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Modeling technology and profitability as moderators of competition, efficiency, and risk in Islamic bank stability

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ABSTRAK

Introduction

Islamic commercial banks in Southeast Asia are facing growing challenges as competition intensifies and digital transformation accelerates. Stability has become a central concern, particularly in Indonesia and Malaysia where Islamic finance holds significant market share. While prior studies highlight competition, efficiency, credit risk, and liquidity risk as determinants of financial stability, the moderating influence of technology adoption and profitability has been less explored.

Objectives

This study investigates the effects of competition, efficiency, credit risk, and liquidity risk on the stability of Islamic commercial banks in Indonesia and Malaysia. It further examines how technology and profitability moderate these relationships, offering a comprehensive understanding of their role in shaping bank resilience.

Method

The research employed a quantitative approach using panel data from 14 Islamic commercial banks between 2010 and 2022. Bank stability was measured with the Z-Score, competition with the Lerner Index, efficiency with operating costs, and credit and liquidity risks with respective ratios. Technology was proxied by non-interest expenditures, while profitability was measured by return on assets. The analysis applied the generalized method of moments to address endogeneity and ensure robust estimates.

Results

The findings reveal that competition enhances bank stability, while credit and liquidity risks undermine it. Efficiency does not significantly affect stability. Technology exerts a dual effect: it improves stability directly but weakens the stabilizing influence of competition and heightens vulnerabilities linked to liquidity risk. Similarly, profitability

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supports stability under moderate risk-taking but magnifies the negative effects of excessive credit and liquidity risks. Bank size strengthens stability, whereas bank age is associated with greater fragility.

Implications
These results highlight that technology and profitability are double-edged factors: they can either reinforce or erode financial stability depending on how banks align them with risk management practices. Regulators and managers must ensure that digitalization and profit strategies are embedded within disciplined governance frameworks to prevent systemic vulnerabilities.

Originality/Novelty
This study contributes to the Islamic banking literature by introducing technology and profitability as moderators in the stability model, using a cross-country dataset and advanced estimation techniques. It offers new insights for policymakers and practitioners on balancing growth, digitalization, and risk control in sustaining the resilience of Islamic commercial banks.

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INTRODUCTION

Banks' financial stability plays a crucial role in the economy, as it reflects the smooth functioning of financial intermediation and fosters public trust (X. Li et al., 2021; Rakshit & Bardhan, 2022; Shahriar et al., 2023). A stable financial system is essential to prevent instability from spreading across sectors. Bank stability fosters public trust, whereas instability can trigger liquidity crises, rising non-performing loans, and potential bank failures. Loss of confidence may lead to large-scale fund withdrawals, credit contraction, and reduced investment, slowing economic growth. Declining asset values can diminish public wealth, while the need to rescue distressed banks imposes fiscal burdens on governments. Such disruptions may create a domino effect, impacting other financial sectors and the real economy. Ultimately, these conditions can lead to economic slowdown or even recession. To mitigate these risks, strict supervision and effective regulation are imperative, ensuring resilience, protecting public confidence, and sustaining long-term economic stability across interconnected sectors (Luo et al., 2024; Susan et al., 2024; Vuong et al., 2024).

Banking competition is one of the factors whose influence on stability is still debated (Louati & Boujelbene, 2015). Fierce competition can encourage banks to take excessive risks, but can also improve efficiency and strengthen capital buffers (Pruteanu-Podpiera et al., 2008; Tan et al., 2021). Competition can trigger interest rate hikes through market mechanisms, although it increases the risk of non-performing loans (De Nicoló et al., 2006; Mateev & Bachvarov, 2021). Previous research has shown

mixed results on the relationship between competition and efficiency to stability (Berger et al., 2010; Saif-Alyousfi et al., 2020), while others affirm the impact of efficiency on stability (Berger & Hannan, 1998; Kasman & Carvallo, 2014; Phan et al., 2019; Pruteanu-Podpiera et al., 2008), so it is important to re-examine this relationship.

Financial stability can be achieved when the banking system distributes risk efficiently (Goodhart & Tsomocos, 2010). Credit and liquidity risks are fundamental risks that can trigger bankruptcy (Freixas & Rochet, 2008; Rjoub et al., 2009). Research on funding risk and stability shows mixed results (Adusei, 2015; Diallo, 2015; Hassan et al., 2019). Weaknesses in implementing good corporate governance can also lead to instability, as seen during the 1998 crisis (Battaglia & Gallo, 2015; Erkens et al., 2012; Mollah et al., 2017). Several studies have shown that GCG has a significant impact on the performance and stability of banks (Beltratti & Stulz, 2012; Iramani et al., 2018), while others do not find this influence (Thoha et al., 2022).

Technology is now integral to banking services, including ATMs, mobile banking, and e-banking. Banks must adopt new technologies to survive in the competitive market. However, overinvestment in technology can harm their stability. On the other hand, technology can also increase efficiency and profitability (Safiullah & Paramati, 2024) and positively influence bank performance (Ozili, 2018; Scott et al., 2017). Technology can strengthen the relationship between efficiency and performance, but systematic risks can reduce the positive impact of technology on stability (Risman et al., 2021).

The inconsistency of the relationship between competition, risk, governance, and stability creates a knowledge gap. Therefore, we propose technology and profitability as moderating variables in this relationship. Profitability has been shown to moderate the relationship between risk and stability (Lesmana & Damayanti, 2021), and it plays a crucial role in maintaining stability (Ali & Puah, 2018; Pessarossi et al., 2020). Technology has also been found to moderate the relationship between financial variables and performance. Then, the subject of our research in Indonesia and Malaysia is based on the IFSB report, 2023. Islamic banks in both countries have higher capital reserves than conventional banks, which shows the ability of Islamic banks to manage their risks well in order to maintain financial stability. Therefore, this study aims to re-examine the influence of competition, efficiency, risk, and good corporate governance on financial stability, with moderation by technology and profitability, in Sharia-compliant commercial banks across both countries.

