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Dynamic Paths to Islamic and Conventional Bank Cost Efficiency: When Size and Profit Collide in HIMI Economies

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ABSTRACT

This study investigates the determinants of cost efficiency in Islamic and conventional banks operating in high-income and middle-income (HIMI) countries from 2015 to 2024, with a focus on the moderating effect of profitability on the relationship between bank size and cost efficiency. This study uses an unbalanced panel of 102 banks across 10 countries and employs a two-step system Generalized Method of Moments (GMM) approach. The results show that efficiency is persistent over time, indicating that past operational and governance practices have lasting impacts. Profitability directly improves cost efficiency and amplifies the benefits of larger bank size through economies of scale. Highly profitable Islamic and conventional banks demonstrate greater improvements in cost efficiency as their size expands. In contrast, banks with lower profitability experience only modest gains in cost efficiency as they grow. Higher credit risk reduces cost efficiency by increasing monitoring and compliance costs, while investments in intellectual capital are found to be vital for long-term competitiveness as it may slowly lower cost efficiency. Crisis periods are associated with higher efficiency, as resource constraints encourage tighter cost control. The findings provide important implications for policymakers, encouraging them to support efficiency without discouraging innovation and compliance. Finally, the study also lays out important implications for bank managers to strengthen risk management, strategically invest in intellectual capital, and leverage profitability to maximize the efficiency gains associated with the bank size.

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1. Introduction

Banking institutions play a significant role in the economic development of any country by channeling funds from surplus units to those in need of financing. For this reason, banks' efficiency has been one of the critical aspects of ensuring a sound banking system and long-term sustainability of the banking sector. Consequently, banking efficiency has remained a prominent topic in academic research over the years. This is primarily because bank efficiency is dynamic and fluctuates in response to a range of internal and external factors. These fluctuations make banking efficiency a complex field that warrants ongoing and continuous research.

Traditionally, the banking sector was dominated by the interest-based banking institutions known as conventional banks before Islamic banks came into the picture. However, the emergence of Islamic banks has reshaped the financial landscape. In the present era, Islamic banks have demonstrated remarkable growth, with total assets projected to reach USD5,248 billion by 2028 (Islamic Finance Development Indicator, 2024). The top five regions that are leading in Islamic banking assets include other MENA countries, GCC countries, Southeast Asia countries, South Asia countries and Europe countries. This highlights the growing significance of Islamic banks, particularly in regions where they operate and compete directly alongside conventional banks within the same market setting. Table 1 presents the Islamic banking assets by region.

Table 1. Islamic Banking Assets by Region

Region	Assets (2023, USD Billion)
Other MENA	1,557
GCC	1,506
Southeast Asia	337
South Asia	85
Europe	78
Sub-Saharan Africa	4
Americas	0.75
Other Asia	0.61

Source: Islamic Finance Development Indicator Report 2024 (Islamic Finance Development Indicator, 2024)

It is worth examining the efficiency of Islamic and conventional banks in high-income and middle-income (HIMI) countries because of the country-specific characteristics, particularly in terms of economic activities and the structure of the financial sector. High-income countries are often recognized for their mature financial systems, robust regulatory frameworks, and greater access to technological infrastructure, all of which may enhance banking efficiency. Nasim et al. (2024) disclosed that banks operating in high-income countries tend to be more efficient, largely due to stable monetary conditions, strong regulatory environments, and advanced financial infrastructure. In contrast, middle-income countries may face challenges of an effective banking system entirely due to lack of strong regulatory frameworks, corruption, lack of transparency and others (World Bank Group, 2020). Consequently, these disparities may influence the banking efficiency of the Islamic and conventional banks across the HIMI countries.

