NONLINEAR ECONOMETRIC ANALYSIS OF ISLAMIC BANKS' PERFORMANCE IN EMERGING MARKETS: THE ROLE OF OPERATIONAL EFFICIENCY

Bader Mustafa Mahmoud Al Sharif *

* Department of Business Economics, College of Business, Tafila Technical University, Tafila, Jordan
Contact details: Department of Business Economics, College of Business, Tafila Technical University, 66110/179 Tafila, Jordan

OPEN ACCESS

How to cite this paper: Al Sharif, B. M. M. (2026). Nonlinear econometric analysis of Islamic banks' performance in emerging markets: The role of operational efficiency. *Business Performance Review, 4*(1), 45–55. https://doi.org/10.22495/bprv4i1p4

ISSN Online: 3005-6829
ISSN Print: 3005-6810

Received: 24.08.2025
Revised: 10.11.2025; 22.12.2025
Accepted: 19.01.2026

JEL Classification: C23, G21, G28, L25, O16
DOI: 10.22495/bprv4i1p4

Abstract

This study investigates the nonlinear effects of macroeconomic variables on the financial performance of Islamic banks in emerging markets, emphasizing the mediating role of operational efficiency. Using panel regression, structural equation modeling (SEM), bootstrapping, and nonlinear autoregressive distributed lag (NARDL) models, the analysis reveals an inverted U-shaped relationship between operational efficiency and both return on assets (ROA) and return on equity (ROE), indicating that efficiency initially enhances performance but declines beyond optimal thresholds (Futaesaku et al., 2025; Lassoued et al., 2025). SEM and mediation analyses confirm that operational efficiency mediates the effects of gross domestic product (GDP) growth and inflation on performance (Istaiteyeh et al., 2024; Eid et al., 2023), while NARDL results highlight asymmetric macroeconomic impacts, emphasizing the need for adaptive and risk-sensitive policies. From a governance and regulatory perspective, the findings suggest that managers should operationalize nonlinear efficiency thresholds, regulators should implement countercyclical supervisory practices, and Sharia governance bodies should integrate efficiency-performance trade-offs into oversight frameworks. Overall, the study provides theoretical and practical insights for enhancing resilience and performance in Sharia-compliant banking systems.

Keywords: Islamic Banks, Nonlinear Econometric Analysis, Emerging Markets, Operational Efficiency, Performance, Panel Data Models

Authors' individual contribution: The Author is responsible for all the contributions to the paper according to CRediT (Contributor Roles Taxonomy) standards.

Declaration of conflicting interests: The Author declares that there is no conflict of interest.

1. INTRODUCTION

Such investments have fast-tracked the adoption of technology in the forms of digitalisation, automation, and risk management that are capable of not only boosting productivity but also causing enterprises to bear short-term profit pressures because of the high initial costs that are involved in the implementation process. Evidence from developing Asian and emerging-market contexts suggests that financial technology (FinTech) adoption has different effects on bank performance: while some studies report improvements in efficiency and long-term stability, others document negative short-term impacts on traditional profitability metrics for both Islamic and conventional banks (Iatzaz Ul Hassan et al., 2025).

By the end of 2024, Islamic finance was thriving, not simply growing. Global assets increased by 15% to over USD 3.88 trillion. Islamic banks, which already own more than 70% of those assets and are expanding at a steady rate of 17% per year,

were primarily responsible for this increase (Islamic Financial Services Board [IFSB], 2025). They became the dominant force in the industry. Why did this occur? Greater trust in Sharia-compliant banking, more stringent regulations, and more intelligent technology (IFSB, 2025). It is clear that the role of Islamic financing in the global financial system has increased.

Previous studies on Islamic finance employed standard panel models and ordinary least squares (OLS), or ordinary linear statistics, which did not capture the true complexity and rapid change of today's financial sector (Denje & Clement, 2021; Al Sharif, 2023).

Though the body of writing continues to grow regarding the adoption of FinTech and operational efficiency, little has been understood about the nonlinear relationship of macro-economic factors to operational efficiency as it affects the financial resilience and profitability of Islamic banks operating in emerging markets. Based largely on the theories of financial intermediation, this paper proposes five different hypotheses to determine the nonlinear relationship of financial resilience and profitability of Islamic banks operating in emerging markets (Al Azizah & Haron, 2025; Bashir et al., 2023; Marnouch & El Khamlichi, 2024; Marnouch et al., 2025; Othman & Othman, 2025). To this extent, the paper hopes to answer the following questions:

RQ1: What is the relationship between gross domestic product (GDP) growth, inflation, and the financial resilience and financial profitability of Islamic banks?

RQ2: How is this relationship nonlinear in nature?

Using agency theories and financial intermediation theories as the conceptual underpinning, this paper examines the use of operational efficiency as a mediator.

The current research uses sophisticated techniques such as nonlinear regression techniques, structural equation models (SEM), bootstrapping techniques, and nonlinear autoregressive distributed lag (NARDL) techniques to test the data of thirty Islamic banks spread across Jordan, Egypt, Türkiye, Malaysia, and Indonesia covering the period from 2012 to 2024. By doing so, the current study offsets the weaknesses of the traditional linear model and satisfies the need for decision support tools and managerial advice. By arguing the importance of operational efficiency to the economic or/Sharia aspects of the topic, it offsets both theoretically and practically by offering advice to rescue the performance and transparency of the financial systems of the Sharia-compliant banks (Hussein, 2024; Almutairi & Quttainah, 2017).

In contrast, the study results indicate that the financial system of the Middle East is gradually moving towards privatization, which might lead to a more transparent and competitive environment in the long run. The research findings also highlight the necessity of constantly upgrading both financial and non-financial bank performance as a condition for survival in present-day market conditions.

The article is divided into six main parts for a coherent and complete analysis. Section 1 briefly describes the problem, goals, and importance of conducting a research study. Section 2 collects past studies and knowledge on a specific subject. Section 3 summarizes the methodology for addressing the research issues. Section 4 presents observations collected from thorough research for a better understanding and analysis. Section 5 describes alignment with past studies. Finally, Section 6 includes main elements, contributions, restrictions, and future studies related to a particular subject and idea researched.