LITERATURE REVIEW

Since the global financial crisis and the recent Covid-19 pandemic, some studies have been conducted to uncover various factors that explain the financial stability of the banking sector (Adusei, 2015; Ali & Puah, 2018; Barra & Zotti, 2019; Diallo, 2015; Djebali & Zaghdoudi, 2020b; Feghali et al., 2021; Ghenimi et al., 2017; J. Gupta & Kashiramka, 2020; Kim et al., 2020; Lesmana & Damayanti, 2021; Mutarindwa et al., 2020; Nair & Anand, 2020; Zaghdoudi, 2019). This study uses several factors as determinants of bank

stability, such as efficiency (Dutta & Saha, 2021), competition (Mateev et al., 2022) funding risk (Adusei, 2015), credit risk, liquidity, and operational risk (Diallo, 2015; Zaghdoudi, 2019), corporate governance (Subhani & Zeb, 2022), quality of governance and financial inclusion (Alexandra et al., 2022), bank size (Ali & Puah, 2019) and accounting (Bischof & Rudolf, 2025). In addition to these factors, several studies use macroeconomic factors as determinants of bank stability, such as political stability (Djebali & Zaghdoudi, 2020a), bank market structure (Feghali et al., 2021), monetary policy (Nair & Anand, 2020), corruption (Ali & Puah, 2019), and economic policy uncertainty (Phan et al., 2019). These studies are significant for bank management in understanding the role of these factors in bank financial stability. Among these factors, management risk is a primary concern for policymakers due to its central role in bank stability (Lassoued et al., 2016). Several studies have identified credit risk, liquidity risk, and operational risk as key risks to financial stability (Djebali & Zaghdoudi, 2020b).

The literature on bank competition and financial stability remains controversial. Empirical research suggests that intense competition can induce banks to take excessive risks and lead to financial ruin (Allen & Gale, 2004; Carletti et al., 2007) or it may bring efficiency through reducing costs and prices of financial services and motivate banks to maintain capital buffers that ensure financial stability (Pruteanu-Podpiera et al., 2008; Schaeck & Cihák, 2014). Furthermore, some research findings provide inconclusive examples of the relationship between competition and stability (Allen & Gale, 2004; Berger et al., 2010; Saif-Alyousfi et al., 2020). These studies reveal different results, which makes the debate on the relationship between risk factors and financial stability inconclusive. Based on some of these studies, it can conclude the concept of research as illustrated in Figure 1.

Financial Stability

The concept of financial stability has been a concern for central banks since Sweden and Europe adopted it; however, there has been no single agreed-upon definition to date. Schinasi (2004) lists more than 10 definitions and He (2016) groups them into five main categories. In general, definitions are divided into two approaches: those that directly describe stability performance (Padoa-Schioppa, 2002; Schinasi, 2004) and those that emphasize the absence of symptoms of instability (Tsomocos et al., 2007). Various indices are used to measure stability, the Z-score being the most widely used due to its probabilistic nature and ability to predict bank bankruptcy (Lepetit & Strobel, 2015).

Capital Structure

Capital structure theories vary, ranging from the Modigliani & Miller's (1958, 1963) model, which emphasizes that capital structure does not affect the value of firms in efficient markets, to considering tax shields as advantages of using debt. The trade-off theory (Kraus & Litzenberger, 1973) emphasizes the balance between tax benefits and bankruptcy costs. The pecking order theory (Donaldson, 1961; Myers & Majluf, 1984) posits that companies prefer internal financing over external financing. Equity multiplier

(EM) measures the portion of assets financed by shareholders (Angell & Brewer, 2003). This ratio is important in assessing funding risk management: the higher the EM, the greater the dependence on debt. Passive management performance can also be measured using EM as a component of David Cole's ROE (Kiely, 1998).

Competition and Financial Stability

The Lerner Index (LEI) measures banks' competition level, with low values reflecting high competition. The LEI enables banks to understand market positions and respond effectively to competitive dynamics. Two main theories discuss the relationship between competition and stability. The first theory states that competition drives higher risk (Allen & Gale, 2004), while the second theory posits that limited competition encourages prudential strategies to maintain "franchise value" (Louati & Boujelbene, 2015). Empirical research yields mixed results: Kasman & Carvallo (2014) show that competition decreases the health of banks, while Mateev & Bachvarov (2021) and Alam et al. (2019) state the opposite, that competition can increase stability and lower the risk of failure.

H1: competition has a significant effect on the financial stability of banks

Financial Efficiency and Stability

Efficiency is the leading performance indicator of the bank. Low-efficiency values indicate optimal resource allocation at the lowest possible cost. Efficient banks are more adaptable to market changes and can maintain long-term profitability. In economics, efficiency is the ratio of maximum output to input (Alber et al., 2019). Efficiency theory emphasizes that efficient banks are better managed, more profitable, and have competitive advantage. Studies such as those by Alber et al. (2019) and Wheelock & Wilson (1995) support the notion that operational efficiency improves bank performance and reduces credit risk.

H2: efficiency has a significant effect on the financial stability of banks.

Financial Risk and Stability

Credit risk refers to the likelihood that a customer will default, resulting in a financial loss for the bank. A portfolio diversification strategy is necessary to reduce risk concentration, and creditworthiness evaluations should be carried out strictly. Effective credit risk management helps to safeguard assets and support operational stability. Acharya & Mora (2015) and Ghenimi (2017) found that credit and liquidity risk hurt stability. Acharya & Mora (2015) stated that liquidity is the leading cause of bank failure. Shim (2019) emphasizes the importance of liquid tools, while DeYoung & Torna (2013) highlight the importance of credit risk over liquidity risk.

H3: credit risk has a significant effect on the financial stability of banks

H4: liquidity risk has a significant effect on the financial stability of banks

Technology, Profitability, and Financial Stability

Technological innovations enhance the efficiency and accessibility of banking services, including online services, transaction security, and customer convenience. However, technology and access inequality persist as ongoing challenges. Significant investments in digital infrastructure are a must for banks to remain competitive. Technology supports service expansion and operational efficiency (Agyekum et al., 2016). Financial inclusion increases through FinTech (Demirgüç-Kunt et al., 2020), but it also increases systemic risks if not followed by sound asset-liability (Allen & Gale, 2004; Koetter & Poghosyan, 2009). Therefore, it is essential to assess whether implementing technology has a lasting positive impact on financial stability.

