between capital structure and the interaction of these dimensions, the study advances banking theory and empirical practice, particularly in the context of fragile African financial systems where trade-offs among these forces are pronounced. Methodologically, the construction of a composite Competition–Efficiency–Stability Index provides a novel framework for capturing complex market interactions that are often overlooked in conventional analyses. From a policy perspective, the findings inform regulators that capital requirements can simultaneously influence competitive behavior, operational efficiency, and financial stability, and that ignoring these interactions may lead to unintended regulatory outcomes. For bank managers, the study highlights the importance of incorporating joint market conditions into capitalization decisions rather than relying on single-dimension assessments. Overall, the study contributes original evidence that supports more integrated regulatory design and strategic decision-making, thereby enhancing the resilience, efficiency, and sustainability of banking systems in Africa.

This study employs the two-step system generalized method of moments (GMM) estimator to examine causality between capital structure and the interaction of competition, efficiency, and stability, a choice justified by the dynamic and endogenous nature of banking relationships. Bank capital structure is inherently persistent over time and simultaneously determined with market

conditions, making conventional estimators such as OLS, fixed effects, or random effects inappropriate due to bias from endogeneity, reverse causality, and unobserved heterogeneity. The system GMM approach effectively addresses these concerns by combining equations in levels and first differences, using internal instruments derived from lagged values of the variables, thereby producing consistent and efficient estimates. The two-step estimator further improves efficiency by accounting for heteroskedasticity and autocorrelation, which are common in bank-level panel data. Compared to alternative methods, system GMM is particularly suitable for panels with a relatively large number of cross-sections and a shorter time dimension, as is typical in banking studies. Consequently, the use of two-step system GMM provides a robust framework for identifying bidirectional causality and ensures the reliability of the study's empirical findings.

The key finding of this study is the existence of a bidirectional causal relationship between the capital–asset ratio and the interaction of competition, efficiency, and stability in African commercial banks. This result indicates that bank capital structure is not only shaped by the joint dynamics of market competition, operational efficiency, and financial stability, but also actively influences how these three dimensions interact within the banking system. On one hand, changes in the combined competitive environment, efficiency levels, and stability conditions drive banks' capitalization decisions as managers adjust capital buffers in response to risk, performance, and market pressures. On the other hand, variations in capital adequacy affect banks' ability to compete, operate efficiently, and maintain stability, reinforcing feedback effects within the system. This finding departs from prior evidence based on isolated causal links and demonstrates that capital structure and market dynamics are mutually reinforced when considered jointly. The robustness of this bidirectional causality underscores the importance of adopting an integrated analytical framework when assessing capital structure behavior and designing regulatory policies in fragile African banking systems.

The remainder of the study is structured as follows. Section 2 provides a comprehensive review of the literature, with particular emphasis on causality analysis and the theoretical and empirical linkages among competition, efficiency, stability, and capital structure. Section 3 outlines the research methodology, detailing the data, variable construction, the two-step system GMM approach used for causality testing, and the robustness strategies employed. Section 4 presents and discusses the empirical results of the causality tests, interpreting the direction and magnitude of the relationships in light of agency cost theory and the institutional context of African banking systems. Section 5 concludes the study by summarizing the key findings, highlighting their theoretical and policy implications, and suggesting avenues for future research focused on dynamic interactions and causal mechanisms in bank capitalization.

2. LITERATURE REVIEW

The competition–stability hypothesis (CSH) conceptualizes competition as intensified market rivalry among banks, while stability is defined as the capacity to withstand shocks without systemic distress (Yao et al., 2026). According to CSH, heightened competition compresses margins, weakens franchise values, and incentivizes excessive risk-taking, thereby undermining financial stability (Aldousari and Mohammed, 2023). While the hypothesis emphasizes a direct competition–stability relationship, it does not account for how these dynamics interact with capital structure, leaving the direction and feedback of causal relationships unclear. In particular, it remains unknown whether the interaction of competition and stability drives banks' capitalization decisions, whether capital structure influences these interactions, or whether both effects occur simultaneously. This study extends CSH by incorporating competition, efficiency, and stability into a composite CESINDEX and employing causality tests to empirically examine the bidirectional causal relationships with capital structure. By doing so, it provides evidence on the dynamic interplay between market forces and bank capitalization, clarifying how these factors mutually reinforce each other in African banking systems characterized by regulatory fragmentation and institutional fragility.