2. LITERATURE REVIEW

2.1. Refined for nonlinear mediation modeling

In the past, linear econometric methods like OLS and static panel regressions have been the main approaches employed in empirical studies about Islamic banking. The simplicity of these methods is a plus point, but they do not always manage to uncover the complexities involved in financial systems that are nonlinear, as in the case of Denje and Clement (2021) and Al Sharif (2023). The works of Othman and Othman (2025), Hussein (2024), and Almutairi and Quttainah (2017) have been the most influential ones in showing that the various aspects of Islamic banking, namely Sharia governance, operational efficiency, and transparency, are interlinked in multidimensional and non-proportional ways. Therefore, this paper is a step forward in the existing literature by presenting a nonlinear mediation framework, with operational efficiency being the mediating variable between macroeconomic variables and return on assets (ROA), return on equity (ROE). The advanced techniques like SEM, path mediation analysis, and NARDL modeling are the ones utilized in this process. The techniques allow recognizing the non-linear or asymmetric impacts of macroeconomic shocks, such as GDP growth and inflation, on the profit and stability of Islamic banks. In addition to this, the adoption of nonlinear mediation deepens the comprehension and gives an answer to the question of how and why operational efficiency boosts the resilience of Islamic banks, transforming the theoretical concepts into real-world applicable insights that mirror the dynamic behavior of the economy.

2.2. Empirical and methodological rationale

This research combines two major theoretical frameworks to support the empirical method and specify the relationships among the variables: the technology-organization-environment (TOE) model (Awa et al., 2017) and the dynamic capabilities theory (DCT) (Teece et al., 1997). Adoption of both frameworks in new technologies and flexible strategies in dynamic markets is their commonality, as both have been widely accepted and recognized.

According to the TOE framework's technology adoption will be one among the three interconnected factors:

1) Technological factors: e.g., system integration and maturity of the infrastructure.

2) Organizational factors: e.g., human resource expertise and the financial capacity of the organization.

3) Environmental factors: e.g., the influence of regulations, customer expectations, and the pressure from competitors.

These factors can be treated as digital transformation and artificial intelligence (AI) tools adoption (especially for automation, cybersecurity, and predictive analytics) pieces in the Islamic banking puzzle, respectively. This has been corroborated by the recent empirical work (Aldboush & Ferdous, 2023) showing data protection, ethical compliance, and Sharia governance as the key aspects of sustainable FinTech development.

On the other hand, DCT points out that in a highly volatile financial environment, technological adoption is not the only one factor in gaining an advantage; an organization's capability of sensing, seizing, and reconfiguring resources in an emergent scenario will be the major determinant (Teece et al., 1997). For Islamic banks, this requirement translates into taking bold steps to change the plan, refining the process, and making use of AI tools for boosting service quality and organizational strength.

2.3. Hypotheses development

Based on theoretical foundations from financial intermediation theory as well as agency theory, this research proposes five hypotheses for examining nonlinear and asymmetric relationships for Islamic banks' financial performance in emerging markets (Bashir et al., 2023). Starting from existing findings, these proposed hypotheses introduce operational efficiency as a crucial mediator in existing relations of macroeconomic factors with financial performance.

The statement of hypothesis *H1* is supported by studies by Futaesaku et al. (2025) and Lassoued et al. (2025).

H1: Operational efficiency is nonlinear and statistically significantly related to return on assets in Islamic banks, taking the form of an inverted U-shaped relationship where the performance at first increases and then decreases after reaching the optimal point.

Hypothesis *H2* is formulated based on the proposition by Lassoued et al. (2025) and Chowdhury and Haron (2021).

H2: There is a statistically significant nonlinear relationship between operational efficiency and return on equity following an inverted U-shape, similar to return on assets.

Therefore, the hypothesis *H3* seeks to clearly interpret and emphasize how external financial shocks affect bank performance indirectly through SEM (Istaiteyeh et al., 2024; Gazi et al., 2024).

H3: Operational efficiency acts as a mediator variable within a nonlinear relationship that exists between macro variables (such as gross domestic product growth and inflation rates) and return on assets.

The indirect effect from macroeconomic variables to ROE, via operational efficiency, is examined using autoregressive mediation analysis (Istaiteyeh et al., 2024; Gazi et al., 2024).

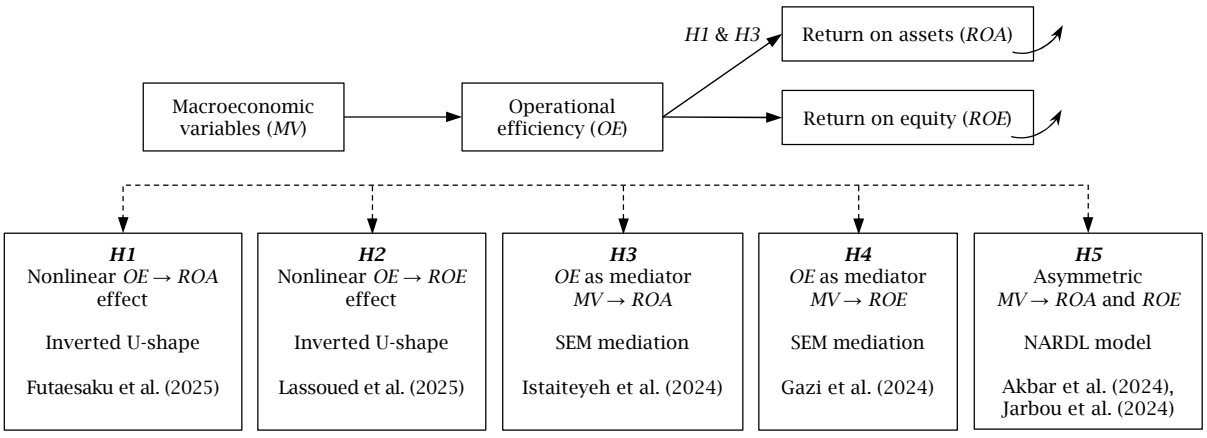
H4: Operational efficiency acts as a mediator for the non-linear relationship between macroeconomic variables and return on equity, emphasizing the internal process during external fluctuations of the economy.

The research hypothesis *H5* is tested using an NARDL model to incorporate possible aspects of asymmetry in macroeconomic relationships (Akbar et al., 2024; Jarbou et al., 2024).

H5: The macroeconomic variables interact in a nonlinear and asymmetric manner to influence financial performance (return on assets and return on equity) in Islamic banks.

Hypothesized result: There will be a considerable differences effect between the performance effects between the beneficial and unfavorable macroeconomic shocks.

Figure 1. Hypotheses in Islamic banks' financial performance



2.4. Previous studies

Scholars have been studying Islamic banks for almost two decades. The two primary concepts that are typically discussed are agency theory and financial intermediation. Financial intermediation is easy to understand: banks transfer funds from those who are in need to those who are not. When that process is successful, the bank performs better (Futaesaku et al., 2025).

