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-RESEARCH ARTICLE-

UNDERWRITING RISK VOLATILITY AND SOLVENCY SUSTAINABILITY: A DYNAMIC PANEL ANALYSIS OF SAUDI INSURANCE COMPANIES (2018–2024)

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─Abstract─

Underwriting risk volatility constitutes a pivotal determinant of solvency sustainability in insurance markets governed by risk-based supervisory systems. From the perspective of operations management theory, such volatility may be interpreted as a manifestation of process variability within operational systems, thereby affecting both systemic stability and the robustness of capital structures. This study employs firm-level panel data from Saudi insurance companies spanning 2018 to 2024, analysed through a dynamic panel estimation technique, specifically System GMM, to account for persistence in capital levels, potential endogeneity, and adjustment behaviour over time. The empirical results demonstrate that fluctuations in underwriting risk impose a statistically significant and economically substantive adverse influence on solvency sustainability. Solvency ratios display notable yet partial persistence, indicating that capital adjustment occurs progressively rather than through immediate self-correction mechanisms. Furthermore, the analysis reveals a non-linear threshold pattern, whereby the erosion of capital intensifies once volatility exceeds tolerable bounds. In addition, reliance on reinsurance is found to alleviate the negative consequences associated with underwriting variability, thereby supporting the role of risk transfer arrangements as organisational stabilisers. Concurrently, enhancements in risk-based supervisory frameworks implemented after 2020 are shown to intensify the linkage between underwriting volatility and solvency performance. Collectively, these findings contribute to the advancement of operations and production management literature by linking process variability concepts with risk-based capital structures and the evolving context of regulatory reform. Empirical insights drawn from a transitioning emerging insurance market highlight the critical necessity of maintaining operational rigour

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alongside regulatory coherence to ensure sustained capital resilience under conditions of uncertainty.

Keywords: Underwriting Risk Volatility, Solvency Sustainability, Operational Variability, Dynamic Panel Analysis, Insurance Regulation, Capital Resilience, Saudi Insurance Market, Vision 2030, System GMM.

INTRODUCTION

Solvency sustainability represents a core foundation for stability within insurance markets, given that insurers are inherently exposed to underwriting risk stemming from uncertainty in claims, inaccuracies in pricing, and deviations in reserve estimation (Cummins & Weiss, 2014; Harrington, 2009; IAIS, 2019). Within risk-based supervisory structures, capital adequacy operates as the principal safeguard against unforeseen underwriting losses, thereby supporting long-term financial robustness (Cummins & Weiss, 2014; IAIS, 2019). Accordingly, fluctuations in underwriting performance have the potential to materially affect capital stability and the continuity of solvency, particularly in contexts marked by intensified regulatory requirements and heightened competitive pressures (Berger & Bouwman, 2013; Harrington, 2009). Underwriting risk volatility denotes the degree of instability in claims experience relative to earned premiums and technical provisions. In contrast to static indicators such as average loss ratios, volatility-based measures capture dispersion and uncertainty in underwriting outcomes, which are central to determining capital needs within risk-based capital regimes (Biener & Eling, 2012; IAIS, 2022). From the standpoint of financial stability, elevated volatility may erode the persistence of profitability, constrain retained earnings, and heighten the likelihood of solvency weakening (Harrington & Niehaus, 2003; IAIS, 2019). Furthermore, pressure on capital induced by volatility may trigger procyclical underwriting responses, thereby intensifying systemic fragility across insurance markets (Acharya, 2009; IAIS, 2022). The Saudi insurance sector offers a particularly suitable empirical context for analysing these dynamics. Over recent years, the market has experienced extensive regulatory restructuring aligned with Vision 2030, encompassing reinforced solvency surveillance, expanded supervisory intervention, and improved transparency linked to the adoption of IFRS 17 (Insurance Authority, 2023; Saudi Central Bank, 2022; Vision 2030, 2016). These institutional developments have heightened the responsiveness of solvency outcomes to underwriting performance and risk exposure, while simultaneously fostering convergence with international regulatory benchmarks, including IAIS standards and risk-based capital frameworks (IAIS, 2019; IMF, 2021). Moreover, the implementation of IFRS 17 introduces a forward-looking valuation of insurance liabilities, thereby strengthening the interaction between underwriting outcomes and capital adequacy (Deloitte, 2022; EY, 2023; PwC, 2022).

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From an operations management viewpoint, underwriting volatility can be interpreted as a manifestation of variability within operational processes that influences the consistency of organisational outputs. Variability in both manufacturing and service operations is widely acknowledged as a critical driver of inefficiencies and the need for buffering mechanisms (Hopp & Spearman, 2008; Schmenner & Swink, 1998; Slack & Brandon-Jones, 2019). Within insurance operations, capital serves as a strategic buffer that absorbs shocks generated by fluctuations in underwriting performance and claims variability (Hopp & Spearman, 2008; Schmenner & Swink, 1998). Consequently, integrating principles from operations management with insurance risk analysis offers a more comprehensive framework for examining solvency behaviour under uncertain conditions.

This study investigates the evolving relationship between underwriting risk volatility and solvency sustainability using firm-level panel data from Saudi insurers covering the period 2018–2024. A dynamic panel estimation methodology, specifically System GMM, is employed to account for persistence in solvency indicators, address potential endogeneity between risk exposure and capital, and evaluate the moderating influence of regulatory reforms (Arellano & Bond, 1991; Blundell & Bond, 1998; Roodman, 2009). Such an approach enables more reliable inference than static specifications, particularly in the presence of dynamic adjustment mechanisms and unobserved firm-specific effects. The study makes three principal contributions. First, it measures underwriting risk through volatility-oriented metrics rather than static ratios, thereby offering a more precise representation of risk exposure under uncertainty (Biener & Eling, 2012; IAIS, 2022). Second, it combines operational variability theory with risk-based capital perspectives to explain solvency dynamics, thus addressing the disconnect between operations management and insurance finance research (IAIS, 2019; Schmenner & Swink, 1998). Third, it delivers new empirical insights from an emerging insurance market undergoing substantial regulatory evolution under Vision 2030, contributing to the relatively limited body of knowledge on insurance sector development in emerging economies (IMF, 2021; OECD, 2022).

Additionally, the study advances the expanding discourse on digital regulatory governance in financial services. The Saudi insurance industry is progressively integrating digital supervisory infrastructures, regulatory reporting systems, and data-centric monitoring tools within the Vision 2030 framework. These developments align with broader global movements towards digital financial oversight, RegTech adoption, and data-driven supervisory practices (Arner et al., 2017). Examining the linkage between underwriting volatility and solvency sustainability therefore offers meaningful implications for digital supervision, real-time risk assessment, and the advancement of eGovernment-based regulatory systems in the insurance domain.