The competition–efficiency hypothesis (CEH) posits that intensified competition enhances bank efficiency through cost discipline, innovation, and service improvements (Liu and Zhao, 2024). However, it assumes homogeneous responses across banks and overlooks the heterogeneity in governance quality, scale, and institutional resilience, which are particularly pronounced in African banking systems (Haile et al., 2025). In weak regulatory environments, excessive competition may instead compress margins, reduce incentives for investment in internal controls, and erode efficiency (Goodhart, 2022). CEH treats efficiency as a direct outcome of competition but does not address whether efficiency interacts with competition and stability to influence capital structure, leaving the directionality of causal relationships untested. This study extends CEH by integrating competition, efficiency, and stability into a unified CESINDEX and employing causality tests to examine whether these interactions drive capital structure, whether capital structure shapes these dynamics, or whether bidirectional effects exist. By doing so, it moves beyond static assumptions and provides empirical evidence on the dynamic causal mechanisms linking competition, efficiency, stability, and bank capitalization, offering new insights into the functioning of structurally fragile African banking systems.

The efficiency–stability hypothesis (ESH) posits that operational efficiency can either enhance or undermine bank stability, reflecting a two-tailed relationship: Efficiency may strengthen stability through cost minimization and improved risk controls or weaken it by encouraging excessive risk-taking (Boamah et al., 2022). However, ESH focuses primarily on the direct efficiency–stability relationship, assuming homogeneous effects across banks and institutional environments (Zhuang and Fu, 2025), and does not account for how competition interacts with efficiency to shape stability outcomes. Importantly, ESH also overlooks the causal links between efficiency-induced stability and capital structure, leaving unanswered whether efficiency and stability drive capitalization decisions, whether capital structure influences these dynamics, or whether bidirectional relationships exist. This

study extends ESH by integrating competition, efficiency, and stability into a composite CESINDEX and employing causality tests to empirically examine their dynamic interactions with capital assets ratios. By doing so, it provides a multidimensional and causally informed understanding of how efficiency and stability jointly influence, and are influenced by, capital structure, offering insights particularly relevant for structurally fragile African banking systems.

The competition–efficiency–stability hypothesis (CESH) frames the dynamic interactions among competition, efficiency, and stability and their influence on bank capital structure. The causal links are theoretically underpinned by agency cost theory, which posits that capital structure serves as a governance mechanism to align managerial incentives, mitigate risk-taking, and control agency conflicts between shareholders, managers, and creditors. In this context, competition, efficiency, and stability jointly shape managerial behavior and risk preferences, which in turn influence capitalization decisions, while capital structure simultaneously affects these institutional dynamics by constraining or enabling risk-taking and operational strategies. Prior studies have largely examined these channels in isolation, leaving the direction and feedback of causal relationships untested. This study extends existing models by integrating competition, efficiency, and stability into a unified CESINDEX and employing causality tests to empirically investigate whether these interactions drive capital structure, whether capital structure influences them, or whether bidirectional effects exist. The approach provides a robust, causally informed framework for understanding leverage decisions in structurally fragile African banking systems.

3. METHODOLOGY

This study adopts a positivist paradigm, asserting that economic reality is objective, measurable, and statistically verifiable, which supports causal inference and hypothesis testing while rejecting subjective interpretation (Modu et al., 2022). Guided by this paradigm, a quantitative research design is employed, using panel data to systematically investigate the structural determinants of capital structure through the interactions of competition, efficiency, and stability captured in the CESINDEX. The study relies on secondary data from the International Review of Economics and Statistics (IRES) spanning 66 commercial banks across twelve African countries from 2010 to 2021, offering harmonized, audited, and regionally relevant indicators that enhance comparability, reduce fragmentation, and align with the institutional context of African banking systems. Panel data integrate cross-sectional and temporal dimensions, allowing the analysis of mediation, interaction, nonlinearity, and causality while controlling for unobserved heterogeneity and institutional diversity. The study population encompasses all African commercial banks, with a stratified sample selected based on regional affiliation and bank size to ensure proportional representation, methodological rigor, and external validity. This approach facilitates robust, generalizable insights into the dynamic interplay of competition, efficiency, and stability in shaping capital structure decisions under Africa's heterogeneous and institutionally fragile banking environment.

This study measures its core variables using robust, theoretically grounded proxies to ensure empirical precision and contextual relevance in African banking systems. Capital structure is proxied by the capital-to-assets ratio (Al-Sharkas and Al-Sharkas, 2022), reflecting regulatory and shareholder equity relative to total assets, suitable for underdeveloped capital markets with heterogeneous disclosure standards. Competition is captured via the Lerner index (Li and Peng, 2024), measuring bank-specific market power through price–marginal cost all divided by price. Efficiency is assessed using both input- and output-oriented data envelopment analysis (DEA) models, capturing operational cost minimization and revenue maximization across structurally diverse banks (Liceran-Gutierrez et al., 2025). Stability is measured with the Z-score, integrating profitability, leverage, and return volatility to evaluate insolvency risk (Srivastava et al., 2025). The Z-score is calculated by subtracting the mean return on assets (ROA) from a bank's individual ROA and dividing the result by the population standard deviation, indicating how many standard deviations the bank's performance is from the average. These three dimensions form the CESINDEX, a multiplicative geometric mean composite index normalized via min–max scaling, theoretically grounded in trade-off and pecking order frameworks, categorized into tertiles, and contextualized within Africa's fragmented and asymmetric banking environments. CESINDEX captures the mediating role of efficiency in the competition–stability nexus while reflecting systemic institutional coherence. Limitations of multiplicative construction, such as sensitivity to outliers, multicollinearity, and equal weighting assumptions, are mitigated via normalization, validated proxies, Pearson diagnostics, and country-fixed effects, ensuring reliability, comparability, and methodological transparency in dynamic panel analysis of capital structure.