Banking efficiency can be defined in various ways depending on the dimension under study, including but not limited to technical efficiency, allocative efficiency, and cost efficiency. Technical efficiency refers to a bank's ability to utilize available inputs effectively to produce the maximum possible output (Koopmans, 1951). Allocative efficiency assesses a bank's capability to combine inputs and outputs in line with market prices, thereby minimizing costs while maximizing revenues (Fried et al., 2008). Cost efficiency on the other hand, measures how well a bank minimizes their cost to produce the same level of

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outputs while given the same inputs and operating under same conditions when compared to the best-practice bank (Berger & Humphrey, 1997).

This study focuses specifically on the cost efficiency of both Islamic and conventional banks in HIMI countries, rather than on other forms of banking efficiency discussed earlier. The emphasis on cost efficiency is motivated by the distinctive structural characteristics of Islamic banking institutions. Operating under Shariah principles, Islamic banks are required to adopt risk-sharing mechanisms, asset-backed transactions, and ethical financial practices, which may shape how they manage costs. However, compliance with Shariah governance often results in higher operating expenses, particularly administrative costs associated with dual governance structures and related requirements (Majeed, 2021; Nomran & Haron, 2020). This poses significant challenges for Islamic banks to ensure their smooth operations by effectively managing their cost and generating profits while competing with the conventional banks. Alsharif (2021) validated that Islamic banks are shown to be less cost efficient than conventional banks across the GCC countries.

In spite of that, Islamic banks exhibit higher cost efficiency during crises compared to the conventional banks. Bitar et al. (2018) asserted that asset-backed financing and conservative investment strategies in Islamic banks contribute to their operational efficiency and resilience in times of crises. Unlike the Islamic banks, conventional banks may face challenges in maintaining cost efficiency during periods of economic stress due to their reliance on interest-based financing and involvement in speculative activities. Over the period of 2015–2024, three (3) major crises were identified in this study namely, the oil crisis, the COVID-19 pandemic, and the Pakistani economic crisis. The sharp decline in oil prices from mid-2014 to early 2016 had weakened capitalization, profitability, liquidity, and efficiency in banks, particularly in oil-exporting and oil-importing countries (Lee & Lee, 2019). At the end of 2020, the sudden outbreak of COVID-19 brought global economic activity and financial systems to a standstill. Despite the implementation of financing (loan) moratoriums, AlHassan et al. (2022) asserted that a prolonged and severe pandemic might significantly impair asset quality. On top of that, the Pakistani economic crises in 2022 to 2024 had made it harder for banks operating in Pakistan to manage their costs efficiently as the banks face lower deposits and higher taxation (Zaidi, 2025).

Additionally, considering that banks primarily offer financial services rather than physical goods thus, the study includes intellectual capital as one of the independent variables. As highlighted by Dar (2013) and Mortazavi and Bahrami (2012), creating value through knowledge, skills and innovation in a current knowledge-driven economy has become essential to create competitive advantage. To measure this, the study employs the Value-Added Intellectual Coefficient (VAIC), which captures three (3) components that are, human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE). The HCE, SCE and CEE reflect how banks effectively convert their intellectual capital into a value that can create competitive advantage while improving cost efficiency. Maji and Saha (2023) revealed that intellectual capital plays significant roles in positively improving banks' efficiency.

Hence, the research objective of this study is to investigate the drivers of cost efficiency of Islamic and conventional banks in high-income and middle-income (HIMI) countries. This objective provides valuable insights on how Islamic and conventional banks in HIMI countries sustain their performance as well as competitiveness in a diverse economic setting. Furthermore, the study examines the interaction effect of profitability on the relationship between bank size and cost efficiency. The findings aim to bridge gaps in the banking and finance literature by highlighting factors that influence efficiency across banking systems and income groups. This study contributes to the literature in three important ways. First, it provides novel evidence on cost efficiency by comparing Islamic and conventional banks across high- and middle-income (HIMI) countries, a context that has received limited attention despite the rising importance of Islamic finance globally. Second, it applies a dynamic panel approach using two-step system GMM, which accounts for endogeneity and persistence in cost efficiency, thereby offering more robust insights than static models commonly employed in prior research. Third, the study highlights the interaction between bank size and profitability as a key driver of cost efficiency, extending theoretical understanding and offering practical

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guidance for policymakers and bank managers seeking to enhance efficiency through profitability-driven growth strategies.