H5: technology can moderate the influence of competition on the financial stability of banks

H6: technology can moderate the effect of efficiency on the bank's financial stability

H7: technology can moderate the influence of credit risk on the bank's financial stability

H8: technology can moderate the influence of liquidity risk on the bank's financial stability

In addition, profitability as an indicator of internal performance can also strengthen or weaken the relationship of variables to stability (Minarni et al., 2023; Tan, 2016; Tan et al., 2017). When profitability is high, banks have sufficient capital reserves and retained earnings to cover the potential loss due to loans, so that the negative impact of credit risk on stability can be reduced (Cristian et al., 2020; Mooney et al., 2022). Strong profitability also makes banks better prepared to face competition, because adequate profits encourage a healthy business strategy without having to take excessive risks (Nisa' et al., 2023; Octrina & Setiawati, 2019; Tan, 2016). In addition, a good level of profit strengthens the benefits of financial efficiency, because profits can be re-invested to support technology, strengthening capital, and more effective risk management. Conversely, low profitability makes banks vulnerable, so credit risk faster eroding stability and rigorous competition can trigger risk behavior. In these conditions, efficiency alone is not enough to sustain stability because limited profits are unable to strengthen financial security. Thus, profitability can weaken the negative effects of risk and competition, as well as strengthen the positive effects of efficiency on bank stability.

H9: profitability can moderate the influence of competition on the financial stability of banks

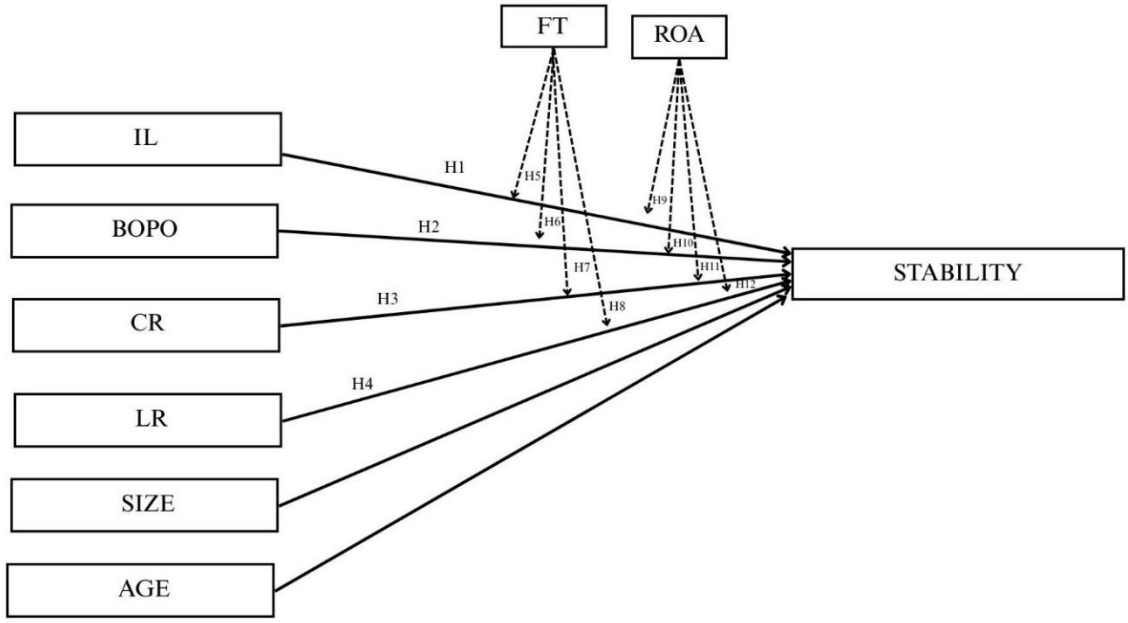
H10: profitability can moderate the influence of efficiency on the financial stability of banks

H11: profitability can moderate the influence of credit risk on the bank's financial stability

H12: profitability can moderate the influence of liquidity risk on the financial stability of banks

Figure 1

Conceptual Framework



Source: various studies, compiled by authors.

METHOD

This research employs a quantitative research approach. This is because problem formulation requires accurate answers that can only be assessed through statistical analysis of research results. The objectivity of the research design is considered important in quantitative research. Quantitative research can also be used for experiments with control factors in studies and to examine cause-and-effect relationships (Disman et al., 2017; Rutberg & Bouikidis, 2018).

The population in this study were all Islamic banks in Indonesia and Malaysia. Furthermore, the sample was selected with purposive sampling with the provisions of the bank officially publishing financial statements in the period 2010 to 2022. Based on these criteria, there were 14 banks selected as research samples. Banks included in the list include Affin IB, Alliance IB, AmBank IB, Maybank IB, Standard Chartered Shaadiq, OCBC IB, RHB IB, BCA Syariah, BTPN Syariah, Bukopin Syariah, Panin Dubai Syariah, Muamalat, Mega Syariah, and Victoria Syariah. This study employs four research variables, as illustrated in Table 1. As a dependent variable, the bank's financial stability is measured by the Z-Score (LNZ) value (Moudud-Ul-Huq, 2019, 2021).

The data analysis technique in this study was carried out through several stages, as follows. The first stage is descriptive statistical analysis, which aims to describe the

characteristics of the data by using summary statistics such as mean values, standard deviations, maximum values, and minimums. The next stage is correlation analysis. The results of this correlation analysis are important as the basis for further testing through regression. Panel Regression Analysis with Moderation Test was used to test hypotheses that have been empirically formulated; this study used three different panel regression models. The following analysis was panel regression with a moderation test. This study developed three-panel regression models designed to test the partial influence and moderation effect of technology and profitability variables on bank stability. The first model (Eq. 1) involves bound variables, independent variables, and control variables, which show the influence of each independent variable on the partially bound variable. The second model (Eq. 2) develops the first model by adding the interaction factor of the technology value, while the third model (Eq. 3) involves the interaction with the profitability.

The parameter estimation technique of these three models uses the Feasible Generalized Least Square (FGLS) approach (Famanta et al., 2024; Pyo & Choi, 2025). This approach was chosen because it effectively addressed the problems of endogeny and unobserved heterogeneity common in financial panel data. Furthermore, to ensure the resistance of the model, this study is accompanied by a robust test. Robust tests are carried out by regressing research models in banks in Indonesia and banks in Malaysia. The results of the two estimates of these models are further considered for the resilience of the main model.