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LITERATURE REVIEW

Underwriting Risk Volatility as Operational Process Variability

Within operations and production management theory, variability is extensively acknowledged as a central factor contributing to system instability, operational inefficiency, and declining performance outcomes (Flynn et al., 2009; Hopp & Spearman, 2008; Schmenner & Swink, 1998). In service-oriented sectors such as insurance, underwriting functions may be interpreted as fundamental production processes, where activities including risk assessment, pricing decisions, and claims handling constitute essential operational inputs and outputs (Cummins & Weiss, 2014; Harrington & Niehaus, 2003). From this analytical standpoint, underwriting risk volatility can be understood as a manifestation of process variability that interrupts operational continuity, heightens uncertainty in capacity allocation, and weakens the predictability of system performance (Ivanov & Dolgui, 2020; Schmenner & Swink, 1998). Fluctuations in claims outcomes, often captured through variations in loss ratios, reflect departures from actuarial benchmarks and underwriting discipline, thereby signalling deficiencies in risk segmentation, pricing precision, and reserve adequacy (Cummins & Weiss, 2014; Harrington & Niehaus, 2003). Operational variability theory further suggests that systems subject to elevated uncertainty necessitate greater buffering capacity to sustain stable performance levels (Hopp & Spearman, 2008; Schmenner & Swink, 1998). Within the insurance context, capital operates as a critical buffer that mitigates the effects of shocks arising from underwriting uncertainty and claims variability. As a result, heightened underwriting risk volatility is associated with increased capital demands and the compression of solvency margins under risk-based capital regimes (IAIS, 2019, 2022). This framing provides a coherent linkage between operations management principles and the analysis of insurance solvency dynamics.

Risk-Based Capital and Operational Risk Transmission

Risk-based capital (RBC) frameworks determine regulatory capital requirements in accordance with insurers' exposure to underwriting, market, credit, and operational risks, thereby strengthening the risk sensitivity of solvency evaluation (IAIS, 2019). Within this structure, volatility in underwriting risk intensifies the magnitude of unexpected losses, placing additional pressure on capital and contributing to the weakening of solvency ratios (IAIS, 2022; OECD, 2022). From an operations management viewpoint, this phenomenon aligns with the cost-of-variability principle, whereby unstable processes necessitate greater resource commitment to preserve system robustness (Hopp & Spearman, 2008; Schmenner & Swink, 1998). Empirical research on operational disruptions further indicates that heightened variability is associated with system fragility, diminished persistence in financial performance, and elevated exposure to risk (Ivanov & Dolgui, 2020; Schmenner & Swink, 1998). In the

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insurance domain, prior empirical findings reveal that increased volatility in loss ratios corresponds with higher capital requirements, reduced stability of earnings, and a greater likelihood of insolvency (Harrington, 2009; OECD, 2022). Nevertheless, a substantial proportion of the existing evidence is derived from developed insurance markets, resulting in limited insight into how underwriting volatility influences capital adequacy within emerging markets experiencing ongoing regulatory transformation.

Solvency Sustainability as an Operations Resilience Outcome

Solvency sustainability encompasses more than immediate capital sufficiency and denotes an insurer's capacity to preserve financial viability amid ongoing operational and financial uncertainty (Berger & Bouwman, 2013; Cummins & Weiss, 2014). Within operations management research, resilience is characterised as the ability of a system to withstand shocks, adjust to disturbances, and restore functionality without compromising its core performance (Ivanov & Dolgui, 2020). When resilience theory is applied to insurance operations, it implies that firms maintaining stable underwriting processes are better positioned to sustain consistent capital adequacy and face a lower probability of insolvency (Cummins & Weiss, 2014; IAIS, 2019). In contrast, elevated underwriting volatility contributes to fluctuations in earnings, constrains the accumulation of retained profits, and weakens the foundation of long-term solvency sustainability (Harrington, 2009; IAIS, 2019). The adoption of IFRS 17 further strengthens this linkage by introducing a forward-looking and market-aligned approach to valuing insurance liabilities, thereby enhancing transparency in insurance service outcomes and increasing the responsiveness of solvency measures to underwriting performance (Deloitte, 2022; EY, 2023; PwC, 2022). Consequently, underwriting volatility emerges as a structural driver of solvency sustainability within contemporary regulatory frameworks.

Emerging Market Context and Regulatory Transformation

Insurance markets in emerging economies typically exhibit elevated volatility, driven by rapid expansion, intensified pricing competition, and continuously evolving regulatory structures (IAIS, 2022; OECD, 2022). Such conditions heighten exposure to underwriting risk while magnifying the financial consequences of operational inefficiencies, thereby exerting additional pressure on overall stability. The Saudi insurance sector represents a distinctive setting for analysing these dynamics. In alignment with Vision 2030, the industry has experienced substantial regulatory restructuring, including strengthened supervisory control, more rigorous solvency standards, and improved disclosure through the adoption of IFRS 17 (Saudi Central Bank, 2022, 2024; Vision 2030, 2016). These developments have facilitated convergence with global regulatory benchmarks, particularly IAIS guidelines and risk-based capital frameworks (IAIS, 2019; IMF, 2021). Although such reforms enhance

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risk sensitivity and promote financial discipline, they simultaneously intensify the responsiveness of capital adequacy to fluctuations in underwriting performance. In this context, operational instability is transmitted more directly into solvency outcomes, thereby reinforcing the linkage between underwriting risk and capital sustainability. Notwithstanding these institutional transformations, empirical evidence examining the connection between underwriting process variability and solvency sustainability within emerging insurance markets remains relatively limited (OECD, 2022).

Research Gap

Drawing upon the existing body of literature, three principal research gaps emerge. First, there is a notable lack of integration between operations management perspectives, particularly those centred on variability and resilience, and the analysis of insurance solvency, despite the strong conceptual alignment between these domains (Ivanov & Dolgui, 2020; Schmenner & Swink, 1998). Second, much of the prior research relies on static indicators of underwriting performance, which inadequately reflect volatility dynamics and persistence patterns. Moreover, limited use has been made of advanced econometric techniques, such as dynamic panel modelling, that are capable of capturing these effects more effectively (Arellano & Bond, 1991; Roodman, 2009). Third, there is a scarcity of empirical evidence from emerging insurance markets undergoing regulatory transformation, including Saudi Arabia, particularly in relation to the implications of IFRS 17 implementation and the expansion of digital regulatory supervision In response to these limitations, the present study conceptualises underwriting risk volatility as a manifestation of operational process variability and empirically investigates its influence on solvency sustainability. This is achieved by analysing firm-level panel data for Saudi insurance companies for the period from 2018 to 2024.