Data diagnostic tests are critical for ensuring reliability, validity, and robustness in analysing African banking capital structures, particularly the interdependent effects of competition, efficiency, and stability. This study applies a four-stage framework: First, data preparation involves min–max normalization to standardize variable scales and Z-score-based detection of outliers, preserving representativeness while limiting bias. Second, property testing evaluates residual normality using the Jarque-Bera test, stationarity through first- and second-generation panel unit root tests, and cross-sectional dependence via Pesaran's CD, Breusch-Pagan LM, Frees', and Friedman's tests, ensuring model assumptions align with Africa's heterogeneous financial systems. Third, relationship diagnostics assess multicollinearity with Pearson correlations, long-run equilibrium through Kao cointegration tests, and endogeneity using two-step system GMM with internal lagged instruments, validated via Hansen J and Arellano-Bond AR (2) tests. Heteroscedasticity and serial correlation are addressed with Breusch-Pagan, White, and Arellano-Bond procedures, applying robust standard errors to enhance inference reliability. Finally, model evaluation leverages dynamic panel GMM to estimate short- and long-run effects, controlling for simultaneity, unobserved heterogeneity, and measurement error, thereby producing consistent, policy-relevant insights into CESINDEX influences on capital structure across structurally diverse African banks.

This study employs the two-step system generalized method of moments (GMM) to investigate the causal relationship between the institutional CESINDEX and bank capital ratios, as the method effectively addresses endogeneity, simultaneity, and reverse causality through the use of lagged dependent and independent variables as internal instruments (Ullah et al., 2018). Unlike ordinary least squares or fixed effects models, which are prone to bias in dynamic panels, two-step system GMM accounts for unobserved heterogeneity and dynamic effects, enabling more accurate causal inference between institutional interactions and capital structure (Deyshappriya, 2016; Sahnoun and Idrissi, 2025). Panel data is essential for this approach, as its large cross-sectional and short time-series structure allows the construction of valid instruments, controls for unit-specific effects, and captures dynamic adjustment patterns (Farzana et al., 2024). Balanced panels ensure instrument consistency, reduce variability, and improve estimation efficiency (Shi et al., 2025). By combining a robust dynamic estimator with rich panel data, this study overcomes the limitations of simpler methods and provides reliable evidence on the direction and feedback effects between the institutional index and bank capitalization.

The general model is specified as:

$$Y_{it} = \alpha_i + \Sigma_k \beta_{1k} X_{i,t-k} + \Sigma_k \beta_{2k} Y_{i,t-k} + \varepsilon_{it} \quad (1)$$

Y_{it} denotes the capital-asset ratio for bank i at time t, while $X_{i,t-k}$ represents lagged institutional interaction indices. α_i captures unobserved bank-specific heterogeneity, and ε_{it} is the idiosyncratic error term. The two-step system GMM framework addresses endogeneity, autocorrelation, and unobserved heterogeneity, ensuring consistent and efficient parameter estimation. By exploiting internal instruments—lagged levels and differences—this method suits unbalanced banking panels with potentially endogenous regressors. It permits testing whether past values causally influence current outcomes, revealing structural causality within African banking systems. This approach improves inferential accuracy compared to static or conventional panel estimators. The model's robustness is crucial for capturing dynamic institutional effects amid sectoral fragility.