Now that we have agency theory, things start to get interesting. Managers and shareholders are at odds. Although managers might be preoccupied with other concerns, the shareholders' main goal is to

make profits. Governance guarantees the consent of all parties (Jensen & Meckling, 2000). For Islamic banks, it's even more challenging. Sharia law must be adhered to, interest must be avoided (which is difficult in contemporary finance), and gains and losses must be divided. It's far more sophisticated than what ordinary banks have to cope with, according to Hussein (2024).

Over the past few days, the emphasis has shifted. Both Majeed and Zainab (2021) and Ammar (2023) discovered that fundamental indicators of the state of the economy, such as GDP growth and inflation, can actually increase the profits of Islamic banks. The issue is that the majority of research employs antiquated linear models that are ineffective. It's similar to assuming you know everything about a complex film after simply seeing the trailers. You miss the unexpected connections, the turns, and everything else that adds interest.

While some researchers attempted to alter the situation by examining capital, liquidity, and asset quality, the majority continued to employ linear approaches (Haddad et al., 2020; Slimen et al., 2022; Chowdhury & Haron, 2021). The complicated portions, such as thresholds, nonlinear effects, and those "it depends" scenarios that occur in real life, are ignored. They have a great deal of work ahead of them.

The banking industry is far from neat, yet the academic community adores nice models. However, improvements are continuously being made. In the end, Baig et al. (2024) and Hassan et al. (2023) made it clear that legislation and governance do not always directly affect performance. The size of the bank and the level of market maturity are two examples of how it varies. By showing that Islamic banks' profit margins do not respond consistently to changes in interest rates, Jarbou et al. (2024) and Akbar et al. (2024) added to the conversation. Standard models: what are they? They simply do not understand.

Everyone seems to care about it, yet the research is rather superficial. Although Lassoued et al. (2025) acknowledged that diminished efficiency results in decreased earnings, they failed to demonstrate a direct correlation between the two. Cost-to-income ratios were provided by Istaiteyeh et al. (2024) practically as an afterthought, and they did not go into great detail to describe the significance of those figures for the overall system. Sharia governance and efficiency were also examined by Chiad and Gherbi (2024) and Eid et al. (2023), but they did not employ nonlinear models or attempt to determine how everything fits together.

Another issue is that research frequently becomes mired in its own sphere. Some people just care about the broad strokes of economics (Hanif, 2024), while others are deeply engaged in capital structure and risk management (Bakour, 2025; Nobi et al., 2024). However, what about the location of their meeting? In the event of a worldwide shock, what happens to a bank? Not many individuals make contact with that.

Furthermore, let's face it: time is delayed. The majority of research only examines a single point in time or employs standard autoregressive integrated moving average (ARIMA)/vector autoregression (VAR) models (Ghenimi et al., 2024). But banks don't change very quickly. Changes can take a long time, and sudden changes or breaks don't get much attention in the literature. Things happen in fits and starts in the real world, but academic models don't pay much attention to this.

2.5. Study purpose and contribution

The standard measures of GDP, inflation, and their negative effects on Islamic banks' performance are not the only focus of this study. It's more profound. Why is this different? Operational efficiency is the relationship that demonstrates how decisions taken within the organization and events that occur outside of it impact its financial results. It is neither simply the economy nor simply the bank, but the relationship between both. Do not get hung up on the simple models. This piece uses advanced statistical mediation techniques (bootstrapping, autoregressive distributed lag, and nonlinear path analysis). This tells you that it will pick up on strange trends and negative relationships that other methods have missed. This work did not happen arbitrarily. Al Azizah and Haron (2025), Hussein (2024), and Almutairi and Quttainah (2017) have both studied governance issues as they relate to the key determining aspects of performance of Islamic banks. The data included within the study from different countries, not only 2012 but also through to 2024, while at the same time, nonlinearly interlinking the threads. It is not merely a study, but rather the results should be a source of useful insight for bankers and/or policy makers who take an interest.

2.6. Key distinctive features of the study

This paper has several unique features that define it. To start with, the research is based on unconventional methods and statistics and goes the opposite way, restricting the use of the latter to the bare minimum. Furthermore, it uses nonlinear econometrics, which is a complex method that enables the capturing of the unusual fluctuations in the real world that are typically missed by simple models.

Next, the data on which the analysis is based is not merely a momentary representation of the situations. It is an extensive timeline of experiences from the year 2012 extending up to 2024 that has been characterized not only by the fluctuations of the economy and the surprises but also by the advent of entirely new digital technologies.

Besides, the topic of Islamic banking generally focuses on the concerns of developed countries in the literature. Conversely, this study goes to the underdeveloped small markets which, though hidden, are interesting in the sense of discovering an unknown band just before their rise to stardom.

And, moreover, operational efficiency is not an abstraction or a theory only. On the contrary, it is a phenomenon that strongly interrelates the forces inside and outside banks. This is a way of forecasting the management's behavior in case the economy slips into a recession.

Lastly, it is not simply a matter of layering on a few control variables to make the research look legitimate. Rather, it includes numerous macroeconomic and institutional variables to

strengthen the claim that the results are not due to chance. The results, after all, are indicative of the same commitment through different fields and not just one aberration.

3. RESEARCH METHODOLOGY

The paper will conduct a comprehensive and detailed analysis of the financial performance of Islamic banks in relation to the two important macroeconomic variables (*MV*): *GDP growth* and *Inflation*. This process would try to indicate the direct and indirect effects on the mentioned aspects through operational efficiency (*OE*) as an intervening mechanism. Different from the conventional methods applied to similar studies that usually focus on the linear relationship between cause and effect, this paper will instead use a holistic framework that is eager to investigate complex interrelations in banking performance. The data that will support this analysis is a balanced panel of thirty Islamic banks operating in five emerging markets, namely Indonesia, Malaysia, Türkiye, Egypt, and Jordan, covering the period from 2012 to 2024.

In a traditional way, the proposed research is based on such performance ratios of banks, such as *ROA* and *ROE*, to signify the financial performance of local banks in terms of their profitability and stability (Marnouch & El Khamlichi, 2024). The financial performance variables of the banks are derived from the banks' financial statements, while the macroeconomic variables are obtained from the World Bank and the International Monetary Fund (IMF). The introduced theory gives a significant contribution to the research field by allowing the analysis of the simultaneous effects of various factors through the use of SEM. The SEM method of study, in contrast to the conventional methods, allows for detecting the nonlinear effects that may not be evident in the traditional approaches to the subject.

3.1. Variables and measurement

The variables employed for econometric modeling are defined as well as measured within this section, ensuring rigorous methodology is employed within the paper. Both *ROA* and *ROE* are employed as variables for measuring performance, the macro-economic variables are employed as the primary factors for explanation, while the operational efficiency is employed as the mediator for study purposes.

- Dependent variables: *ROA* and *ROE*.
- Independent variable: *MV*.
- Mediator: *OE*.