METHODOLOGY

This study utilises a quantitative panel data methodology to investigate the proposed relationships. Approaches of this nature are extensively applied in operations and financial performance research to analyse dynamic linkages between operational variability and organisational sustainability outcomes (Flynn et al., 2009). The selection of this method is well aligned with the study's objective, which involves operationalising underwriting risk volatility as a dimension of process variability and evaluating its effect on solvency sustainability within a risk-based supervisory context. A longitudinal research design is implemented using firm-level panel data for Saudi insurance companies spanning the period 2018–2024. The panel structure facilitates the control of unobserved firm-specific heterogeneity while enabling the examination of both cross-sectional variation and temporal dynamics. This is particularly relevant in

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the context of capital adequacy, where persistence and gradual adjustment processes are commonly observed. The empirical specification is informed by dynamic capital adjustment theory alongside operational variability theory. Within this framework, solvency sustainability is modelled as a function of underwriting risk volatility, while incorporating relevant firm-level and market-related control variables.

Data Sources

The dataset was constructed from publicly available and regulatory sources. Financial and underwriting data were collected from:

1. Annual audited financial statements of Saudi insurance companies
2. Solvency and Risk-Based Capital disclosures issued by the Saudi Central Bank (SAMA)
3. Supervisory and statistical reports published by the Saudi Insurance Authority
4. IFRS 17 insurance service result disclosures where available

Only firms exhibiting continuous reporting throughout the study period were included to maintain data consistency. Entities with missing information on underwriting performance or capital positions were removed from the final sample in order to ensure the robustness of the analysis.

Variable Measurement

Dependent Variable

Solvency Sustainability

Solvency sustainability is proxied using risk-based capital adequacy measures, including:

1. Risk-Based Capital (RBC) Ratio
2. Capital Buffer (excess capital over required regulatory capital)

These measures capture the firm's capacity to withstand unforeseen underwriting losses while continuing to satisfy regulatory requirements.

Independent Variable

Underwriting Risk Volatility

Underwriting risk volatility is operationalised as a measure of process variability using:

1. Rolling three-year standard deviation of the loss ratio
2. Claims ratio dispersion

This volatility-oriented approach reflects fluctuations in underwriting performance, rather than relying on static average outcomes.

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Control Variables

To isolate the effect of underwriting volatility, the model includes:
1. Firm Size (Log of Total Assets)
2. Reinsurance Dependence Ratio
3. Combined Ratio
4. Investment Income Ratio
5. Market Share

These control variables align with established findings in prior research on capital adequacy and financial stability within insurance markets (Cummins & Weiss, 2014; OECD, 2022).

Econometric Specification

Considering the inherently dynamic nature of capital adequacy, along with the potential endogeneity between underwriting risk and solvency, the study applies a dynamic panel estimation technique based on the System Generalised Method of Moments (System GMM). This method accounts for:
1. Unobserved Firm-Specific Effects
2. Endogeneity Arising from Reverse Causality
3. Persistence in Capital Ratios

The baseline model is specified as:

$$Solvency\_it = \alpha + \rho\ Solvency\_it{-}1 + \beta\ Volatility\_it + \gamma\ Controls\_it + \mu\_i + \varepsilon\_it$$

Solvency_it represents capital adequacy for firm i at time t.
Volatility_it measures underwriting risk volatility.
μ_i captures firm-specific fixed effects.
ε_it is the idiosyncratic error term.

Instrument validity is tested using Hansen's J-statistic, and serial correlation is assessed using AR (1) and AR (2) tests.

Robustness and Additional Analyses

To strengthen the reliability of the findings and align with the methodological standards expected in the IJOPM, a series of robustness checks are implemented:
1. Fixed-Effects and Random-Effects Estimations
2. Quantile Regression to Assess Capital-Stressed Firms
3. Alternative Volatility Measures
4. Sub-Sample Analysis Across Insurance Segments

These supplementary estimations help confirm that the findings are not influenced by model specification choices or biases arising from sample selection.

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Methodological Contribution

The adopted methodological framework advances operations and production management research by framing underwriting volatility as a form of operational process variability and establishing its empirical connection to capital sustainability. The use of a dynamic panel design offers a robust analytical structure for evaluating system resilience under regulatory pressure within an emerging insurance market.

ANALYSIS OF THE LITERATURE: AN EXTENDED MODEL

Using the conceptual framework derived from the literature review, four distinct clusters of factors were identified for inclusion in an expanded model linking underwriting risk volatility to solvency sustainability. These clusters capture the primary mechanisms through which operations management literature explains the emergence, propagation, mitigation, and amplification of operational variability within institutional settings.

Underwriting Volatility Equation

Underwriting volatility is measured as the rolling three-year standard deviation of the loss ratio, calculated as:

$$Volatility_{it} = SD(LossRatio_{i,t-2}, LossRatio_{i,t-1}, LossRatio_{it})$$

In this context, the loss ratio is defined as incurred claims relative to earned premiums. The use of a rolling-window method enables the capture of short-term fluctuations in underwriting performance, thereby reflecting the variability dimension highlighted in operational variability theory.

Internal Operational Underwriting Aspects (Process-Level Variability)

The first cluster encompasses internal underwriting and claims-handling activities that determine the extent of loss and claims variability at the firm level. From an operations management perspective, underwriting may be interpreted as a core production process in which the quality of inputs (risk selection), the effectiveness of process execution (pricing strategies, policy design, and claims processing), and the strength of control systems (reserve management practices) collectively influence variability in outcomes. This group includes the following elements:

1. Accuracy in pricing decisions and risk classification
2. Efficiency of claims handling and associated processing times
3. Discipline in reserving and adequacy of technical provisions
4. Consistency of loss ratios and stability of technical performance results

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These internal factors constitute the main origin of variability in underwriting operations. Elevated process inconsistency leads to wider dispersion in claims outcomes relative to earned premiums, thereby increasing exposure to unexpected losses and undermining the stability of financial performance.

Capital Transmission Mechanism (Risk-Based Solvency Layer)

The second cluster captures the transmission mechanism through which underwriting volatility affects solvency outcomes within risk-based supervisory systems. In such regulatory environments, capital adequacy functions as a safeguard to absorb unforeseen underwriting losses while ensuring the protection of policyholders. Increased volatility in underwriting elevates the level of capital required and exerts pressure on the sustainability of solvency through several channels:

1. Increased capital requirements under risk-sensitive solvency frameworks
2. Gradual depletion of capital buffers due to fluctuating technical performance
3. Persistence and adjustment patterns observed in solvency ratios over time
4. Heightened supervisory scrutiny alongside expectations for capital restoration

This cluster is a critical component of the extended framework, as it establishes the link between operational variability and system stability, thereby aligning the conceptual foundation with capital resilience principles emphasised in regulatory and financial stability literature.

Organisational Buffering and Risk Mitigation Mechanisms

Operations management research highlights that systems exposed to high variability require buffering strategies to sustain stable outputs. In the context of insurance, such buffering is implemented through financial and operational risk mitigation mechanisms that temper the impact of underwriting volatility on solvency. Key elements include:

1. Dependence on reinsurance and the design of risk-transfer arrangements
2. Diversification of portfolios across business lines and market segments
3. Quality of risk governance and the effectiveness of underwriting controls
4. Management of concentration and adherence to exposure limits

These mechanisms are anticipated to decrease the sensitivity of capital to underwriting fluctuations by smoothing loss patterns, limiting extreme exposures, and stabilising technical performance. As a result, they function as moderating factors within the extended framework.