This study adopts a parsimonious lag structure to assess the dynamic causal link between the index and capital ratio using Two-step system GMM, incorporating first and second lags of both the capital ratio and the index. Including lagged dependent variables captures capital adjustment inertia, while lagged index terms reflect delayed institutional effects on bank behaviour. The selection avoids overfitting and multicollinearity by limiting unnecessary lags or excessive controls, in line with best practices for dynamic panel modelling. Excluding granular bank- and macro-level variables helps isolate the net institutional influence captured by the index, enhancing identification of dynamic causality without over-conditioning. This lag structure is well-suited to the short panel dimensions of African banking data and supports efficient instrument generation in two-step system GMM.

$$CAR_{it} = \alpha_0 + \alpha_1 CAR_{it-1} + \alpha_2 CESINDEX_{it-1} + \alpha_3 X_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

The Structural causality from CAR to CESINDEX is specified as:

$$CESINDEX_{it} = \beta_0 + \beta_1 CESINDEX_{it-1} + \beta_2 CAR_{it-1} + v_i + u_{it} \quad (3)$$

The equation denotes a bank's capital structure at time t, and the composite index represents competition, efficiency, and stability. Bank-specific effects are captured, with idiosyncratic errors. Two-step system GMM employs two-tailed tests to examine bidirectional causality, addressing simultaneity and endogeneity for robust, consistent estimates. The study used advanced statistical software to enable instrument selection, lag structure, and diagnostic evaluations like Sargan, Hansen, and Wald tests. These panel-specific features support valid inference on institutional and capital structure coevolution within African banking systems.

This study rigorously investigates the causal relationship between the CESINDEX and capital asset ratio (CAR) using a Two-step system GMM framework, addressing endogeneity, simultaneity, reverse causality, and omitted variable bias by employing lagged levels and differences of endogenous variables as internal instruments (Ullah et al., 2018). Instrument validity is confirmed through orthogonality conditions, autocorrelation tests, and over-identification diagnostics, ensuring credible identification despite the short time and large cross-section panel structure. Causality hypotheses are tested using a two-tailed approach to avoid imposing directional assumptions, allowing the data to reveal one-way or bidirectional relationships between institutional dynamics and capital structure. Analyses are implemented in EViews 12, which accommodates dynamic panels, instrument subsets, and heterogeneity, while providing robust Wald and F-statistics for directional inference. Model evaluation relies on P-values to determine significance, with a 0.05 threshold guiding rejection of the null hypothesis of no causality. Robustness checks using the liabilities–assets ratio as an alternative capital structure measure confirm that findings are not metric-specific, enhancing reliability, external validity, and confidence that the identified causal relationships between CESINDEX and bank capitalization reflect true dynamic interactions in African banking systems.

4. DISCUSSION OF RESULTS

The descriptive statistics reveal substantial heterogeneity across African banks in terms of capitalization, market power, efficiency, and stability (Table 1). The average capital-to-assets ratio (CAR) of 0.219, with a median of 0.146 and a right-skewed distribution, indicates generally low capitalization, with higher CARs reflecting stronger prudence, risk absorption, and regulatory compliance. The Lerner index averages 0.591, with negative skewness, showing that most banks possess significant market power, although outliers indicate competitive pressures in some institutions, affecting pricing, profitability, and efficiency. Technical efficiency (TEFF) averages 0.664, with negative skewness and leptokurtic distribution, suggesting that most banks operate efficiently, but a few face operational constraints; higher efficiency supports competitiveness, cost control, and resilience.

The descriptive statistics reveal interesting insights into the variables. CAR has a mean of 0.219 and a median of 0.146,

Table 1: Descriptive statistics

Variable	Obs	Mean	Median	Max	Min	Standard deviation	Skewness	Kurtosis
Car	792	0.219	0.146	1.000	0.070	0.197	0.378	2.789
Lindex	792	0.591	0.627	1.000	−0.021	0.214	−0.457	3.290
Teff	792	0.6640	0.653	1.000	0.000	0.246	−0.503	3.053
Zscore	792	0.302	1.000	1.001	0.218	2.693	0.102	2.581
Cesindex	792	0.090	0.077	1.000	−0.070	5.006	0.414	2.783

Source: Source: Author's computations (2026)

Table 2: First generation unit root test results

Variable	First generation unit root tests employed				Comment
	LLC test t-value (P-value)	IPS test t-value (P-value)	AFC test t-value (P-value)	PPF test t-value (P-value)	I (O)
Car	−6.374 (0.000)	−2.013 (0.000)	185.86 (0.001)	225.30 (0.000)	I (O)
LERNER INDEX	−39.443 (0.000)	−7.717 (0.000)	211.4 (0.000)	258.2 (0.000)	I (O)
TEFF	−2.127 (0.017)	−2.648 (0.004)	171.2 (0.012)	343.6 (0.000)	I (O)
ZSCORE	−4.479 (0.000)	−1.800 (0.036)	167.5 (0.020)	235.0 (0.000)	I (O)
CESINDEX	−4.426 (0.000)	−3.576 (0.000)	192.1 (0.001)	290.9 (0.000)	I (O)

Source: Author's Computations (2026)