$$Z_{score(i,t)} = \alpha + \beta 1_{i,t} IL_{i,t} + \beta 2_{i,t} BOPO_{i,t} + \beta 3_{i,t}\, CR_{i,t} + \beta 4_{i,t} LR_{i,t} + \gamma 1_{it} Size_{i,t} + \gamma 2_{i,t} Age_{i,t} \quad (1)$$

$$Z_{score(i,t)} = \alpha + \beta 1_{i,t} IL_{i,t} + \beta 2_{i,t} BOPO_{i,t} + \beta 3_{i,t}\, CR_{i,t} + \beta 4_{i,t} LR_{i,t} + \beta 6_{i,t} CyberTech_{i,t} + \beta 7_{i,t} IL_{i,t} * CyberTech_{i,t} + \beta 8_{i,t} BOPO_{i,t} * CyberTech_{i,t} + \beta 9_{i,t}\, CR_{i,t} * CyberTech_{i,t} + \beta 10_{i,t} LR_{i,t} * CyberTech_{i,t} + \gamma 1_{it} Size_{i,t} + \gamma 2_{i,t} Age_{i,t} \quad (2)$$

$$Z_{score(i,t)} = \alpha + \beta 1_{i,t} IL_{i,t} + \beta 2_{i,t} BOPO_{i,t} + \beta 3_{i,t}\, CR_{i,t} + \beta 4_{i,t} LR_{i,t} + \beta 6_{i,t} ROA_{i,t} + \beta 7_{i,t} IL_{i,t} * ROA_{i,t} + \beta 8_{i,t} BOPO_{i,t} * ROA_{i,t} + \beta 9_{i,t}\, CR_{i,t} * ROA_{i,t} + \beta 10_{i,t} LR_{i,t} * ROA_{i,t} + \gamma 1_{it} Size_{i,t} + \gamma 2_{i,t} Age_{i,t} \quad (3)$$

Table 1

Definition of Operating Variables Research

Variable	Description	Type	Formula
Respond Variable			
Y (Z_{Score})	Bank Stability (Z-Score) (Moudud-Ul-Huq, 2019; Moudud-Ul-Huq et al., 2018)	Ratio	$Z_{Score} = \frac{ROA + CAR}{\sigma\ ROA}$
Predictor Variable			
X1 (IL)	Competition/ *Lerner Index (IL)* (Moudud-Ul-Huq, 2021; Zheng et al., 2017)	Ratio	$IL = \frac{Total\ \ Revenue - Total\ Cost}{Total\ Revenue}$
X2 (BOPO)	Efficiency (Alber et al., 2019; L. Li et al., 2019; Ray & Das, 2010; Saif-Alyousfi et al., 2020)	Ratio	$CR = \frac{Non\ performing\ loans}{total\ loans.}$

Variable	Description	Type	Formula
X3 (CR)	Credit Risk (CR) (Djebali & Zaghdoudi, 2020a; Mateev et al., 2021; Pak, 2019)	Ratio	$CR = \frac{Non\ performing\ loans}{total\ loans.}$
X4 (LR)	Liquidity Risk (LR) (Djebali & Zaghdoudi, 2020a; Mateev et al., 2021; Pak, 2019)	Ratio	$LR = \frac{Liquid\ Assets}{Total\ Assets}$
Moderating Variable			
M1 (FT)	Technology (Uddin et al., 2020)	Ratio	$FT = ln(noninterest\ Expenses)$
M2 (ROA)	Profitability/ Return on Asset (ROA)	Ratio	$ROA = \frac{Net\ Income}{Total\ Assets}$
Control Variable			
Z1 (Size)	Sharia bank size (Alwi et al., 2021; N. Gupta & Mahakud, 2020)	Ratio	$\ln(Total\ Assets)$
Z2 (Age)	Sharia Bank age (Alwi et al., 2021)	Ratio	

Source: Primary data. Authors' estimate.

RESULTS

Descriptive Statistical Analysis Results

The characteristics of the data in this study describe the summary statistics of various financial ratios used as research variables (Table 2). This analysis includes each variable's mean, minimum, maximum, and standard deviations. This study includes data from 14 Sharia Commercial Banks in Indonesia and Malaysia from 2010 to 2022. The financial stability of Islamic banks is measured using the Z-Score, with the highest score of 6.30 achieved by BTPN Syariah and the lowest score of -2.83 by AMBANK IB (Malaysia) in 2021. The average Z-Score of Islamic banks in Malaysia is higher than that of Indonesia, although the most stable banks are from Indonesia. The Lerner Index shows a high level of competition with an average of 0.93. Malaysia is slightly more competitive (0.94) than Indonesia (0.92). Regarding efficiency, the BOPO ratio showed an average of 107.36 and a standard deviation of 71.18, indicating that operational management is quite efficient and stable in most banks.

Table 2

Descriptive Statistical Analysis Results in Indonesia and Malaysia (IM), Indonesia (I), and Malaysia (M)

Variable	Mean	Std Dev.	Maximum	Minimum
IL (IM)	0.9290	0.12340	0.9999	0.3461
IL (I)	0.9225	0.14837	0.9981	0.3461
IL (M)	0.9355	0.09235	0.9999	0.5548
BOPO (IM)	107.3650	71.1762	376.6400	10.7233
BOPO (I)	94.1216	26.2022	217.4000	50.7600
BOPO (M)	120.6084	95.6407	376.6400	10.7233
CR (IM)	2.9678	2.3357	12.5200	0.0000
CR (I)	3.1968	2.4999	12.5200	0.0000
CR (M)	2.7387	2.1484	11.8000	0.0800
LR (IM)	0.9157	0.1723	0.9999	0.0001
LR (I)	0.8666	0.2239	0.9990	0.0001

Variable	Mean	Std Dev.	Maximum	Minimum
LR (M)	0.9648	0.0686	0.9999	0.5258
SIZE (IM)	16.7329	3.9553	30.4304	8.6932
SIZE (I)	16.2874	5.3718	30.4304	8.6932
SIZE (M)	17.1785	1.4849	20.0493	14.4060
AGE (IM)	28.4000	34.6000	147.0	1.0
AGE (I)	13.4000	9.1000	33.0	1.0
AGE (M)	43.3000	43.3000	147.0	3.0
FT (IM)	16.7336	7.0314	28.5277	6.6695
FT (I)	12.9030	7.3355	28.5277	6.6695
FT (M)	12.1769	1.9060	16.0242	9.0126
ROA (IM)	1.2831	2.6342	13.5800	-10.7700
ROA (I)	1.7729	3.6421	13.5800	-10.7700
ROA (M)	0.7933	0.4523	1.5000	-22.0000
STABILITY (IM)	1.9526	1.5998	6.3024	-2.8373
STABILITY (I)	1.1290	1.4339	6.3024	-2.1868
STABILITY (M)	2.7762	1.3114	5.8191	-2.8373

Source: Secondary data. Processed by Authors.