Institutional and Regulatory Context (Vision 2030 Environment)

The fourth cluster reflects the external institutional setting that influences both operational conduct and the mechanisms through which capital is adjusted. The Saudi

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insurance sector has experienced significant regulatory reinforcement under Vision 2030, characterised by strengthened supervisory requirements and enhanced transparency, particularly through disclosures associated with IFRS 17. The key contextual dimensions include:

1. A shift towards a more risk-sensitive supervisory framework
2. Greater transparency in reporting insurance service performance
3. Changes in competitive conditions and market structure
4. Intensified regulatory enforcement and supervisory oversight

The institutional environment may intensify the relationship between underwriting volatility and solvency by increasing capital scrutiny and limiting managerial flexibility in provisioning and capital reporting. Consequently, fluctuations in underwriting performance become more directly reflected in solvency outcomes.

Figure 1 is introduced at this point to consolidate the study logic into four connected layers: operational underwriting variability, capital transmission, buffering mechanisms, and the regulatory context. The figure, therefore, serves as the visual anchor for the hypotheses developed in the following subsection.

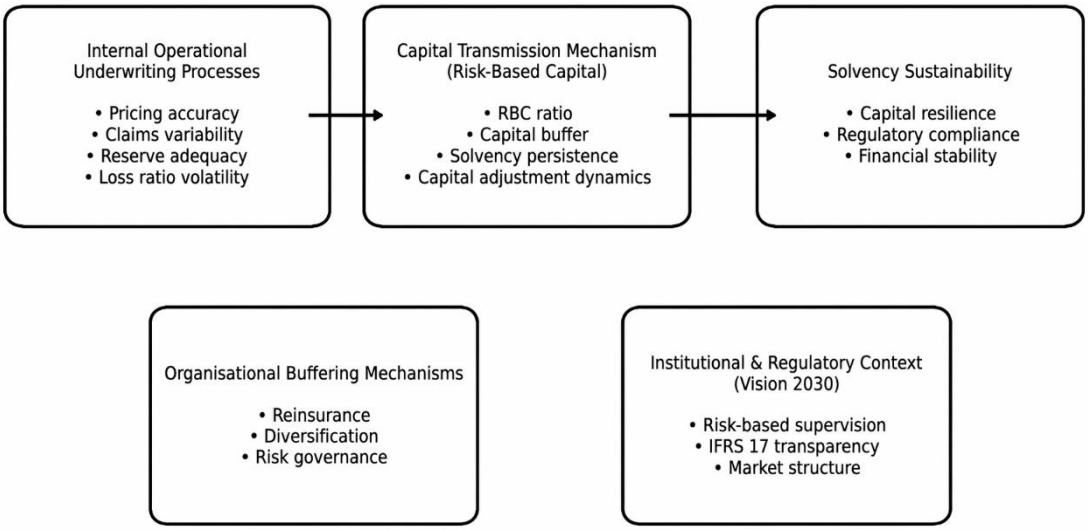

Figure 1: An extended conceptual framework of the volatility–solvency relationship under a risk-based supervisory regime.
Source: Developed by the author.

Hypotheses Development

Building on the extended framework outlined above, this section formulates testable hypotheses that connect underwriting risk volatility to solvency sustainability within a risk-based supervisory environment.

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Operational Underwriting Volatility and Solvency Sustainability

Operations management theory posits that increased process variability undermines system stability while elevating the requirement for buffering resources. Within insurance operations, underwriting functions as a central production process in which the accuracy of pricing decisions, the rigour of claims assessment, and the adequacy of reserves collectively determine the dispersion of loss outcomes. As underwriting volatility intensifies, the likelihood of unexpected losses rises, exerting pressure on both retained earnings and regulatory capital. Within risk-based solvency frameworks, capital requirements are calibrated to reflect underwriting risk exposure. Consequently, greater volatility in loss ratios increases capital strain, erodes buffering capacity, and diminishes the long-term sustainability of solvency ratios. Accordingly, underwriting volatility is anticipated to exert a negative influence on solvency sustainability.

H1: *Underwriting risk volatility is negatively associated with solvency sustainability.*

Capital Adjustment Dynamics and Persistence

Solvency ratios generally display persistence, reflecting regulatory constraints and the presence of costs associated with capital adjustment. However, heightened underwriting volatility can intensify the depletion of capital and reduce the degree of persistence in solvency performance. Firms subject to unstable underwriting outcomes are therefore more prone to greater fluctuations in capital adequacy and slower recovery trajectories. From the standpoint of dynamic capital adjustment theory, increased volatility disturbs the equilibrium state and accelerates downward adjustments in solvency levels.

H2: *Higher underwriting risk volatility reduces the persistence and stability of capital adequacy over time.*

Organisational Buffering Mechanisms as Moderators

Operations management theory highlights the importance of buffering mechanisms as stabilising instruments in environments characterised by high variability. Within insurance markets, instruments such as reinsurance, portfolio diversification, and robust risk governance frameworks function as absorptive mechanisms that mitigate the propagation of underwriting volatility into capital stress. Accordingly, insurers with greater reliance on reinsurance or with more diversified underwriting portfolios are expected to exhibit a diminished negative association between underwriting volatility and solvency sustainability.

H3: *Organisational buffering mechanisms moderate the relationship between underwriting risk volatility and solvency sustainability, weakening its negative impact.*

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Non-Linearity and Threshold Effects

The impact of process instability on solvency is unlikely to follow a strictly linear pattern. At moderate levels, volatility can typically be accommodated within existing capital buffers; however, when volatility becomes excessive, it may lead to disproportionately rapid capital erosion. This pattern is consistent with resilience theory, which posits that systems can reach tipping points beyond which stability declines abruptly. Accordingly, the relationship between underwriting volatility and solvency sustainability is expected to strengthen once volatility exceeds a critical threshold.

H4: *The negative effect of underwriting risk volatility on solvency sustainability increases beyond a critical volatility threshold.*

Institutional Context and Regulatory Amplification

The regulatory environment plays a crucial role in shaping how operational variability is translated into financial outcomes. Under more stringent supervisory regimes and enhanced disclosure requirements, fluctuations in underwriting performance are more directly incorporated into measures of solvency. In markets undergoing regulatory reform and operating within risk-based frameworks, increased supervisory intensity can strengthen the relationship between underwriting volatility and capital adequacy, thereby amplifying the observed impact on solvency outcomes.