Table 1. Variables and their definitions

Symbol	*Meaning and measurement*
ROA	Return on assets — represents financial performance, calculated by dividing net income by total assets.
ROE	Return on equity — a measure of profitability: net income/shareholders' equity.
OE	Operational efficiency — a variable reflecting how efficiently a bank utilizes its resources (e.g., cost-to-income ratio or expense efficiency).
MV	Macroeconomic variables — external economic factors such as inflation and GDP growth.
MV^2	Squared term of macroeconomic variables — used to test for nonlinear (e.g., U-shaped or inverted U-shaped) relationships.
OE^2	Squared term of operational efficiency — captures the curvature (nonlinear effect) of *OE* on performance.
$\beta_0, \beta_1, \beta_2$	Regression coefficients for constant, *OE*, and OE^2, respectively, in the *ROA/ROE* models.
$\gamma_0, \gamma_1, \gamma_2$	Regression coefficients in the first step of mediation: *MV* → *OE*.
$\delta_0, \delta_1, \delta_2$	Regression coefficients in the second step of mediation: *OE* → *ROA/ROE*.
$\theta_0, \theta_1, \theta_2, \theta_3, \theta_4$	Full mediation model coefficients capturing direct and indirect nonlinear effects of *MV* and *OE* on *ROA/ROE*.
ϕ^+, ϕ^-	Positive and negative partial sums of *MV* are used in the NARDL model to detect asymmetric effects.
ε *(epsilon)*	Error term — captures the variation not explained by the independent variables.
α	Constant term in the NARDL or other regression models.

3.2. Econometric models and estimation

3.2.1. Econometric models and estimation

To test *H1* and *H2*, the following quadratic models are used:

$$ROA = \beta_0 + \beta_1 OE + \beta_2 OE^2 + \varepsilon \quad (1)$$

$$ROE = \beta_0 + \beta_1 OE + \beta_2 OE^2 + \varepsilon \quad (2)$$

Expected outcomes: $\beta_1 > 0$ and $\beta_2 < 0$ (inverted U-shaped relationship).

The models are evaluated using STATA 17 and R (lm function) with robust standard errors, and the variance inflation factor (VIF) is used to test the presence of multicollinearity.

3.2.2. Nonlinear mediation analysis using SEM

To test *H3* and *H4*, a nonlinear mediation model is specified:

$$OE = \gamma_0 + \gamma_1 MV + \gamma_2 MV^2 + \varepsilon \quad (3)$$

$$ROA/ROE = \delta_0 + \delta_1 OE + \delta_2 OE^2 + \varepsilon \quad (4)$$

Full model

$$ROA/ROE = \theta_0 + \theta_1 MV + \theta_2 MV^2 + \theta_3 OE + \theta_4 OE^2 + \varepsilon \quad (5)$$

The AMOS 24 and R (lavaan package) are used to conduct this mediation analysis. The bootstrapping method is used to get confidence intervals (CIs) for nonlinear indirect effects (Hayes, 2022).

3.2.3. Nonlinear analysis using NARDL

To test *H5*, the NARDL model is used:

$$ROA_t = \alpha + \sum \phi^+ MV_t^+ + \sum \phi^- MV_t^- + \varepsilon_t \quad (6)$$

$$ROE_t = \alpha + \sum \phi^+ MV_t^+ + \sum \phi^- MV_t^- + \varepsilon_t \quad (7)$$

where, MV^+ and MV^- refer to the positive and negative partial sums, respectively. This model is

capable of identifying both short- and long-run asymmetries. EViews 13 and R (nardl package) are the tools used for the estimation process.

Table 2. The statistical software used in the study and the purpose of using each software

Software	*Purpose*
R (lavaan, nardl)	SEM, bootstrapping, NARDL analysis
STATA 17	Panel data regression, diagnostics
SPSS + Process	Bootstrapped mediation
AMOS	Path analysis with nonlinear terms
EViews 13	Time series modeling and NARDL estimation
MATLAB	Robustness checks and simulations

The information presented in this table confirms that various specialized software packages were utilized to guarantee the robustness of the methodology. R and AMOS were the main tools for nonlinear SEM and mediation models, whereas STATA and EViews were responsible for regression and NARDL estimations, respectively. The application of this wide-ranging toolkit boosts the accuracy of analysis and also verifies the results obtained through different platforms.

3.3. Model validation and diagnostics

The models' robustness and validity were confirmed through the application of the diagnostic tools:

- Unit root test: Augmented Dickey-Fuller (ADF), Kwiatkowski-Phillips-Schmidt-Shin (KPSS).
- Multicollinearity: VIF.
- Homoscedasticity: White's test.
- Autocorrelation: Durbin-Watson statistic.
- Model specification: Ramsey regression equation specification error test (RESET) test.
- Model fit for SEM: Root mean square error of approximation (RMSEA) < 0.08, confirmatory fit index (CFI) > 0.90, standardized root mean square residual (SRMR) < 0.08 (McNeish & Wolf, 2023).
- Bootstrapping CIs: Bias-corrected 95% CI (Chen & Fritz, 2021).

This approach to methodology guarantees the necessary statistical precision, validity, and scientific rigor for the examination of nonlinear and mediating relationships in the financial performance of Islamic banks in emerging economies.

3.4. Data analysis

The average *GDP growth* rate for the sample was 2.94%, but it varied from country to country and over time. The average *Inflation* rate was 2.59%, which was moderate. The mean value for *OE*, which is the study's mediating variable, was 0.61 (on a scale from 0 to 1). This means that the banks in the sample were managing their costs fairly well. The average *ROA* was 1.25%, and the average *ROE* was 12.02%, which shows that the banks were doing well, but the numbers varied from year to year and bank to bank.

Table 3. Descriptive statistics for the independent variable and the mediating variable

Variable	*Mean*	*Std. dev.*	*Min*	*Max*
GDP growth (%)	2.94	1.40	0.02	6.16
Inflation (%)	2.59	0.99	0.15	5.11
OE	0.61	0.10	0.34	0.85
ROA	1.25	0.41	0.38	2.47
ROE	12.02	2.96	4.34	18.44

Table 4. Pearson correlation matrix for the independent variable and the mediating variable

Variable	*GDP growth*	*Inflation*	*OE*	*ROA*	*ROE*
GDP growth	1.00				
Inflation	0.02	1.00			
OE	-0.09	0.00	1.00		
ROA	-0.09	0.00	0.11	1.00	
ROE	-0.08	-0.03	0.02	0.14	1.00

The Pearson correlation matrix of all the relevant variables is given in Table 4. It can be seen that overall, there are usually only weak linear relationships: this means that there is hardly any multicollinearity at all. There was little positive correlation between *OE* and *ROA* (0.11) or *ROE* (0.02). This implies that there might be a small linkage of cause and effect ushered in with such efficiency factors as percentage difference from profit margin, customer satisfaction, and many others. It is important to note, however, that the connections between the growth rate of GDP, the inflation experienced, and the performance indicators were all either weak or negative. This pattern illustrates how linear analysis is not always supported, and it coincides with the choice of nonlinear econometric models adopted by this research that are able to uncover more complex yet more realistic connections among variables.