Note: IL (Lerner Index), BOPO (Efficiency), CR (credit Risk), LR (Liquidity Risk), FT (Financial Technology)

The average credit risk (CR) of 2.96 indicates a relatively low non-performing financing rate, with a maximum value of 12.52 and a minimum of 0.00. Liquidity risk (LR) is higher in Malaysia (0.96) than in Indonesia (0.87), indicating the readiness of Malaysian banks to face short-term liabilities. Technology adoption as measured by the logarithm of non-interest costs, has an average of 16.73 and is widespread. The maximum value was achieved by BTPN Syariah (28.52) and the minimum by Bank Muamalat (6.67). Meanwhile, profitability (ROA) showed an average of 1.28 with a significant variation (standard deviation of 2.63), where Indonesia recorded a higher ROA value than Malaysia.

Correlation of Research Variables

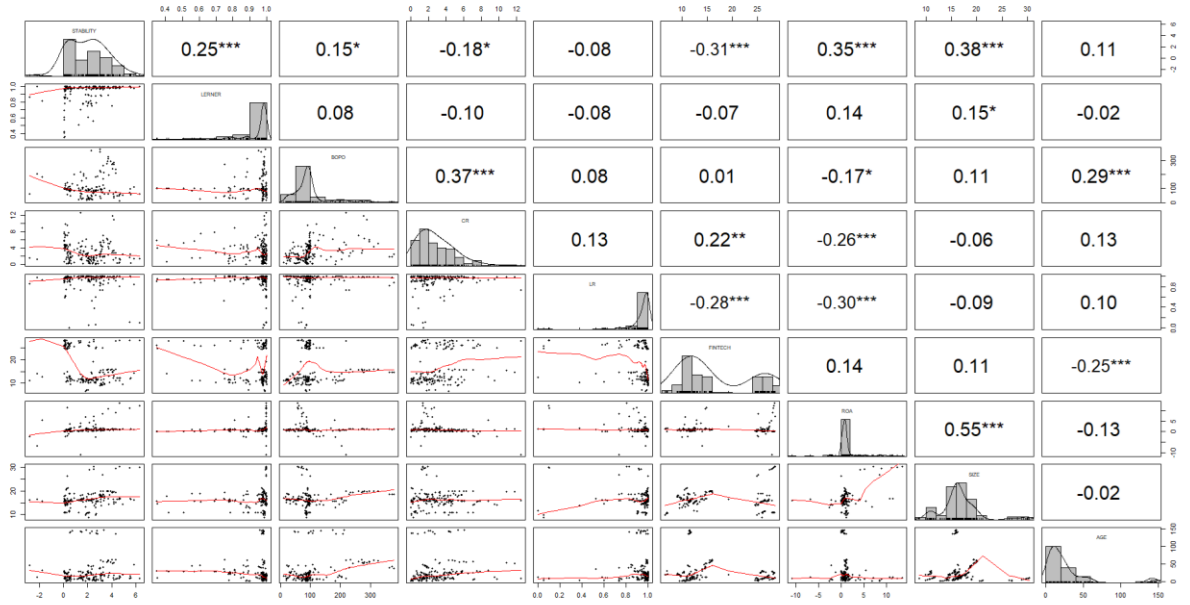
Correlation analysis is conducted as the initial stage in data processing to identify the relationship between research variables. This correlation test aims to determine the direction and strength of the relationship between variables, but it cannot be used to conclude the existence of a direct causal influence (Senthilnathan, 2019; Gogtay & Thatte, 2017). Therefore, advanced testing, such as regression, must support correlation results.

Based on Figure 2, it is known that the Z-Score as an indicator of bank financial stability has a significant relationship with several variables, namely competition (LERNER), efficiency (BOPO), credit risk (CR), technology (FINTECH), profitability (ROA), bank size (SIZE), and bank age (AGE). Most of these significant relationships are positive, suggesting that increasing these variables can increase bank stability. On the other hand, variables with a negative relationship indicate that an increase in value can reduce stability. Specifically, competition has a significant positive correlation to the Z-Score. It indicates that banks with market strength (high Lerner Index) tend to be more

stable. Efficiency (BOPO) also showed a significant positive correlation, indicating that effective management of operational costs is associated with better stability.

Figure 2

Correlation of Research Variables



Source: Secondary data. Processed by Authors.

In contrast, credit risk had a significant negative correlation to the Z-Score. The higher non-performing financing, the lower the bank's financial stability. Financial technology, as measured by non-interest spending-based technology, showed similar results, having a significant negative correlation to the Z-Score. This suggests that increasing technology costs, not offset by efficiency gains, can negatively impact the bank's stability.

Profitability has a strong positive relationship with financial stability, which means that more profitable banks tend to be more stable. Likewise, the bank size (SIZE) has a significant positive correlation to stability. Banks with significant assets have a better capacity to maintain stability. The bank's age is also positively correlated with the Z-Score, indicating that operational experience has strengthened the bank's financial resilience.

Furthermore, ROA showed a significant correlation for almost all research variables, both in the direction and in the opposite direction. A one-way relationship was found with Z-Score, LERNER, FINTECH, and SIZE. On the other hand, AGE is significantly related to almost all variables liquidity risk and bank size. The bank size only showed a significant correlation between stability and competition with varying relationship directions depending on the variables involved.

Regression Analysis Test Results

This study uses a panel regression approach in the first model without involving moderation variables to determine the main variables' direct influence on Islamic banks' financial stability (Table 3). The regression results showed that the competition variable (IL) had a positive and significant at 10% coefficient. This shows that the higher the level of competition, the greater the bank's financial stability. These findings support the theory that competition drives efficiency and better risk management, strengthening financial resilience.

Table 3

Effect Test Results

Variable	Coefficients and Significance of Testing		
	Model 1	Model 2	Model 3
Intercept	3.26434015	2.3475	3.7294892
IL	1.53681280*	8.0343e+00**	-0.1366347
BOPO	0.00078959	1.0121e-03	0.8799327
CR	-0.05227694	-4.4541e-02	0.0017654*
LR	-1.95744527*	2.0596e+00*	-0.0774425
FT		4.3528e-01	
ROA			-0.4070634
IL× FT		-3.1664e-01***	
BOPO× FT		7.1416e-07	
CR× FT		6.9250e-04	
LR× FT		-1.9072e-01***	
IL × ROA			0.5639406
BOPO × ROA			0.0002913
CR × ROA			-0.0596201 ***
LR × ROA			-0.1713593***
SIZE	0.05962716 *	9.5582e-02*	-0.0051431*
AGE	-0.02412735*	-2.7997e-02*	-0.0291889*

Source: Secondary data. Processed by Authors.

Note: * p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001.