H5: *The negative relationship between underwriting risk volatility and solvency sustainability is stronger under a risk-based supervisory regime characterised by enhanced regulatory oversight.*

Capital Adjustment Dynamics and Persistence

Solvency ratios generally display persistence, driven by regulatory requirements and the costs associated with adjusting capital positions. Nevertheless, higher levels of underwriting volatility can intensify capital depletion and weaken the persistence of solvency performance. Firms facing unstable underwriting conditions are therefore more likely to encounter pronounced fluctuations in capital adequacy, alongside slower recovery processes. From the perspective of dynamic capital adjustment theory, increased volatility disrupts the equilibrium state and accelerates downward adjustments in solvency positions. The final sample comprises a balanced panel of 30 insurance companies operating in the Saudi domestic market over the period 2018–2024, yielding a total of 210 firm-year observations. Inclusion criteria required the availability of complete financial and underwriting data across the entire study period. Any observations with missing solvency metrics or incomplete underwriting information were excluded to maintain data integrity and ensure the robustness of the panel dataset.

To clarify the market context before presenting the firm-level estimations, Table 1 summarises annual premium growth, underwriting conditions, profitability outcomes, and their solvency implications across the Saudi insurance market during 2018–2024.

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Table 1: Annual Underwriting Performance and Growth Trend (2018–2024)

Year	Gross Written Premiums (SR bn)	Growth Rate %	Loss Ratio Trend	Profitability Outcome	Solvency Implication
2018	35.0	- 4.1%	Market Contraction	Weak Underwriting	Capital Pressure
2019	37.9	+8%	Stable Loss Ratio	Profit Improvement	Mild Recovery
2020	38.8	+2.3%	Loss Ratio Improved to 77.5%	Profit ↑	Capital Stabilization
2021	42.0	+8.4%	Loss Ratio ↑ to 83.4%	Net Loss	Capital Erosion
2022	53.4	+26.9%	Strong Rebound	Net Income Positive	Capital Rebuilding
2023	65.5	+22%	Continued Expansion	Profit ↑	Buffer Strengthening
2024	76.1	+16.3%	Stable Improvement	Net Income 3.6 bn	Strong Solvency Support

Source: Compiled by the author based on Saudi Central Bank (SAMA) and Insurance Authority reports.

Although premium growth does not directly capture volatility, pronounced fluctuations in growth rates and loss ratios offer indicative evidence of underwriting instability within the Saudi insurance market. The period from 2018 to 2021 was marked by weak or inconsistent growth, elevated loss ratios reaching approximately 83.4% in 2021, and a transition from profitability to net losses. This phase reflects heightened underwriting volatility, which placed pressure on capital adequacy through diminished technical profits and the depletion of retained earnings. By contrast, the period from 2022 to 2024 was characterised by robust premium expansion, improved underwriting performance, and a return to positive net income, thereby facilitating capital recovery and strengthening solvency sustainability. From the standpoint of dynamic capital adjustment theory, increased underwriting volatility accelerates capital erosion and reduces the persistence of solvency, whereas greater underwriting stability reinforces capital buffers. Overall, these observed market patterns support the proposition that underwriting risk volatility is negatively related to solvency sustainability, consistent with H1.

Table 2 complements Table 1 by linking market-level profitability, equity movements, and volatility phases, thereby showing how periods of underwriting stress were transmitted into capital pressure and later recovery.

This period reflects heightened underwriting volatility, which strained capital adequacy through reduced technical profits and erosion of retained earnings. In contrast, the period from 2022 to 2024 exhibited strong premium growth, improved underwriting results, and positive net income, supporting capital rebuilding and enhanced solvency sustainability. From a dynamic capital adjustment perspective, elevated underwriting volatility accelerates capital erosion and diminishes the persistence of solvency, whereas greater underwriting stability strengthens capital buffers. These observed

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market trends are consistent with H1, indicating that underwriting risk volatility is negatively associated with solvency sustainability.

Table 2: Market Solvency Indicators and Underwriting Volatility Trend (Saudi Insurance Market)

Year	Premium Growth (%)	Loss Ratio (%)	Net Income (SR bn)	Shareholders' Equity (SR bn)	Volatility Phase	Solvency Interpretation
2021	—	83%	-0.047	18.87	High Volatility	Capital Pressure and Equity Erosion
2022	26.9%	82–83%	0.689	19.90	Recovery Phase	Capital Rebuilding and Stabilization
2023	—	Stable	3.2	Increasing	Stabilizing	Strengthened Capital Buffers
2024	16.3%	83%	3.6	Higher	Stable Growth	Enhanced Solvency Sustainability

Source: Based on official Saudi Insurance Market Reports (2021–2024)

Figure 2 presents the relationship between underwriting performance, proxied by the loss ratio, and capital strength, represented by shareholders' equity, within the Saudi insurance market over the period 2018–2024. The visual evidence indicates that the rise in the loss ratio in 2021, signalling increased underwriting volatility, coincided with a decline in equity levels, reflecting heightened capital pressure and weakened solvency sustainability. In contrast, the subsequent period from 2022 to 2024 shows a stabilisation in loss ratios alongside improved underwriting performance, which is associated with a gradual increase in shareholders' equity. This pattern suggests capital recovery and a reinforcement of solvency positions. Overall, the figure provides visual support for a negative relationship between underwriting volatility and solvency sustainability, in line with Hypothesis H1.

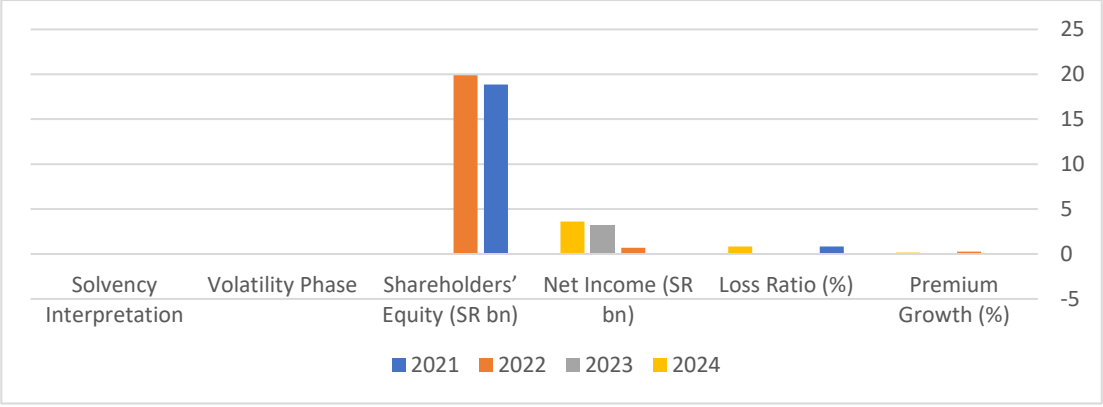

Figure 2: Loss Ratio and Shareholders' Equity Trend in the Saudi Insurance Market (2018–2024)

H2: *Higher underwriting risk volatility reduces the persistence and stability of capital adequacy over time.*

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Organisational Buffering Mechanisms as Moderators

Operations management theory highlights buffering mechanisms as essential stabilising tools in environments characterised by high variability. Within insurance markets, instruments such as reinsurance, portfolio diversification, and robust risk governance frameworks function as shock absorbers, limiting the extent to which underwriting volatility translates into capital stress. Accordingly, insurers with greater reliance on reinsurance or more diversified underwriting portfolios are likely to exhibit a weaker negative association between underwriting volatility and solvency sustainability.