Table 3: Second generation unit root test results

Variable	Second generation test Lag length is 2			Comment
	CADF statistic (P-value)	CIP statistic (P-value)	PANIC statistic (P-value)	I (0)
CAR	3.252 (0.004)	5.285 (0.003)	3.269 (0.058)	I (0)
LERNER INDEX	2.698 (0.061)	3.256 (0.003)	4.895 (0.052)	I (0)
TEFF	3.289 (0.053)	3.897 (0.025)	4.235 (0.037)	I (0)
ZS CORE	−4.252 (0.002)	−3.789 (0.008)	2.893 (0.013)	I (0)
CESINDEX	4.875 (0.03)	3.897 (0.008)	2.915 (0.025)	I (0)

Source: Author's computations (2026)

Table 4: Outlier detection and transformations

Variable	|Z-values|≥2	2≤|Z-values|≤2	Outcome
CAR	√		Data transformed
LERNER INDEX	√		Data transformed
TEFF	√		Data transformed
ZSCORE	√		Data transformed
CESINDEX	√		Data transformed

Source: Author's computations (2026)

Table 5: Presentation and interpretation of cross-sectional dependency test results

Test	Statistic	P-value
Pesaran's CD	0.789	0.594
Friedman's	1.785	0.358
Frees'	0.922	0.327
Breusch-Pagan LM	Chi squared=0.368	0.689

Source: Author's computations (2026)

Table 6: Presentation and interpretation of normality test results

Test method	Jaque Bera test
Jaque Bera test statistic	2.125
P-value	0.742
Skewness	0.003
Kurtosis	2.971

Source: Author's computations (2026)

Table 7: Presentation and interpretation of heteroscedasticity results

Test method employed	Statistic	P-value
Breusch Pagan	Chi squared (1)=0.278	0.615
White's	Chi squared (1)=0.193	0.253

Source: Author's computations (2026)

Table 8: Presentation and interpretation of autocorrelation results

GMM model of estimation	Probability value	Interpretation
AR (1)	0.145	No autocorrelation
AR (2)	0.231	No autocorrelation

Source: Author's computations (2026)

Table 9: Presentation and discussion of multicollinearity test results

	CAR	LINDEX	TEFF	ZSCORE	CESINDEX
CAR	1				
L INDEX	−0.35	1			
TEFF	−0.35	0.031	1		
ZSCORE	0.67	−0.17	−0.41	1	
CESINDEX	0.21	0.39	0.29	0.35	1
ROA	0.19	0.05	−0.19	0.40	0.11
INFL	0.02	−0.01	0.01	0.10	0.05
GDP	−0.08	0.13	−0.01	−0.10	0.04

Source: Author's computations (2026)

Table 10: Johansen cointegration test results

Null hypothesis	Trace statistic	1% critical value	5% critical value	10% critical value	Decision
r=0	86.831	8.714	23.521	25.266	Reject H_0
r≤1	58.114	5.667	17.904	19.521	Reject H_0
r≤2	21.015	6.501	8.184	11.657	Reject H_0

Source: Author's computations (2026)

indicating a slightly skewed distribution (skewness = 0.378), with a moderate standard deviation of 0.197. LINDEX has a mean of 0.591 and a median of 0.627, suggesting a relatively symmetric distribution (skewness = −0.457). TEFF has a mean of 0.664 and

Table 11: Presentation and interpretation of over identification test

Test methodology	J-statistic	Prob (J statistic)
GMM test	44.915	0.518

Source: Author's computations (2026)

Table 12: List of banks in the sample

Country	Number of banks in sample	Bank name in the sample
Ghana	8	ADB, Cal, Ecobank, GCR, Republic Bank, SCB, and Trust Bank
Botswana	4	Absa, FNB, Investec, and SCB
Kenya	8	Stanbic, NCBA, KCB, Equity, DTKL, COBK, SCB, and Absa
Malawi	5	FNB, National Bank, NIT, NBS, and Standard Bank
Mauritius	2	Fincorp and NIT
Namibia	8	Capricon, First Rand, Investec, NAM, Nedbank, Standard Bank, Trustco, and Vikile
Nigeria	12	Abbey, Access, Ecobank, FCMB, Fidelity, Guaranty, Stanbic, Union, United, Unity, Wema, and Zithin
Rwanda	3	Equity, BK, and KCB
South Africa	7	Absa, Capitec, FINBOND, First Rand, Investec, Nedbank, and Standard Bank
Tanzania	2	CRDB and KCB
Zambia	2	SCB and ZNC
Zimbabwe	7	CBZ, NMBZ, ZB, Nedbank, Stanbic, and Agribank
Total number	66	

Source: Author's computations (2026)

Table 13: Presentation of results: Causality from CESINDEX to CAR

Variable	Coefficient	Standard error	t-statistic	Probability
C	−0.442	2.083	−0.212	0.832
CAR (−1)	22.795	12.298	1.854*	0.064
CAR (−2)	−20.264	11.192	−1.811*	0.071
CESINDEX (−1)	−0.823	1.179	0.698	0.486
CESINDEX (−2)	0.370	0.548	0.675	0.500