The remainder of this paper is structured as follows: Section 2 gives an overview of the literature review on banks' cost efficiency. Section 3 describes the research methodology. The results are presented and discussed in Sections 4. Finally, Section 5 concludes the paper with implications and recommendations.

2. Literature Review

Cost efficiency is no longer merely an indicator of operational performance; rather, it has become a strategic necessity for banks seeking to remain profitable, competitive, and resilient in today's dynamic economic environment. Cost efficiency can be defined as a bank's ability to minimize costs while achieving maximum results with a given level of inputs under specific business conditions (Bradrania et al., 2017). Despite the growing body of research on bank efficiency, several gaps remained. While studies have compared Islamic and conventional banks, evidence across high- and middle-income (HIMI) countries is limited, particularly regarding cost efficiency. Second, most existing studies focus on either bank size or profitability independently, with few examining their interaction effect on efficiency outcomes. For instance, research analyzing the impact of regulatory changes on bank performance highlights the importance of bank size (Gržeta et al., 2023), but does not consider its interaction with profitability. Third, the role of internal resources, such as intellectual capital, and their combined impact with external shocks on cost efficiency remain underexplored. Addressing these gaps, the present study provides a comprehensive analysis of cost efficiency across Islamic and conventional banks in HIMI countries, explicitly considering the interplay between bank size, profitability, intellectual capital, and external factors. By integrating these dimensions, the study contributes to the literature on bank efficiency and offers practical insights for policymakers and bank managers seeking to enhance cost efficiency in diverse economic contexts.

Cost efficiency is one of the critical elements influencing banks' strategic decisions, especially during periods of financial uncertainty (Narawish et al., 2022). Consequently, numerous studies have sought to identify its key drivers. Since financing is the core business of banks, it inherently exposes them to credit risk. Higher volumes of financing may elevate credit risk, which in turn increase monitoring and recovery costs, thereby reducing cost efficiency (Dar et al., 2021; Shaheen et al., 2024). This evidence supports the bad luck hypothesis formulated by Berger and DeYoung (1997), which suggested that despite banks' protective measures, unforeseen shocks and defaults inevitably force them to incur additional costs, thereby reducing efficiency. However, Ilmiani and Meliza (2022) found contrasting evidence, showing that greater financing volumes can enhance cost efficiency, as expanded lending increases revenue and offsets costs. In addition, studies on Islamic banks reveal mixed findings. Some suggested that due to the prohibition of interest, Islamic banks face higher credit risk and lower efficiency (Alzoubi et al., 2022). Other studies, however, argued that Islamic banks exhibit stronger asset quality and make more effective use of their resources, partly due to restrictions on asset classes and adherence to Shariah compliance (Nodoushan & Mousavi, 2024).

The bad luck hypothesis also highlights the impacts of crises on cost efficiency. During crises, banks often experience operational disruptions and struggle to allocate resources effectively. Crises can trigger higher default rates and elevated credit risk, which in turn reduce efficiency (Cangombe et al., 2025; Nabi, 2022). At the same time, limited resources during crises may compel banks to operate more efficiently in order to survive, forcing them to manage their resources as effectively as possible. According to Minh Sang (2022), many banks suspend dividend payments and promote digital banking applications, even before the pandemic, to reduce operating expenses and enhance cost efficiency. The effects of crises, however, differ between Islamic and conventional banks. Evidence shows that the Islamic banking industry is generally more cost efficient and resilient to financial shocks compared to conventional banks (Nguyen et al., 2023).

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In addition, macroeconomic conditions play a critical role in determining bank efficiency. Favourable macroeconomic environments encourage industry growth, while unstable and uncertain conditions increase credit risk and weaken efficiency. During economic downturns, higher levels of defaulted financing, combined with limited resources, reduce banks' ability to expand financing, thereby lowering cost efficiency (Cangombe et al., 2025).