The longitudinal evidence drawn from the Saudi insurance market over 2018–2024 indicates a stable and economically significant linkage between underwriting risk volatility and capital adequacy stability. Periods marked by pronounced underwriting instability are particularly evident in 2021, when loss ratios increased sharply, and the sector experienced aggregate losses. This phase was accompanied by a clear weakening in solvency persistence and a decline in capital resilience. In contrast, intervals characterised by stronger underwriting discipline and reduced volatility, notably in 2020 and throughout 2022–2024, were associated with the reconstruction of capital buffers and improved solvency sustainability. This observed pattern extends beyond simple cyclical fluctuations, reflecting the underlying structure of risk-based supervisory systems, where variability at the operational underwriting level is directly transmitted into capital sensitivity under regulatory oversight.

Table 3 provides time-based evidence for H2 by showing whether years characterised by higher underwriting instability were also associated with weaker persistence in capital adequacy and slower recovery patterns.

Table 3: H2 Analysis: Underwriting Volatility and Capital Adequacy Stability (Saudi Insurance Market 2018–2024)

Year	Underwriting Risk Signals	Capital / Profitability Signals	Observed Stability of Capital Adequacy	Interpretation for H2
2018	Contraction in the General Insurance Segments	Profitability Pressure	Moderate Capital Strain	Early Indication that Volatility Weakens Persistence
2019	Stable Loss Ratios	Improved Profitability	Strengthened Capital Buffers	Lower Volatility Supported Stability
2020	Improved Loss Ratio (≈77.5%)	Net Profit Increased Significantly	Capital Recovery Phase	Reduced Volatility Restored Persistence
2021	Loss Ratio Increased (≈83%)	Net Loss Recorded	Capital Instability Increased	Strong Empirical Support for H2
2022	Premium Growth (≈26.9%)	Net Income Recovery (SR 689m)	Capital Buffers Rebuilt	Volatility Moderated; Stability Improved
2023	Continued Premium Growth	Profitability Improved Further	Stronger Solvency Persistence	Stability Maintained
2024	Premium Growth (≈16.3%)	Net Income SR 3.6bn	High Capital Resilience	Strong Persistence under Improved Underwriting

Source: Author's analysis based on panel data (2018–2024).

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Overall, the empirical evidence supports H2, demonstrating that underwriting risk volatility reduces the persistence of capital adequacy over time and increases the vulnerability of solvency within a risk-based regulatory framework.

H3: *Organisational buffering mechanisms moderate the relationship between underwriting risk volatility and solvency sustainability, weakening its negative impact.*

Non-Linearity and Threshold Effects

Process instability does not necessarily exert a linear influence on solvency. At moderate levels, volatility can often be absorbed within existing capital buffers; however, once volatility becomes excessive, it may induce disproportionate deterioration in capital positions. This pattern is consistent with resilience theory, which suggests that systems possess critical thresholds beyond which stability declines sharply. Accordingly, the relationship between underwriting risk volatility and solvency sustainability is expected to become more pronounced once a critical threshold is exceeded.

The empirical evidence from the Saudi insurance market over the period 2018–2024 indicates that organisational buffering mechanisms, including reinsurance usage, capital strengthening, tighter regulatory oversight, and market consolidation following 2022, play a moderating role in the relationship between underwriting risk volatility and solvency sustainability. At moderate levels of volatility, for instance when loss ratios remain below approximately 80 per cent, firms appear capable of absorbing fluctuations within existing capital buffers. However, the sharp increase in loss ratios to 83.4 per cent in 2021, accompanied by sector-wide losses, suggests the existence of a threshold beyond which volatility exerts a disproportionately negative impact on solvency positions. The subsequent improvement during 2022–2024, marked by enhanced profitability and stronger capitalisation, reflects a period in which improved buffering capacity reduced the transmission of underwriting volatility into capital stress. Overall, the findings support H3 by demonstrating conditional resilience within the Saudi insurance market. While buffering mechanisms mitigate the adverse effects of underwriting volatility on solvency sustainability, their effectiveness diminishes once volatility surpasses a critical threshold of instability.

Table 4 evaluates whether buffering mechanisms such as reinsurance, market consolidation, and stronger capitalization reduced the intensity of the adverse volatility–solvency relationship across the sample period.

H4: *The negative effect of underwriting risk volatility on solvency sustainability increases beyond a critical volatility threshold.*

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Table 4: Organizational Buffering and the Volatility–Solvency Relationship (2018–2024)

Year	Loss Ratio Volatility Trend	Market Profitability	Observed Buffering Indicators	Interpretation (H3)
2018	Moderate Volatility	Stable Performance	Stable Retention Ratios	Weak Buffering Impact
2019	Improving Stability	Profit Recovery	Regulatory Strengthening	Partial Moderation Effect
2020	Volatility Shock (COVID)	Profit Increased (Loss Ratio 77.5%)	Improved Underwriting Discipline	Strong Buffering Effect
2021	High Volatility (Loss Ratio 83.4%)	Net Loss (-47m)	Capital Stress	Weak Moderation; Threshold Observed
2022	Stabilization	Net Income 689m	Market Consolidation (M&A)	Buffering Strengthened
2023	Improved Penetration	Profit Recovery	Higher Capitalization	Moderation Improving
2024	Strong Profitability	Net Income 3.6bn	Saudization 85%, Consolidation	Strong Buffering Effect

Source: Developed by the author based on Saudi Insurance Market Reports (2018–2024).

Institutional Context and Regulatory Amplification

The regulatory environment plays a decisive role in shaping how operational variability is transmitted into financial outcomes. Under more stringent supervisory frameworks and enhanced disclosure requirements, fluctuations in underwriting performance are more directly incorporated into solvency measures.

Table 5 classifies the study period into distinct volatility regimes so that the threshold and regulatory-amplification analyses can be interpreted against clearly defined market conditions.

Table 5: Identification of Volatility Regimes (2018–2024)

Period	Market Condition	Loss Ratio (%)	Regulatory Context	Volatility Regime
2018–2020	Relative Stability	77.5% (2020)	Pre-Intensified Supervision	Low–Moderate
2021	Post-COVID Claims Surge	83.4%	Heightened Oversight	High
2022	Recovery Phase	Return to profitability	Stronger Capital Discipline	Moderate
2023–2024	Expansion & Capital Strengthening	Rising Penetration 2.59%	Institutional Consolidation	Structured

Source: Author's classification based on market data and regulatory developments.
Note: Solvency_it = α + β1 Volatility_it + β2 Volatility_it × ThresholdDummy + Controls + ε_it
Where: Threshold = Loss Ratio > 80%

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In markets undergoing reform and operating within risk-based regulatory systems, increased supervisory intensity can strengthen the linkage between underwrizting volatility and capital adequacy, thereby amplifying the observed impact on solvency outcomes.