Source: Author's analysis (2026)

Table 14: Interpretation of Wald test results: From CESINDEX to CAR

Test statistic	Value	Degrees of freedom	Probability
F statistic	6.568	(4,589)	0.0000
Chi squared	26.272	4	`0.000

Source: Author's Analysis (2026)

Table 15: Presentation of Wald test results for causality from CESINDEX To CAR

Test statistic	Value	Degrees of freedom	Probability
F statistic	6.568	(4.589)	0.0000
Chi squared	26.272	4	`0.000

Source: Author's Analysis (2026)

a median of 0.653, with a slight negative skewness (−0.503), indicating a relatively platykurtic distribution (kurtosis = 3.053).

Table 16: Presentation of causality results: CAR To CESINDEX

Variable	Coefficient	Standard error	t-Statistic	Probability
C	−1.4.894	4.989	−2.986	0.003
CESINDEX (−1)	10.781	2.488	4.333	0.000
CESINDEX (−2)	−4.587	1.203	−3.814	0.000
CAR (−1)	36.751	38.574	0.953	0.341
CAR (−2)	−28.148	35.575	−0.791	0.429

Source: Author's analysis (2026)

Table 17: Wald restriction test results: Causality from CAR to CESINDEX

Test statistic	Value	Degrees pf freedom	Probability
F-Statistic	5.171	(4.589)	0.0004
Chi Squared	20.683	4	0.0004

Source: Author's analysis (2026)

Table 18: Robustness test: Causality from CESINDEX to LAR

Variable	Coefficient	Standard error	t-Statistic	Probability
LAR (−1)	0.0766	0.006	12.106***	0.000
CESINDEX (−1)	0.056	0.002	29.910***	0.000
CESINDEX (−2)	0.008	0.001	6.313	0.000

Source: Author's analysis (2026). J Hansen statistic=54.273; Probability of J Statistic=0.351; AR (1)=0.0019; AR (2)=0.6948, and ***means significant at 1% level

Table 19: Wald test robustness results: Causality from CESINDEX to LAR

Test statistic	Value	Degrees of freedom	Probability
F statistic	7.070	(3.589)	0.0001
Chi squared	21.208	3	0.0001

Source: Author's Analysis (2026)

ZSCORE has a mean of 0.302, with a high standard deviation of 2.693 and a skewness of 0.102, suggesting a relatively symmetric but platykurtic distribution (kurtosis = 2.581). CESINDEX has a mean of 0.090, a high standard deviation of 5.006, and a skewness of 0.414, indicating a relatively asymmetric distribution. Overall, the variables exhibit varying degrees of skewness and kurtosis, highlighting the importance of considering these characteristics in further analysis.

The first-generation unit root test results indicate that all variables (CAR, LERNER INDEX, TEFF, ZSCORE, and CESINDEX) are stationary at level, i.e., I(0), as all $P < 0.05$, suggesting no unit root and allowing for standard econometric analysis without spurious regression concerns (Table 2).

The second-generation unit root test results confirm that all variables (CAR, LERNER INDEX, TEFF, ZSCORE, and CESINDEX) are stationary at level, i.e., I(0) (Table 3). Most tests (CADF, CIP, and PANIC) show $P < 0.05$, indicating no unit root, except for a few borderline cases (LERNER INDEX CADF $P = 0.061$, TEFF CADF $P = 0.053$, and CAR PANIC $P = 0.058$), which are still considered stationary given the overall evidence. This supports using standard econometric techniques for analysis.

The outlier detection results indicate that all variables (CAR, LERNER INDEX, TEFF, ZSCORE, and CESINDEX) have outliers, as their absolute Z-values exceed 2 (Table 4). To address this, the data for all variables were transformed using the max-min approach, which likely involved rescaling the data to a common range, thereby reducing the impact of extreme values and improving the robustness of subsequent analyses.

The cross-sectional dependency test results indicate no evidence of cross-sectional dependence among the variables. Pesaran's CD test (0.789, P = 0.594), Friedman's test (1.785, P = 0.358), Frees' test (0.922, P = 0.327), and Breusch-Pagan LM test (Chi-squared = 0.368, P = 0.689) all have P > 0.05, suggesting that the null hypothesis of no cross-sectional dependence cannot be rejected (Table 5). This implies that the variables are likely independent across sections, allowing for standard panel data analysis techniques to be applied without adjustments for cross-sectional dependence.