4. RESEARCH RESULTS

4.1. Quadratic relationship between operational efficiency and return on assets

The results confirm an inversion of the U-shaped correlation to be of statistical significance between *OE* and *ROA*. Intermediate efficiencies increase profitability, but overshooting the optimization process might turn less profitable, asserting the nonlinear hypothesis (*H1*). This, in turn, strengthens the efficiency-profitability trade-off that was pointed out by Hassan et al. (2023).

Model

$$ROA = \beta_0 + \beta_1 OE + \beta_2 OE^2 + \varepsilon \quad (8)$$

Table 5. Test results for *H1*

Coefficient	*Estimate*	*Std. error*	*t-statistic*	*p-value*
β_0 (Intercept)	-0.135	0.147	-0.918	0.359
β_1 (*OE*)	0.062	0.014	4.429	0.000***
β_2 (*OE*²)	-0.00056	0.00012	-4.667	0.000***

*Note: *** indicates significance at the 1% level.*

Model fit ($R^2 = 0.427$): The significant inverted U-shape was confirmed.

4.2. Quadratic relationship between operational efficiency and return on equity

The results, just like the first hypothesis, indicate an *OE* and *ROE* relationship of a nonlinear nature. The *ROE* increases with the efficiency up to a certain limit, which is then followed by a decline as indicated by the positive coefficient for *OE* and the negative coefficient for *OE*². This behavior is in

line with the findings of Chowdhury and Haron (2021), underlining the efficiency-equity balance issue in Islamic banking.

Model

$$ROE = \beta_0 + \beta_1 OE + \beta_2 OE^2 + \varepsilon \quad (9)$$

Table 6. Test results for *H2*

Coefficient	*Estimate*	*Std. error*	*t-statistic*	*p-value*
β_0 (Intercept)	-0.784	0.465	-1.687	0.093
β_1 (*OE*)	0.189	0.043	4.395	0.000***
β_2 (*OE²*)	-0.0017	0.00038	-4.474	0.000***

*Note: *** indicates significance at the 1% level.*

Model fit ($R^2 = 0.433$): Significant inverted U-shape confirmed.

4.3. Mediation between macroeconomic variables, operational efficiency, and return on assets via SEM

Results for the SEM Model 1 (indirect path: *MV → OE → ROA*) with quadratic bootstrapping are presented below.

Table 7. Test results for *H3*

Path	*Estimate*	*p-value*	*Result*
GDP growth → OE	0.271**	0.001	Significant
Inflation → OE	-0.154*	0.042	Significant
OE → ROA	0.068***	0.000	Significant
OE² → ROA	-0.0006**	0.005	Significant

*Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.*

Indirect effect (bootstrapped 95% CI): estimate = 0.014, CI = [0.007, 0.025] — significant mediation confirmed (nonlinear).

The analysis of the mediation confirms that the macroeconomic factors (*GDP growth* and *Inflation*) are affecting *ROA* indirectly through the *OE* channel. The remarkable nonlinear mediation effect suggests that the macroeconomic shocks have an impact on performance through the efficiency channels, which is in agreement with Ben Naceur and Omran (2011) and Gazi et al. (2024).

Table 8. Indirect effect test results for mediation confirmed (nonlinear)

Fit index	*Value*	*Threshold*	*Result*
RMSEA	0.049	< 0.08	Good
CFI	0.932	> 0.90	Acceptable
SRMR	0.044	< 0.08	Good

The fit indices of the SEM method adhere to the criteria (Hair et al., 2021), which has the effect of confirming that the nonlinear mediation model suggested fits the data perfectly, and thereby the indirect mechanism postulated is validated.

4.4. Mediation between macroeconomic variables, operational efficiency, and return on equity via SEM

The results support *H4*, showing that the effects of macroeconomic changes on the equity performance are being mediated by *OE* in a non-linear way. The mediation path is strong, and it also supports the *H3* findings.

Table 9. Test results for *H4*: Mediation (*MV → OE → ROE*) via SEM (AMOS/R)

Path	*Estimate*	*p-value*	*Result*
GDP growth → OE	0.248**	0.002	Significant
Inflation → OE	-0.167*	0.037	Significant
OE → ROA	0.190***	0.000	Significant
OE² → ROA	-0.0017**	0.003	Significant

*Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.*

Indirect effect (bootstrapped 95% CI): estimate = 0.038, CI = [0.021, 0.061] — mediation confirmed as significant.

Table 10. Model fit indices (indirect effect)

Fit index	*Value*	*Threshold*	*Result*
RMSEA	0.054	< 0.08	Good
CFI	0.919	> 0.90	Acceptable
SRMR	0.049	< 0.08	Good

The overall SEM model for *H4* gets acceptable fit indices, which again proves the internal consistency and stability of the mediation structure in the model.

4.5. Asymmetric nonlinear relationship between macroeconomic variables, return on assets, and return on equity

The outcomes indicate that the different directions of changes in the *MV* have an unequal impact on *ROA*. *GDP growth* increases *ROA* more powerfully than the decline in *ROA* due to recession, while *Inflation* demonstrates the opposite drawback, which is being positively supported by Fakhrunnas et al. (2023).

Table 11. Test asymmetric nonlinear relationship (*MV → ROA*)

Variable	*Short-run coeff.*	*Long-run coeff.*	*p-value*
MV^+ (*GDP growth*$^+$)	0.034	0.162	0.012**
MV^- (*GDP growth*$^-$)	-0.021	-0.148	0.021**
MV^+ (*Inflation*$^+$)	-0.019	-0.075	0.031**
MV^- (*Inflation*$^-$)	0.008	0.042	0.067

*Note: ** indicates significance at the 5% level.*

Wald test for asymmetry (*ROA*): short-run $\chi^2 = 8.47$ ($p = 0.015$), long-run $\chi^2 = 12.31$ ($p = 0.002$) — asymmetric impact confirmed.