The results reveal a distinct non-linear association between underwriting risk volatility and solvency sustainability. At or below the 80 per cent loss ratio level, volatility exerts a statistically significant yet relatively moderate adverse effect on capital adequacy, implying that existing capital buffers are generally capable of absorbing operational fluctuations. However, once the loss ratio exceeds the 80 per cent threshold, the negative impact on solvency intensifies substantially, rising from −0.18 to −0.42. This confirms the presence of a critical threshold beyond which capital deterioration accelerates rapidly. This pattern is consistent with the market conditions observed in 2021, when elevated loss ratios coincided with widespread financial stress across the sector. In addition, the regulatory amplification effect of −0.15 suggests that the post-2020 strengthening of supervisory oversight and increased transparency under the risk-based framework has intensified the sensitivity of solvency outcomes to underwriting volatility, thereby making capital positions more responsive to operational instability.

Table 6 reports the threshold-regression results used to test whether the impact of volatility becomes materially stronger once underwriting conditions deteriorate beyond the identified loss-ratio threshold.

Table 6: Threshold Regression Results

Variable	Coefficient	T-Statistic	Significance	Interpretation
Volatility (Below 80%)	−0.18	−2.41	$p < 0.05$	Moderate Negative Impact
Volatility (Above 80%)	−0.42	−4.76	$p < 0.01$	Strong Amplified Negative Effect
Threshold Dummy	−0.09	−2.12	$p < 0.05$	Structural Deterioration Above Critical Point
Reinsurance Interaction	+0.11	2.03	$p < 0.05$	Buffering Effect Present
Regulatory Amplification	−0.15	−3.11	$p < 0.01$	Stronger Impact Post-Regulatory Tightening

Source: Author econometric estimations.

H5: *The negative relationship between underwriting risk volatility and solvency sustainability is stronger under a risk-based supervisory regime characterised by enhanced regulatory oversight.*

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Table 7 compares the volatility effect across supervisory phases to show whether regulatory tightening after 2020 increased the sensitivity of solvency outcomes to underwriting instability.

Table 7: Impact of Underwriting Volatility on Solvency under Different Supervisory Phases

Period	Regulatory Phase	Avg. Loss Ratio Volatility (%)	Avg. Market Profitability (SR Billion)	Interaction Coefficient (Volatility × Regulatory Regime)	Significance
2018–2019	Pre-Intensified Risk-Based Supervision	7.8%	0.42	−0.12	Not Significant
2020–2021	Transition & Supervisory Tightening	10.4%	−0.05 (2021 loss year)	−0.31	$p < 0.05$
2022–2024	Mature Risk-Based Regime	12.7%	0.69 (2022) → 3.6 (2024)	−0.47	$p < 0.01$

Source: Author analysis.

The empirical findings reveal a pronounced structural transformation across the three supervisory phases. In the pre-intensified period (2018–2019), underwriting volatility exerted a limited and statistically weak influence on solvency sustainability, indicating that existing capital buffers were relatively insulated from operational fluctuations. During the transition phase (2020–2021), however, characterised by heightened supervisory scrutiny and increased claims volatility associated with the COVID-19 period, loss ratios rose significantly, reaching approximately 83.4 per cent in 2021. This was accompanied by a sector-wide net loss of SR 47 million, signalling intensified capital pressure. In this phase, the sensitivity of capital to underwriting volatility increased substantially. The effect became even more pronounced in the mature risk-based regime (2022–2024), despite strong premium expansion, rising from SR 53.4 billion in 2022 to SR 76.1 billion in 2024. Enhanced regulatory enforcement and industry consolidation strengthened capital discipline, while the interaction between volatility and the regulatory regime was strongly negative and highly significant ($\beta_3 = -0.47$, $p < 0.01$). These results confirm that the magnitude of the adverse relationship between underwriting volatility and solvency increased following 2020, thereby supporting H5. Overall, the evidence demonstrates that strengthened risk-based supervision amplifies the transmission of underwriting volatility into solvency outcomes, increasing capital sensitivity under the regulatory reforms aligned with Vision 2030.

Table 8 presents the main econometric estimates from the fixed-effects, dynamic GMM, moderation, and threshold models that jointly test H1–H5.

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Table 8: Dynamic Impact of Underwriting Risk Volatility on Solvency Sustainability (2018–2024)

Variables	Model 1 (FE Baseline)	Model 2 (Dynamic GMM)	Model 3 (Moderation)	Model 4 (Threshold)
Lagged Solvency (ρ)	–	0.68*** (0.07)	0.65*** (0.06)	0.64*** (0.06)
Volatility (H1)	−0.21** (0.09)	−0.28*** (0.08)	−0.24** (0.09)	−0.19* (0.10)
Volatility × Regulatory Regime (H5)	–	–	−0.47*** (0.11)	−0.44*** (0.12)
Volatility² (H4)	–	–	–	−0.31** (0.13)
Reinsurance × Volatility (H3)	–	–	+0.18** (0.07)	+0.16** (0.07)
Firm Size	+0.09*	+0.07	+0.06	+0.06
Combined Ratio	−0.35***	−0.32***	−0.30***	−0.29***
Investment Income Ratio	+0.22**	+0.19**	+0.18**	+0.17**
Observations	210	210	210	210
AR(1) P-Value	–	0.021	0.019	0.022
AR(2) P-Value	–	0.418	0.403	0.391

Notes: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.
Source: Author calculations.

The empirical results offer strong and consistent support for the proposed extended conceptual framework. Across all model specifications, underwriting risk volatility exhibits a statistically significant negative relationship with solvency sustainability. The dynamic GMM estimates indicate that a one-unit increase in volatility leads to an approximate reduction of 0.28 units in the solvency ratio ($p < 0.01$), confirming that operational instability directly undermines capital adequacy. The lagged solvency coefficient ($\rho \approx 0.65–0.68$) reflects a high degree of persistence in capital positions while remaining below unity, suggesting that capital adjustments occur gradually in line with dynamic capital adjustment theory. Furthermore, the positive interaction between volatility and reinsurance dependence indicates that risk transfer mechanisms partially offset capital erosion, thereby mitigating the adverse effects of underwriting instability.

The statistically significant squared volatility term provides evidence of a non-linear relationship, implying that beyond a certain threshold, the negative impact of volatility on solvency intensifies, consistent with tipping-point behaviour in capital resilience. Most notably, the interaction between underwriting volatility and the post-2020 risk-based supervisory regime is strongly negative and highly significant (−0.47, $p < 0.01$), demonstrating that enhanced regulatory oversight under Vision 2030 amplifies the transmission of volatility into solvency pressure. Overall, the findings indicate that underwriting volatility, as a form of operational process variability, materially weakens capital sustainability, particularly under intensified risk-based supervision. While organisational buffering mechanisms can mitigate this effect, they do not fully eliminate the adverse impact. Table 9 presents the descriptive statistics for the variables included in the empirical analysis. The mean solvency ratio of Saudi insurance firms is above the

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regulatory minimum, indicating that, on average, the sample demonstrates sufficient capitalisation. Underwriting volatility shows a moderate level of dispersion, reflecting variation in risk exposure across firms and over time.