The normality test results indicate that the data follows a normal distribution (Table 6). The Jarque-Bera test statistic is 2.125, with a P = 0.742, which is >0.05, suggesting that the null hypothesis of normality cannot be rejected. Additionally, the skewness (0.003) is close to 0, and the kurtosis (2.971) is close to 3, further supporting the normality of the data. This implies that the data meets the normality assumption, allowing for the use of parametric statistical tests and techniques that assume normality.

The heteroscedasticity test results indicate that the variance of the residuals is constant, suggesting homoscedasticity (Table 7). The Breusch-Pagan test (Chi-squared = 0.278, P = 0.615) and White's test (Chi-squared = 0.193, P = 0.253) both have P > 0.05, indicating that the null hypothesis of homoscedasticity cannot be rejected. This implies that the error terms have constant variance, meeting one of the key assumptions of linear regression, and suggesting that the model's estimates are reliable and efficient.

The autocorrelation test results indicate that there is no autocorrelation in the residuals (Table 8). The Arellano-Bond tests for AR (1) and AR (2) have P = 0.145 and 0.231, respectively, both >0.05, suggesting that the null hypothesis of no autocorrelation cannot be rejected. This implies that the model's residuals are not serially correlated, meeting one of the key assumptions of the GMM estimator, and indicating that the model's estimates are reliable and efficient.

The correlation matrix reveals relationships between variables (Table 9). Notably, CAR is moderately correlated with ZSCORE (0.67) and weakly correlated with CESINDEX (0.21) and ROA (0.19). LINDEX has weak correlations with CESINDEX (0.39) and GDP (0.13). TEFF is weakly correlated with ZSCORE (−0.41) and CESINDEX (0.29). ZSCORE is moderately correlated with CESINDEX (0.35) and ROA (0.40). Most correlations are weak to moderate, suggesting no severe multicollinearity issues (none exceed 0.8). The results indicate that the variables can be used together in a regression model without significant multicollinearity concerns (Tables 10-13).

The Wald test confirms that the competition-efficiency-stability index (CESINDEX) is jointly significant in explaining variations in capital structure, as measured by the capital assets ratio (CAR) (Table 14). The statistically significant F-statistic and Chi-square values validate the rejection of the null hypothesis, affirming that CESINDEX has a significant causal influence on CAR. This finding provides a more comprehensive understanding of the factors driving capital structure decisions than models that examine single dimensions in isolation. Unlike previous studies that established causal links between individual factors and capital structure, this research offers a unified framework that captures the interplay between competition, efficiency, and stability. By introducing CESINDEX, this study provides a more nuanced understanding of the institutional realities of African banks, where these factors co-evolve and jointly influence capital decisions, offering a more accurate and context-sensitive explanation of capital structure dynamics.

The causality results indicate that the CESINDEX exerts a unidirectional influence on the capital asset ratio (CAR), highlighting the institutional determinants of bank capitalization in African banking systems (Table 15). This relationship operates through three interdependent transmission mechanisms: competition, which incentivizes banks to maintain adequate capital buffers amid market rivalry; efficiency, which enhances internal capital generation through cost reduction and asset productivity; and stability, which bolsters depositor and investor confidence, reducing funding costs and facilitating capital accumulation. The findings suggest that banks adjust their capital structures in response to systemic institutional conditions rather than shaping them, reflecting proactive capital planning in robust institutional contexts and reactive strategies in more fragile environments. Theoretical interpretation under agency cost theory indicates that CESINDEX mitigates managerial opportunism by enforcing market discipline, improving operational accountability, and lowering monitoring costs, thereby guiding prudent capital accumulation. Compared to prior studies focused on isolated firm variables, these results extend empirical understanding by demonstrating that the combined interactions of competition, efficiency, and stability systematically drive capital structure decisions, emphasizing the importance of institutional dynamics in shaping leverage in emerging banking systems.

The results in Table 16 below reveal a statistically significant and dynamic relationship between CESINDEX and CAR, with both lagged CESINDEX terms exhibiting high significance (P < 0.01). Specifically, CESINDEX (−1) yields a robust positive effect (10.781, P = 0.000), whereas CESINDEX (−2) manifests a significant negative effect (−4.587, P = 0.000).

The findings indicate that the relationship between the competition-efficiency-stability index (CESINDEX) and capital structure is complex and nuanced, with recent increases in competition, efficiency, and stability having a positive effect on capital ratios, while past increases have a dampening effect. This suggests that the impact of these institutional factors on capital structure decisions evolves over time. Additionally, the capital structure appears to be influenced more by current changes in CESINDEX rather than past levels of capital structure itself, as evidenced by the

statistically insignificant lagged capital assets ratio (CAR) values. The significant and negative constant term suggests that, in the absence of CESINDEX effects, there is a downward shift in the baseline CAR level, highlighting the importance of CESINDEX in shaping capital structure decisions.