Table 12. Test asymmetric nonlinear relationship (*MV → ROE*)

Variable	*Short-run coeff.*	*Long-run coeff.*	*p-value*
MV^+ (*GDP growth*$^+$)	0.095	0.282	0.008***
MV^- (*GDP growth*$^-$)	-0.076	-0.239	0.011**
MV^+ (*Inflation*$^+$)	-0.038	-0.142	0.023**
MV^- (*Inflation*$^-$)	0.021	0.091	0.044*

*Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.*

Wald test for asymmetry (*ROE*): short-run $\chi^2 = 11.96$ ($p = 0.006$), long-run $\chi^2 = 14.73$ ($p = 0.001$) — asymmetric impact confirmed.

The asymmetric pattern continues for *ROE*, thus indicating the banks' larger reactions to good macroeconomic shocks than to poor ones. The fact

that Islamic banking equity returns are still behaving in the same way under good conditions goes hand in hand with the findings of Fakhrunnas et al. (2023).

Table 13. Summary of hypotheses results

Hypothesis	*Result*
H1	Supported — nonlinear (*ROA*)
H2	Supported — nonlinear (*ROE*)
H3	Supported — nonlinear mediation (*ROA*)
H4	Supported — nonlinear mediation (*ROE*)
H5	Supported — asymmetric nonlinear

Statistical evidence backs up all hypotheses (*H1–H5*), and, thus, the proposed nonlinear and asymmetric framework is validated. The results together imply that *MV* and *OE* are interlocked in a complicated nonlinear way to affect Islamic banks' financial performance.

5. DISCUSSION OF THE RESULTS

The investigation has identified a nonlinear (inverted U-shaped) association between operational efficiency and both ROA and ROE, thus backing up hypotheses *H1* and *H2*. At first, the step-up in efficiency is positively associated with performance, but after a certain point, the ROA and ROE would decline due to the increase in efficiency ($\beta_1 > 0$, $\beta_2 < 0$). Such findings are greatly consistent with the financial intermediation theory (Futaesaku et al., 2025) and the empirical work done recently pointing out the significance of efficiency thresholds in the performance of banks (Lassoued et al., 2025). Researchers using linear models (Slimen et al., 2022; Chowdhury & Haron, 2021) have found it difficult to pinpoint these nonlinear effects, thus revealing the restrictions of the conventional approaches. The findings in this paper stress the necessity of identifying the optimum efficiency levels for the enhancement of Islamic banks' performance.

The application of SEM and the bootstrapping technique demonstrates that operational efficiency is the intermediary in the process whereby the macroeconomic variables (GDP growth and inflation) influence ROA and ROE, thus validating hypotheses *H3* and *H4*. Average GDP growth increases operational efficiency, which, in turn, raises financial performance, whereas very high inflation or economic decline leads to the opposite effect, lowered performance. This finding backs up Istaiteyeh et al.'s (2024) claim about the phenomenon of diminishing returns of efficiency but goes ahead by revealing nonlinear and time-sensitive mediating effects, which were not discussed in previous studies (Eid et al., 2023; Chiad & Gherbi, 2024). Likewise, Ammar (2023), Gazi et al. (2024), and Majeed and Zainab (2021) recognized macroeconomic factors' effects on Islamic bank performance but did not take into account the mediation by operational efficiency, thus marking this study's contribution.

The research conducted via NARDL modeling has confirmed *H5*: macroeconomic variables have an asymmetric impact on both ROA and ROE. It was observed that the performance was overall improved by GDP growth, while profitability was merely down to a greater extent in the case of high inflation or recession periods. The study further concluded that giving up on the Islamic banks' universal indicator and acknowledging their specific economic conditions would lead to a better understanding of the potential conflicts in their Sharia-compliant interest frameworks. Non-traditional linear techniques like ARIMA or VAR (Ghenimi et al., 2024) are not good enough to measure these diverse consequences, thus proving the importance of the use of nonlinear techniques.

The upward limity U-shaped for operational efficiency implies that banks ought to strive for a peak inoperability threshold. Operational efficiency plays the role of a mediator at the same time, which causes the need for synchronization of the internal processes and the external environment (*H3* and *H4*). Nonlinear macroeconomic reactions (*H5*) are a further reason for Islamic banks to develop risk-oriented policies. The present research brings a new dimension to earlier studies by embracing a combination of nonlinear modeling, mediation analysis, and autoregressive distributed lag methodologies to give an all-around vision of the Islamic banks' performance over different economic conditions (Hussein, 2024; Almutairi & Quttainah, 2017).

In a way, the work on agency theory is extended by classifying operational efficiency as a mediator between macroeconomic conditions and financial performance (Jensen & Meckling, 2000). It also opens up the financial intermediation theory by unraveling the nonlinear threshold effects in the Islamic banking sector (Futaesaku et al., 2025).

Optimal efficiency levels for the maximum ROA and ROE returns can be determined by managers. The asymmetrical impacts of GDP growth and inflation can be taken into account by policymakers when designing economic policies. Sharia governance boards can align operational strategies with performance outcomes.

6. CONCLUSION

This study examines the nonlinear dynamics linking operational efficiency and financial performance in Islamic banks operating in selected emerging markets over the period 2012–2024. By focusing on ROA and ROE as key performance indicators, the research responds to growing calls in the literature to move beyond linear efficiency performance assumptions and to account for threshold effects and asymmetric macroeconomic influences. This research can proficiently identify direct and indirect effects in different economic situations by applying a comprehensive empirical strategy that combines nonlinear quadratic regressions, SEM, nonlinear mediation analysis with bootstrapping, and NARDL techniques.

The findings provide robust evidence of an inverted U-shaped relationship between operational efficiency and bank performance, indicating that efficiency improvements enhance profitability only up to an optimal point, beyond which further efficiency gains exert a detrimental effect. This result confirms the existence of efficiency saturation effects in Islamic banking and highlights the risks associated with excessive cost optimization strategies. In addition, operational efficiency is shown to act as a significant nonlinear mediator through which macroeconomic variables — GDP growth and inflation — affect financial performance. This mediating mechanism reveals

asymmetric and state-dependent transmission channels, whereby moderate economic expansion supports profitability, while high inflation or adverse economic conditions impose disproportionately negative effects.

From a theoretical perspective, the study advances agency theory and financial intermediation theory by explicitly modeling operational efficiency as a nonlinear mediating construct rather than a purely linear determinant of performance. The current study heralds a change in the story of Islamic banking by showing the existence of a non-monotonic relationship between the efficiency technology chosen by the manager and the macroeconomic factors. Therefore, it enhances the modeling of banks operating within developing nations. A strict approach using a combination of techniques such as nonlinear regression analysis, SEM models, and NARDL within the modeling process provides a more refined and accurate representation of the relationship than the traditional linear approach of analyzing the relationship.