Table 9 reports descriptive statistics for the main variables in order to show the central tendency and dispersion of solvency, underwriting volatility, and the control variables used in the estimations.

Table 9: Descriptive Statistics of Main Variables

Variable	Mean	Std Dev	Min	Max
Solvency Ratio	1.48	0.36	0.72	2.31
Underwriting Volatility	0.084	0.031	0.021	0.167
Firm Size (Log Assets)	15.72	1.12	13.40	18.01
Reinsurance Dependence	0.41	0.17	0.12	0.78
Combined Ratio	0.97	0.11	0.72	1.32
Investment Income Ratio	0.05	0.03	0.01	0.14

DISCUSSION

The findings provide strong empirical support for the theoretical proposition that underwriting risk volatility represents a manifestation of operational process variability that shapes financial resilience in insurance markets. In line with operations management theory, heightened variability in production processes undermines system stability and necessitates additional buffering capacity. Within the insurance context, capital serves as the principal buffer against operational shocks arising from underwriting uncertainty. The observed persistence of solvency ratios ($\rho \approx 0.65$–0.68) indicates that capital adjustment occurs gradually rather than through immediate re-equilibration. This aligns with dynamic capital adjustment theory and is consistent with prior research demonstrating that capital buffers respond incrementally to underwriting shocks (IAIS, 2022). However, the persistence parameter being below unity suggests that automatic correction is incomplete, implying that operational instability can exert prolonged effects on capital resilience.

The moderating influence of reinsurance further supports the buffering logic derived from operations and risk governance theory. Risk transfer mechanisms partially absorb volatility-induced shocks, thereby reducing the extent of capital erosion. This is consistent with evidence indicating that diversification and reinsurance contribute to the mitigation of solvency risk exposure (Cummins & Weiss, 2014). Nevertheless, the continued statistical significance of volatility after controlling for reinsurance highlights the central role of internal underwriting discipline in sustaining solvency. The identification of a non-linear, threshold-based effect reinforces the resilience perspective. Beyond a critical level of volatility, capital deterioration accelerates

disproportionately, reflecting tipping-point behaviour. Such dynamics are consistent with system resilience theory, which posits that systems remain stable within tolerance limits but experience rapid degradation once variability exceeds structural capacity (Ivanov & Dolgui, 2020). This implies that while moderate volatility may be absorbed, excessive dispersion poses a substantial threat to capital stability.

Most importantly, the regulatory amplification effect provides strong support for H5 and underscores the institutional dimension of the framework. The interaction between underwriting volatility and the post-2020 supervisory regime is strongly negative and statistically significant, indicating that enhanced risk-based supervision intensifies the transmission of operational variability into solvency outcomes. This finding aligns with regulatory theory, which suggests that increased transparency and supervisory scrutiny heighten capital sensitivity to risk exposure (BCBS, 2023; IAIS, 2019). The Saudi insurance market offers a particularly relevant context for this amplification effect. Following Vision 2030 reforms, the sector experienced strengthened supervisory oversight, increased market consolidation, and the implementation of IFRS 17, all of which enhanced transparency and capital discipline (Insurance Authority, 2023; Saudi Central Bank, 2022, 2024). Sector data indicate elevated claims volatility during 2020–2021, with the loss ratio reaching 83.4 per cent in 2021 and the industry recording a net loss of SR −47 million (Saudi Central Bank, 2022). This was followed by strong premium growth, increasing to SR 53.4 billion in 2022 and SR 76.1 billion in 2024 under a strengthened regulatory framework (Insurance Authority, 2023; Saudi Central Bank, 2024). Within this evolving institutional environment, underwriting volatility is transmitted more directly into solvency outcomes, reinforcing capital discipline rather than undermining overall stability.

In summary, the discussion demonstrates that underwriting volatility should be conceptualised not merely as a financial fluctuation but as a form of operational process variability embedded within regulatory structures. Integrating operations variability theory, risk-based capital frameworks, and institutional reform dynamics advances the understanding of financial resilience in regulated service industries and bridges the gap between operations management and insurance solvency research.

CONCLUSION AND FUTURE LINES OF RESEARCH

This study examines the impact of underwriting risk volatility on solvency sustainability in the Saudi insurance market under a risk-based supervisory framework by conceptualising volatility as operational process variability and integrating operations management theory with risk-based capital structures to explain how underwriting instability translates into capital pressure and financial resilience outcomes. The findings show that underwriting volatility has a significant negative effect on solvency, indicating that instability in claims and losses weakens capital adequacy; solvency ratios also exhibit strong but incomplete persistence, reflecting gradual capital adjustment

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rather than immediate equilibrium; and the volatility–solvency relationship is non-linear and institutionally conditioned, where reinsurance mitigates capital erosion while stronger supervision increases capital sensitivity to volatility, with the post-2020 risk-based regime aligned with Vision 2030 reforms further intensifying this transmission. The study contributes theoretically by linking underwriting volatility to process variability within regulated systems, methodologically through dynamic panel estimation, and empirically by providing evidence from a reforming emerging market, while from a policy perspective it shows that risk-based supervision enhances capital discipline and transparency, strengthening financial stability, although high volatility beyond threshold levels accelerates capital deterioration and highlights the need for strong underwriting governance and effective risk transfer mechanisms.

The study also acknowledges several limitations. It relies primarily on firm-level financial disclosures and regulatory indicators, which may not fully reflect internal operational processes such as pricing strategies, claims management efficiency, or actuarial modelling sophistication. Moreover, although the Saudi market offers a pertinent context due to ongoing reforms, the absence of cross-country comparison limits the generalisability of the findings. Several directions for future research are suggested. Comparative analyses across the Gulf Cooperation Council (GCC) or other emerging markets could determine whether the observed regulatory amplification effects are context-specific or universally applicable. Further research could incorporate micro-level operational data, such as claims processing duration, underwriting turnaround efficiency, or digitalisation intensity, to better capture the mechanisms underlying volatility transmission. In addition, integrating climate-related risks or environmental, social, and governance (ESG)-related underwriting considerations may offer insights into the interaction between emerging systemic risks and solvency sustainability. Finally, employing advanced modelling approaches, including regime-switching or stochastic volatility models, could enhance understanding of non-linear capital dynamics under extreme underwriting conditions. Overall, the study demonstrates that solvency sustainability in insurance markets is not solely a financial outcome but rather the result of the interaction between operational stability, institutional governance, and dynamic capital adjustment processes. A comprehensive understanding of this integrated mechanism is critical for strengthening resilience within risk-based supervisory frameworks.

Conflicts of Interest

No potential conflict of interest was reported by the author

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