Meanwhile, credit risk (CR) significantly negatively influences stability. This means that the higher the credit risk faced by the bank, the lower the level of financial stability. This shows the importance of problematic financing management in maintaining the resilience of Islamic banks. The efficiency (BOPO) and liquidity risk (LR) did not significantly influence this model, so the impact on stability could not be firmly concluded.

The second model was developed by adding the technology moderation variable and its interaction with the main variables. The regression results show that the direct influence of competition (IL) on financial stability increases significantly. This reinforces previous findings that competition drives stability, especially when technological factors are also considered. However, the interaction between IL × FT showed a significant negative influence (-0.3166), indicating that high technology adoption can

weaken the positive impact of competition on stability if not accompanied by adequate risk management.

On the other hand, liquidity risk (LR) shows a change in direction to positive. Higher liquidity supports stability when technology is involved. However, the interaction between LR × FT showed a significant negative influence, reinforcing the suspicion that technology can also exacerbate liquidity risks if not carefully regulated. Meanwhile, the efficiency variable (BOPO) and its interaction with financial technology did not show a significant influence, so the existence of the technology has not been proven to strengthen or weaken the relationship between efficiency and stability in this context.

The third model is designed to evaluate the role of profitability moderation (ROA) on the relationship between key variables and the bank's financial stability. The results showed that the credit risk (CR) variable exerted a positive and significant influence on stability. In the opposite direction to the previous two models. This shows that under conditions of sufficient profitability; banks can cover the pressure from credit risk so that the impact on stability is positive. However, the interaction between CR × ROA showed a significant negative coefficient. The higher profitability can reinforce the negative impact of credit risk if not managed properly. Meanwhile, liquidity risk (LR) remains significantly negative, and its interaction with ROA (LR × ROA) is also significantly negative. This reinforces the finding that although banks have high profitability, a heavy reliance on liquidity remains a source of vulnerability. The variables IL, BOPO, and ROA themselves did not show a significant influence in this model. Similarly, the SIZE and AGE control variables, although still significant, showed only a small and consistent influence as in the previous model.

Robust test (Table 4) also shows the results that are in accord with the main model. Islamic bank competition, credit efficiency and risk have a significant effect on bank stability. Furthermore, technology and profitability have a negative effect on stability. This result is interesting because it is different from general conditions. But this is possible because technology and profitability can also pose unexpected risks due to negligence of management.

Table 4

Robustness Test Effect

Variable	**Coefficients and Significance of Testing for Indonesia Bank**			**Coefficients and Significance of Testing for Malaysia Bank**		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Intercept	4.0304012**	0.12659565*	1.0132315	-3.83613*	-5.3242000*	5.3553303*
IL	0.9411277*	0.63195684	0.5133345	3.612126*	1.4198000	2.7063957
BOPO	-0.0147527**	-0.01401053	0.0075535	0.001782*	-0.015805	0.00359
CR	-0.0637235	-0.15965417	-0.1118782*	-0.00096	0.026670	-0.033942
LR	-1.6279875	4.05572518*	0.239688	0.955576	4.2446000*	-7.825607*
FT		0.20574158			3.840400*	
ROA			-1.4589865			-7.189066*

IL× FT		0.01028382			-0.905090	
BOPO× FT		-0.00023013			0.001057	
CR× FT		0.00644344			-0.000020	
LR× FT		-0.25558042**			-2.926700*	
IL ×ROA			1.9574583*			1.8082788
BOPO×ROA			0.0013995			-0.004684
CR × ROA			-0.0572969***			0.0611862
LR × ROA			-0.2236648*			8.9317828*
SIZE	-0.0341406*	-0.05496638*	-0.0920257*	0.136662*	-0.006610*	0.0037044*
AGE	-0.0185041*	-0.02438063*	-0.0055175*	-0.00503*	-0.001747*	-0.001428*

Source: Secondary data. Processed by Authors.

Note: * p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001.

DISCUSSION

The Role of Competition in Sharia Bank Stability

The Lerner Index is an important measure for determining the level of competition in the banking industry, including in Islamic banks (Goetz, 2018; Mateev et al., 2021). This index indicates the extent to which a bank has market power to set prices or margins above the costs incurred. The higher the Lerner Index value, the greater the market power held by the bank and the lower the competition among banks tends to be. Conversely, if the Lerner Index value is low, competition among banks becomes more intense and the room for banks to gain profit becomes more limited (Goetz, 2018; Phuong et al., 2024). The test results indicate that banking competition, as measured by the Lerner Index, has a positive and significant impact on the financial stability of Islamic banks . The higher the Lerner value, which indicates greater market power and lower levels of competition, the higher the Z-Score value, indicating more stable banking conditions.

Meanwhile, bank stability is often measured using the z-score. This indicator reflects a bank's ability to withstand the risk of bankruptcy through a combination of profitability, capital resilience, and income volatility (Goodhart & Tsomocos, 2010; Thoha et al., 2022). The higher the z-score, the more stable the bank is, as it has sufficient profit and capital reserves to absorb potential losses. Conversely, a low z-score indicates greater vulnerability to shocks and a higher risk of failure.

The relationship between the Lerner index and the z-score can be understood through the mechanism by which competition affects bank profitability and resilience (Phuong et al., 2024). When the Lerner index is high, Islamic banks are able to set higher profit margins due to relatively low competition. Higher margins allow banks to increase profitability, boost capital reserves, and ultimately strengthen stability as reflected by a higher z-score. Thus, in a less competitive market environment, bank stability tends to be better maintained. However, when the Lerner index is low, meaning competition is increasingly fierce, bank profit margins become thinner. This situation can put pressure

on profitability and increase income uncertainty, making it more difficult for banks to strengthen their capital (Goetz, 2018). As a result, the z-score may decline, signaling that bank stability is becoming more fragile.

Nevertheless, from some perspectives, high competition can also have a positive impact by encouraging banks to become more efficient, reduce unnecessary expenses, and avoid risky monopoly practices in the long term (Amendola et al., 2025; Clark et al., 2018; Liu et al., 2025; Phuong et al., 2024; Shaffer & Spierdijk, 2020). Therefore, the relationship between the Lerner index and z-score in Islamic banks is no single-faceted and may differ depending on market dynamics. In general, the greater the market power of a bank as reflected by a higher Lerner index, the higher the potential for bank stability through increased profitability and capital. However, healthy competition can also offer its own benefits for the efficiency and sustainability of the Islamic banking industry.