The results also carry important implications for governance and regulation. The documented nonlinear efficiency-performance relationship suggests that regulatory and governance frameworks should emphasize optimal efficiency thresholds rather than unconditional efficiency maximization. Moreover, the asymmetric response of Islamic banks to macroeconomic shocks implies that uniform supervisory policies may be insufficient in emerging economies. Therefore, in incorporating adaptive strategies coupled with countercyclical prudence, having capital requirements that adapt in terms of "one-eye-in-the-sky" risk surveillance, as well as prudence that adapts according to their contexts, would better align with financial stability objectives. The role of operational efficiency in intervening in this scenario explains, in turn, the rationale available in ensuring efficiency measures within Sharia governance structures.

Several practical implications follow from these findings. Islamic banks are encouraged to pursue digital transformation and process automation strategies that enhance efficiency without undermining resilience. Policymakers should account for the nonlinear and asymmetric effects of inflation and economic growth when designing macroprudential policies for the Islamic banking sector. Strengthening coordination between Sharia boards and executive management can also support balanced decision-making that reconciles efficiency objectives with risk-sharing principles. A regional approach to a greater degree of regulatory harmonization among the emerging markets could form the basis of consistency, credibility, and stability for the Islamic financial systems. The key aspect of the matter, however, comes into view that the asymmetric results provided by the NARDL test imply the need to distinguish between the short-run and long-run expectations, where the former, particularly the inflationary pressures, require adaptive management of liquidity, and the latter requires maintaining efficiency at optimal levels instead of focusing on maximum reductions in costs.

Notwithstanding its contributions, this study has certain limitations. The sample is restricted to a selected group of Islamic banks in emerging markets, limiting the generalizability of the findings to conventional banking systems or developed economies. In addition, Sharia governance characteristics were not measured in detail, and cross-country regulatory heterogeneity was not fully incorporated into the empirical models. In respect of this, the model-specific limitations have played an important part, including, by way of example, the nonlinear models such as SEM and NARDL, which largely depend on the assumptions put in place in the model. On the other hand, the quantitative measurements of operational efficiency, including those based in accountancy, may measure, in fact, only the quantitative dimension of the managerial or technological aspect, which happens to be qualitative in nature, thus leading to inefficiencies in measurement. In fact, this analysis failed to give any actual credence to the extreme economic shocks, as well as any behaviors and cultures, either. A means by which this research may now further develop itself includes, by way of initial suggestion, a comparative approach which includes Islamic banks and conventional banks crosswise, including, by way of expansion, adding an authoritative evaluation of the efficacy of Sharia governance to the mix, and, by way of further suggestion, analyzing the resilience of banks to large-scale economic shocks, such as pandemics as well as geopolitical events. In addition, by adding actual behaviors and, by way of expansion, sophisticated approaches, including machine learning methodologies, in addition to other nonlinear methodologies, may lead to the actual development of new, perhaps hitherto unpreventable, interactions and patterns, thus increasing, by way of conclusion, the praxis-related applications as well as, by extension, the academic contribution of this particular research.

REFERENCES

Akbar, F., Isnurhadi, Mu'izzuddin, & Widiyanti, M. (2024). Institutional quality & bank stability: A study on ASEAN-5. *International Journal of Economic Perspectives, 18*(1), 42–52. https://ijeponline.org/index.php/journal/article/view/533

Al Azizah, U. S., & Haron, R. (2025). Unveiling the nexus: Corporate governance practices and corporate financial performance of an Islamic banking. *Business Performance Review, 3*(1), 37–47. https://doi.org/10.22495/bprv3i1p4

Al Sharif, B. M. M. (2023). The impact of macroeconomic variables on the performance of Islamic banks: An empirical study. *International Journal of Professional Business Review, 8*(4), Article e01347. https://doi.org/10.26668/businessreview/2023.v8i4.1347

Aldboush, H. H. H., & Ferdous, M. (2023). Building trust in FinTech: An analysis of ethical and privacy considerations in the intersection of Big Data, AI, and customer trust. *International Journal of Financial Studies, 11*(3), Article 90. https://doi.org/10.3390/ijfs11030090

Almutairi, A. R., & Quttainah, M. A. (2017). Corporate governance: Evidence from Islamic banks. *Social Responsibility Journal, 13*(3), 601–624. https://doi.org/10.1108/SRJ-05-2016-0061

Ammar, A. (2023). Performance assessment of Islamic banks the light of Maqasid Al-Shariah: A global evidence. *International Journal of Islamic Banking and Finance Research, 11*(2), 20–31. https://doi.org/10.46281/ijibfr.v11i2.2124

Awa, H. O., Ojiabo, O. U., & Orokor, L. E. (2017). Integrated technology-organization-environment (T-O-E) taxonomies for technology adoption. *Journal of Enterprise Information Management, 30*(6), 893–921. https://doi.org/10.1108/JEIM-03-2016-0079

Baig, M. M., Malik, Q. A., & Ellahi, N. (2024). Corporate governance and credit rating of Islamic banks: Moderating role of Shariah governance attributes. *Sage Open, 14*(2). https://doi.org/10.1177/21582440241247386

Bakour, A. (2025). Islamic vs. conventional banking: What about the efficiency during coronavirus? *Journal of Islamic Accounting and Business Research, 16*(6), 1100–1111. https://doi.org/10.1108/JIABR-02-2023-0048

Bashir, M. S., Edris, M. M. A. M., & Muslichah, M. (2023). Does Shari'ah supervisory board characteristics affect Islamic banks' financial performance? Evidence from Saudi Arabia. *Corporate Board: Role, Duties and Composition, 19*(2), 15–25. https://doi.org/10.22495/cbv19i2art2

Ben Naceur, S., & Omran, M. (2011). The effects of bank regulations, competition, and financial reforms on banks' performance. *Emerging Markets Review, 12*(1), 1–20. https://doi.org/10.1016/j.ememar.2010.08.002

Chen, D., & Fritz, M. S. (2021). Comparing alternative corrections for bias in the bias-corrected bootstrap test of mediation. *Evaluation & the Health Profession, 44*(4), 416–427. https://doi.org/10.1177/01632787211024356

Chiad, F., & Gherbi, A. (2024). The role of Islamic banks in promoting economic growth and financial stability: Evidence from Saudi Arabia. *Investment Management and Financial Innovations, 21*(3), 357–369. https://doi.org/10.21511/imfi.21(3).2024.29

Chowdhury, M. A. M., & Haron, R. (2021). The efficiency of Islamic banks in the Southeast Asia (SEA) region. *Future Business Journal, 7*, Article 16. https://doi.org/10.1186/s43093-021-00062-z