The results reveal a complex and dynamic causal interplay between the CAR and CESINDEX. The unidirectional causality from CAR to CESINDEX indicates that banks' capital structures actively shape institutional conditions by influencing competition, efficiency, and stability (Table 17). Strong capitalization enhances risk absorption, operational efficiency, and strategic positioning, signalling financial strength and fostering investor confidence, which in turn reinforces systemic stability and market discipline. Conversely, the unidirectional causality from CESINDEX to CAR highlights that institutional dynamics drive banks' capital decisions, with robust competition, efficiency, and stability shaping proactive capital planning, while weaker institutions induce reactive or constrained strategies. When combined, the bidirectional causality demonstrates a feedback loop: CAR empowers governance and market outcomes, while institutional quality simultaneously guides capital strategies, creating a mutually reinforcing relationship. These dynamics operate through risk management, asset allocation, signalling, and monitoring channels, reflecting agency cost theory where capital structure and institutional pressures jointly mitigate managerial opportunism. In African banking systems, characterized by institutional heterogeneity, this reciprocal causality underscores the critical need for integrated capital and institutional policies to enhance bank resilience, competitiveness, and systemic stability.

The Wald test F-statistic for the robustness model examining the causality from interactions to capital structure is recorded at 7.070, with 3 degrees of freedom in the numerator and 589 degrees of freedom in the denominator. This result demonstrates statistical significance at the 0.0001 probability level, allowing for the rejection of the null hypothesis that posits no causality (Tables 18 and 19).

The robustness tests confirm and reinforce the main findings of bidirectional causality between CESINDEX and capital structure, now proxied by the liabilities-assets ratio (LAR). CESINDEX exhibits a significant positive effect on LAR, with a coefficient of 0.056 for CESINDEX (−1) and a smaller but persistent effect of 0.008 for CESINDEX (−2), supported by a Wald F-statistic of 7.070 and a Chi-squared value of 21.208, both significant at the 0.0001 level. Conversely, LAR also significantly influences CESINDEX, with LAR (−1) having a coefficient of 0.371 and LAR (−2) −0.713, while CESINDEX (−1) and CESINDEX (−2) show coefficients of 0.075 and −0.142 respectively; the Wald F-statistic of 6.463 and Chi-squared of 19.389 ($P < 0.001$) confirm this effect. Diagnostic tests, including Hansen J-statistics (53.059 and 54.273) and AR (2) tests (0.079 and 0.6948), validate model specification and instrument reliability. These figures closely align with previous CAR–CESINDEX results, confirming a robust, bidirectional causal relationship, demonstrating that institutional dynamics and capital structure mutually influence each other consistently across different leverage measures, with implications for strategic bank management and policy design.

5. CONCLUSION

This study concludes that there is a significant bidirectional causal relationship between the combined interaction of competition, efficiency, and stability (CESINDEX) and capital structure in African commercial banks. The results show that institutional dynamics captured by CESINDEX drive capital structure decisions, as banks adjust capital buffers in response to competitive pressures, efficiency gains, and stability considerations, while capital structure simultaneously influences institutional outcomes by shaping risk management, operational efficiency, and competitive behaviour. These causal dynamics differ from analyses of each dimension in isolation, highlighting the importance of considering their combined effect. Explicitly accounting for the CES interaction provides a more accurate and comprehensive explanation of capitalization behaviour, demonstrating that integrated institutional management is critical for resilience. Overall, the findings emphasize that both institutional conditions and capital decisions co-evolve, underscoring the need for policies and managerial strategies that recognize the reciprocal and dynamic nature of the CES–capital structure relationship in fragile African banking systems.

This study makes several important contributions by establishing a robust bidirectional causal relationship between the capital assets ratio (CAR) and the composite CESINDEX, demonstrating that capital structure and institutional dynamics mutually shape each other rather than following a unidirectional path. Methodologically, it introduces novelty by integrating CESINDEX as a multidimensional measure of competition, efficiency, and stability within a two-step System GMM framework, addressing endogeneity, simultaneity, and dynamic feedback, while robustness checks with alternative capital proxies confirm the validity of the results. Practically, the findings inform banks on proactive capital management, enabling dynamic stress testing, risk-adjusted performance monitoring, and governance frameworks aligned with institutional conditions. Policy-wise, embedding CESINDEX into regulatory assessments supports adaptive macroprudential measures, early warning systems, and targeted oversight, improving resilience in fragmented African banking systems. Nonetheless, limitations such as potential reverse causality, omitted variables, measurement errors, sample constraints, and structural breaks necessitate cautious interpretation, guiding future research toward larger datasets, higher-frequency analysis, alternative models, and advanced econometric or machine learning techniques to further validate and refine understanding of the CAR–CESINDEX feedback nexus.

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