According to this theory, three main mechanisms explain the negative relationship between competition and stability. First, in a concentrated market, banks have high franchise value, the future economic value of sustainable profits. This value causes banks to be conservative and avoid excessive risks, as losing franchise value means losing a long-term source of profit. Second, a more concentrated banking system is easier for regulators to oversee. The small number of large banks allows for more effective supervision, thereby reducing systemic risks. Third, large banks with market power typically have better portfolio diversification capabilities. This diversification helps lower individual risk and improves the system's overall stability. These findings support the view of "competition-fragility," which is the theory that high competition can weaken the banking sector's stability (Berger et al., 2010; Kasman & Kasman, 2016; Keeley, 1990).

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Efficiency as a Stability Driver

In the realm of Islamic banking, the efficiency metric, specifically the operating cost to operating income ratio, frequently does not exert a significant influence on stability. This phenomenon can be attributed to the managerial orientation of Islamic banks, which prioritizes Sharia compliance, the sustainability of customer relationships, and the principle of prudence over mere cost efficiency (Oluseyi-sowunmi et al., 2019; Yuniarti et al., 2018). The relatively elevated costs associated with Islamic banking operations may stem from the necessity to uphold service quality, meet transparency

requirements, and ensure that contracts are executed in accordance with Sharia principles (Tan et al., 2017). Although these factors contribute to increased operating costs, they ultimately enhance customer trust and support long-term stability.

Furthermore, the limitations inherent in the formulation of the operating cost to operating income ratio suggest that this metric does not comprehensively capture a bank's stability (Abd-Elmageed et al., 2020; Koetter, 2008). This ratio primarily indicates the short-term efficiency with which a bank manages its costs and income, without considering aspects of sustainable profitability or capital resilience. Notably, in the z-score, which serves as a measure of stability, factors such as profitability and capitalization are accorded greater significance. Consequently, enhanced cost efficiency does not necessarily correlate directly with the increased stability of Islamic banks.

For instance, several Islamic banks in Indonesia exhibit relatively high operating cost to operating income ratios, attributable to the expenses associated with developing Sharia-compliant product contracts and investing in digital infrastructure (Alandejani, 2022; Hidayat et al., 2021; Joseph & Richard, 2025; Miah & Uddin, 2017). Nonetheless, these banks can sustain high stability due to robust profitability, consistent growth in third-party funds, and substantial capital reserves. This scenario illustrates that, in practice, efficiency is not invariably the primary determinant of stability; rather, risk management, Sharia governance, and capital strategies play a more significant role (Fries & Taci, 2005; Pasiouras & Kosmidou, 2007).

Credit and Liquidity Risk as a Threat to Stability

Financial risk represents the potential for a divergence between anticipated outcomes and actual results, which can impact the continuous operations of a bank (Hidayat et al., 2021; Joseph & Richard, 2025; Tan et al., 2017). In terms of stability, risk is considered the primary determinant of a bank's ability to sustain its performance amidst shocks. Unmanaged risk poses a significant threat to stability. For Islamic banks, credit risk and liquidity risk are the most pertinent types of risk, as they are directly associated with the collection of public funds and the allocation of financing. Credit risk is typically assessed by the ratio of non-performing financing to total financing, whereas liquidity risk is generally evaluated by the ratio of financing to third-party funds. Theoretically, elevated credit risk diminishes stability by suppressing profitability and increasing the potential for losses (Hidayat et al., 2021).

However, empirical research indicates that credit risk does not significantly affect stability in Islamic banking. This can be attributed to the fact that Islamic financing employs contracts based on profit-sharing, murabahah, and other agreements that feature distinct risk distribution mechanisms compared to conventional loans (Joseph & Richard, 2025; Utomo et al., 2021). The risk-sharing between the bank and the customer implies that problematic financing does not invariably have an immediate adverse impact on stability. Furthermore, the presence of real asset guarantees in many Islamic financing contracts also mitigates the potential for losses. Nevertheless, the interaction between CR × ROA is significantly negative, suggesting that high

profitability can exacerbate the adverse impact of credit risk if management is inadequate.

Conversely, Liquidity Risk (LR) also exhibits a negative influence, and its interaction with technology and profitability amplifies these negative effects, underscoring the necessity for prudent management of liquid funds, particularly in the digital era. In Islamic banks, liquidity is crucial due to the limited availability of Islamic money market instruments that can be utilized to address short-term funding shortages. Dependence on third-party funds, primarily savings and deposits based on trust, renders Islamic banks highly vulnerable when there is a mismatch between fund withdrawals and financing disbursements (Jin & Lee, 2020; Nasrulloh, 2021). The inability to promptly fulfill liquidity obligations can potentially undermine public trust and trigger greater instability. Therefore, although credit risk is significant, liquidity risk plays a more dominant role in influencing the stability of Islamic banks.

This phenomenon is observable in the practice of Islamic banking in Indonesia and other countries. For instance, when there is a surge in withdrawals by customers due to macroeconomic factors or trust issues, Islamic banks experience intense liquidity pressure. This condition can directly affect the z-score, which reflects stability, even though the level of non-performing financing does not increase significantly. This demonstrates that liquidity management is a critical aspect for Islamic banks in maintaining their stability.

The Impact of Financial Technology

The integration of financial technology (fintech) within the financial sector has precipitated substantial transformations in competitive dynamics and liquidity management. Fintech introduces streamlined, technology-driven, and cost-effective business models, necessitating that banks, including Islamic banks, enhance their operational efficiency (Asl et al., 2024; Khan et al., 2023; Uddin et al., 2020). The competitive pressures engendered by fintech's penetration necessitate that banks eschew reliance on high profit margins; instead, they must curtail operational expenses and harness technology to deliver services more swiftly, conveniently, and economically. In this context, fintech serves as an external catalyst that fortifies the nexus between competition and efficiency. Heightened competition compels Islamic banks to engage in digital innovation, service automation, and technology integration to maintain competitiveness.

In Malaysia, fintech's penetration has intensified the financial market, providing customers with a broader array of options for accessing financial services, including Sharia-compliant financing via digital platforms (Alsmadi et al., 2023; Shaikh et al., 2020). This scenario obliges Islamic banks in Malaysia to invest in digital, mobile, and app-based services. The escalating competitive pressure ultimately fosters enhanced efficiency, as banks are impelled to diminish intermediation costs, optimize their operational cost structures, and accelerate service delivery processes.