Denje, G. R., & Clement, O. O. (2021). CAMEL rating system and financial performance of Islamic banks in Kenya. *Asian Journal of Economics, Business and Accounting, 21*(17), 37–53. https://doi.org/10.9734/ajeba/2021/v21i1730490

Eid, Q. M. A., Al Houl, M. A. A., Alqudah, M. T. S., & Almomani, M. A.-A. (2023). The role of financial inclusion in the stability of Islamic banks. *International Journal of Professional Business Review, 8*(4), Article e01214. https://doi.org/10.26668/businessreview/2023.v8i4.1214

Fakhrunnas, F., Chowdhury, M. B. H., & Anto, M. A. M. (2023). The asymmetric impact of macroeconomic variables on Islamic bank home financing in Indonesia. *Jurnal Ekonomi & Keuangan Islam*, *9*(2), 151–166. https://doi.org/10.20885/JEKI.vol9.iss2.art1

Futaesaku, N., Kitagawa, N., & Shuto, A. (2025). Delegated bank monitoring by bond investors: Evidence from Japanese main banks. *European Accounting Review, 34*(2), 817–839. https://doi.org/10.1080/09638180.2023.2281380

Gazi, M. A. I., Karim, R., Senathirajah, A. R. b. S., Ullah, A. K. M. M., Afrin, K. H., & Nahiduzzaman, M. (2024). Bank-specific and macroeconomic determinants of profitability of Islamic Shariah-based banks: Evidence from new economic horizon using panel data. *Economies, 12*(3), Article 66. https://doi.org/10.3390/economies12030066

Ghenimi, A., Chaibi, H., & Omri, M. A. (2024). Risk and performance of Islamic and conventional banks under COVID-19 pandemic: Evidence from MENA region. *Arab Gulf Journal of Scientific Research, 42*(4), 1788–1804. https://doi.org/10.1108/AGJSR-03-2023-0098

Haddad, A. E., Shibly, B. S., & Haddad, R. (2020). Voluntary disclosure of accounting ratios and firm-specific characteristics: The case of GCC. *Journal of Financial Reporting and Accounting, 18*(2), 301–324. https://doi.org/10.1108/JFRA-04-2019-0055

Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). SAGE Publications.

Hanif, M. (2024). Performance evaluation of Islamic banking services industry: Evidence from GCC. *Journal of Risk and Financial Management, 17*(11), Article 523. https://doi.org/10.3390/jrfm17110523

Hassan, R., Salman, S. A., Haron, R., Yusoff, A., Hasan, A., & Mohd Yusoff, S. S. (2023). Risk assessment of Islamic banking products: Special focus on mudarabah and musharakah, *Onomázein, 62*, 1165–1179. https://www.researchgate.net/publication/369575108

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). The Guilford Press.

Hussein, M. A. (2024). Determinants of Islamic banks' profitability in an emerging economy: An empirical evidence from Bangladesh. *Finance & Economics Review, 6*(1), 61–68. https://doi.org/10.38157/fer.v6i1.628

Iatzaz Ul Hassan, M., Wu, M., Lu, J., Sohu, J. M., Ali, S., Anjum, H. N., & Bilal, M. (2025). Financial technology and banking performance in developing countries: Evidence from an advanced quantile regression approach. *Humanities and Social Sciences Communications volume, 12*, Article 1455. https://doi.org/10.1057/s41599-025-05571-8

Islamic Financial Services Board (IFSB). (2025). *Islamic financial services industry: Stability report*. https://www.ifsb.org/wp-content/uploads/2025/05/IFSI-Stability-Report-2025.pdf

Istaiteyeh, R., Milhem, M. M., Najem, F., & Elsayed, A. (2024). Determinants of operating efficiency for the Jordanian banks: A panel data econometric approach. *International Journal of Financial Studies, 12*(1), Article 12. https://doi.org/10.3390/ijfs12010012

Jarbou, S. I., Irimia-Diéguez, A., & Prieto-Rodríguez, M. (2024). Financial performance of Islamic and conventional banks in MENA region: A GLS approach. *Journal of Islamic Accounting and Business Research*. Advance online publication. https://doi.org/10.1108/JIABR-11-2023-0380

Jensen, M. C., & Meckling, W. H. (2000). Theory of the firm: Managerial behavior, agency costs and ownership structure. In R. I. Tricker (Ed.), *Corporate governance*. Gower.

Lassoued, N., Khanchel, I., & Saidani, W. (2025). Comparative study on the efficiency of Islamic banks and conventional banks during the COVID-19 outbreak. *Sage Open, 15*(1). https://doi.org/10.1177/21582440241309726

Majeed, M. T., & Zainab, A. (2021), A comparative analysis of the financial performance of Islamic banks *vis-à-vis* conventional banks: Evidence from Pakistan. *ISRA International Journal of Islamic Finance, 13*(3), 331–346. https://doi.org/10.1108/IJIF-08-2018-0093

Marnouch, B., & El Khamlichi, A. (2024). Risk governance and financial stability of Islamic banks: A systematic literature review. *Corporate & Business Strategy Review, 5*(2), 218–234. https://doi.org/10.22495/cbsrv5i2art19

Marnouch, B., El Boudaly, H., & El Khamlichi, A. (2025). Bibliometric analysis of risk governance and financial stability in Islamic banks [Special issue]. *Risk Governance & Control: Financial Markets & Institutions, 15*(3), 187–202. https://doi.org/10.22495/rgcv15i3sip2

McNeish, D., & Wolf, M. G. (2023). Dynamic fit index cutoffs for confirmatory factor analysis models. *Psychological Methods, 28*(1), 61–88. https://doi.org/10.1037/met0000425

Nobi, M. N., Billah, M. A., Ali, M. M., & Khatun, M. (2024). Efficiency measurement of conventional and Islamic banks in Bangladesh: A case study by using data envelopment analysis (DEA) and stochastic frontier analysis (SFA) approaches. *Studies of Applied Economics, 42*(3). https://doi.org/10.25115/sempjk92

Othman, N. E., & Othman, I. W. (2025). The nexus between fraud risk factors, Islamic corporate governance, and occupational fraud in the Islamic banking industry. *Risk Governance & Control: Financial Markets & Institutions, 15*(2), 69–79. https://doi.org/10.22495/rgcv15i2p6

Slimen, R. B., Belhaj, F., & Hadriche, M. (2022). Banking short- and long-term stability: A comparative study between Islamic and conventional banks in GCC countries. *Copernican Journal of Finance & Accounting, 10*(4), 139–158. https://doi.org/10.12775/CJFA.2021.019

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. In N. J. Foss (Ed.), *Resources, firms, and strategies: A reader in the resource-based perspective*. Oxford University Press. https://doi.org/10.1093/oso/9780198781806.003.0019