From a liquidity standpoint, fintech also exerts a significant influence. Fintech platforms, particularly in digital payments, peer-to-peer lending, and crowdfunding,

offer novel alternatives for the public to store and distribute funds. This necessitates that Islamic banks manage their liquidity with greater precision to retain their customer base. In this regard, the interplay between fintech and liquidity ratios incentivizes Islamic banks to optimize the sourcing and utilization of funds, as well as expedite the processes of fund collection and distribution. Ultimately, this process reduces intermediation costs and enhances efficiency.

An empirical phenomenon is evident in the context of Islamic banking in Indonesia, where fintech penetration is notably increasing, particularly in digital payment and platform-based financing services. Data from OJK indicates a continuous growth in the number of Sharia fintech, which complements the Islamic banking ecosystem (Dewi & Arsyianti, 2023; Khan et al., 2023). This competitive environment compels Islamic banks to develop Sharia mobile banking, QRIS-based digital payment systems, and collaborations with fintech to expand their service reach. In practice, such collaborations assist Islamic banks in reducing the operational costs associated with physical branches, enhancing transaction management efficiency, and maintaining liquidity by diversifying fundraising channels (Cristian et al., 2020; Rakshit & Bardhan, 2022; Wirdiyanti, 2018).

In essence, the advent of fintech not only intensifies competition and pressures banks to enhance efficiency but also bolsters liquidity management, positively impacting the operational efficiency of Islamic banks. Several prominent Islamic banks in Malaysia, including Bank Islam and Maybank Islamic, have actively collaborated with fintech firms to introduce digital Sharia services, such as payment applications, QR-based financing, and integration with e-commerce platforms. These innovations enable banks to decrease reliance on physical branches and traditional operational costs, thereby improving efficiency. Concurrently, such collaborations enhance liquidity by facilitating customer transactions more swiftly and flexibly.

Profitability as a Moderation Factor

In the context of Islamic banking, profitability is indeed crucial for maintaining stability, as higher profits enable the accumulation of larger capital reserves to absorb potential losses. However, the interaction of profitability with credit risk and liquidity risk does not invariably yield a positive impact on stability. Regarding credit risk, for instance, elevated profitability often incentivizes banks to adopt a more aggressive approach in extending financing, aiming for higher returns (Humairah et al., 2023; Tan et al., 2017). The greater the volume of financing distributed, the higher the likelihood of encountering problematic financing (Hidayat et al., 2021; Utomo et al., 2021). An increase in non-performing financing can transform profitability, initially serving as a buffer, into a vulnerability, as profits are depleted to cover losses, thereby diminishing stability.

A similar scenario unfolds with liquidity risk. High profitability may prompt an expansion of financing that outpaces the growth of third-party funds. This imbalance exerts liquidity pressure, as a significant portion of the bank's assets is committed to medium- to long-term financing, while liquidity liabilities, such as savings and deposits, remain subject to immediate withdrawal. A severe mismatch in this regard can impair

the bank's capacity to fulfil its liquidity obligations. This situation is perilous, as liquidity is intrinsically linked to public trust, the cornerstone of Islamic banks (Junttila & Nguyen, 2022; Mateev et al., 2021). A decline in customer trust heightens the risk of mass withdrawals, thereby threatening the bank's stability.

Consequently, although profitability functions as a risk buffer, its interaction with credit and liquidity risks can yield adverse effects. The pursuit of excessive profits may exacerbate exposure to problematic financing and liquidity mismatches. As a result, rather than enhancing the z-score as an indicator of stability, profitability, under such conditions, may undermine the stability of Islamic banks. To mitigate these risks, Islamic banks must strike a delicate balance between profitability and prudent risk management practices. This involves implementing robust credit assessment procedures, maintaining adequate liquidity buffers, and fostering strong relationships with depositors to maintain their trust. Additionally, regulatory bodies should closely monitor Islamic banks' risk-taking behaviours and enforce appropriate measures to ensure their stability and adherence to Sharia principles.

CONCLUSION

This study elucidates that internal financial determinants specifically competition, credit risk, and liquidity risk exert a significant impact on the financial stability of Sharia banks in Indonesia and Malaysia. The analysis indicates that technology assumes a dual role: while it can bolster stability, excessive or misaligned technological investment may undermine the beneficial effects of competition and exacerbate liquidity risk. Similarly, profitability enhances the positive impact of efficiency on stability but may also intensify the adverse effects of financial risks if not managed judiciously. These findings underscore the necessity of integrating robust risk management with strategic technological and profitability planning.

Policymakers and banks should not consider technology and profitability in isolation but as instruments whose efficacy is contingent upon their alignment with internal bank performance and market conditions. Thus, enhancing stability in Sharia banks necessitates a balanced approach: fostering healthy competition, improving efficiency, rigorously managing risk, and adopting technology within a clear governance framework. This balanced approach should be underpinned by robust regulatory oversight to ensure compliance with Sharia principles and international banking standards. Regulators must work closely with Islamic financial institutions to develop guidelines that promote innovation while safeguarding financial stability. Furthermore, Sharia banks should invest in continuous training and development of their workforce to keep pace with technological advancements and evolving market dynamics.

Limitations of the Study

This research was conducted on several Islamic banks in Indonesia and Malaysia, with a sample of 14 Islamic banks. With limited data availability, researchers feel that further research with a broader sample coverage and more complex variables is needed. Bank

stability is not a simple concept that can be defined from several aspects; rather, it is the other way around. It is also necessary to include external variables that can also affect the stability of the bank.

Recommendations for Future Research

This research still has room for further development in subsequent studies. First, quantitative data can be complemented by a qualitative approach to make the analysis more comprehensive. Second, the country's coverage can be extended to other regions to strengthen the generalization of the findings. Third, subsequent studies are recommended to add external variables that affect banking stability.

Author Contributions

Conceptualization	U.K.O. & T.M.	Resources	U.K.O. & T.M.
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Formal analysis	U.K.O. & T.M.	Supervision	U.K.O. & T.M.
Funding acquisition	U.K.O. & T.M.	Validation	U.K.O. & T.M.
Investigation	U.K.O. & T.M.	Visualization	U.K.O. & T.M.
Methodology	U.K.O. & T.M.	Writing – original draft	U.K.O. & T.M.
Project administration	U.K.O. & T.M.	Writing – review & editing	U.K.O. & T.M.

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Informed Consent Statement

Informed consent was not required for this study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest

The authors declare no conflicts of interest.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT, DeepL, Grammarly, and PaperPal to translate from Bahasa Indonesia into American English and improve the clarity of the language and readability of the article. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

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