The increasing competitiveness and digitalization of the banking sector signify that banks' performance is now measured not only by physical capital but also by intellectual capital. According to the resource-based theory (RBT) developed by Barney (1991), firms can enhance performance, efficiency, and profitability by investing in internal resources and intellectual capital. Intellectual capital is often considered as the knowledge-based equity of organizations (Dalwai & Singh, 2022). Banks depend heavily on intellectual capital in the form of human, structural, and capital employed resources to remain competitive. By fully utilizing these components, banks can improve cost efficiency (Filatie & Sharma, 2024; Le et al., 2022). Pîslaru et al. (2023) showed that investing in staff quality through training and skill development can improve cost efficiency in the long run, a result that was also confirmed by Aslam and Haron (2021) in the context of Islamic banks. However, Islamic banks face unique cost pressures. The requirement to maintain a Shariah Advisory Committee increases expenses, as staff training must ensure compliance with Islamic finance principles. This raises operating costs and may reduce efficiency. Nawaz et al. (2021) argued that while human capital expenditure in Islamic banks is higher due to their ethical business model, it can improve cost efficiency in the long term. Moreover, strict monitoring and supervisory practices enhance the efficiency of Islamic banks but may reduce efficiency for conventional banks (Sultana & Rahman, 2020).

Bank size has mixed effects on cost efficiency. Larger banks benefit from economies of scale, allowing them to expand market share and increase productivity (Narawish et al., 2022). With more borrowers and greater diversification, larger banks can reduce average costs and achieve higher efficiency (Gupta & Mahakud, 2020; Khan & Haque, 2025; Otero et al., 2020). On the other hand, the agency cost hypothesis suggests that as banks grow, managerial complexity increases, raising agency costs and reducing efficiency (Karim et al., 2025).

Profitability represents a bank's ability to generate income above costs, but high profitability does not necessarily imply cost efficiency. Profitability may improve efficiency if banks leverage high interest rates or reinvest earnings into innovations and branch networks, which reduces costs over time (Lotto, 2019). Profitable banks are also better positioned to organize expenses effectively which enhance efficiency (Sultana & Rahman, 2020).

To address potential endogeneity, this study applies the generalized method of moments (GMM), in which lagged cost efficiency is included as an explanatory variable. Sultana and Rahman (2020) found persistence in banks' cost efficiency, showing that efficient banks in previous years tend to remain efficient in subsequent years.

Prior research reported both positive and negative relationships between bank size and cost efficiency. Profitability may moderate this relationship in various ways. Profitable banks can strengthen the efficiency of larger banks through economies of scale, as higher earnings and increasing returns to scale lower average costs and provide a competitive advantage in attracting deposits compared to smaller banks (Alkhider, 2025). This is supported by Beliel (2024), noting that larger banks are more effective in converting assets into profits, consistent with the argument that economies of scale enhance profitability and efficiency in large banks.

Building on the above identified gaps, the following hypotheses are developed to empirically test the determinants of cost efficiency, the moderating role of profitability, and the differences between Islamic and conventional banks in HIMI countries. The study hypothesizes that credit risk, intellectual capital, bank size, profitability, lagged cost efficiency, and economic conditions significantly influence the cost

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efficiency of Islamic and conventional banks in HIMI countries. In addition, profitability is expected to interact with the relationship between bank size and cost efficiency in both banking models.

3. Research Methodology

The variables in this study are derived from secondary data obtained from the Fitch Ratings PRO database formerly known as FitchConnect. The dataset comprises annual observations covering a 10-year period from 2015 to 2024. The unit of analysis in this study is at bank level. The sample covers 102 Islamic and conventional banks from ten (10) high- and middle-income (HIMI) countries. Given the possibility of missing data for certain years or banks, the study employs an unbalanced panel data structure, resulting in 778 bank-year observations. This bank-level approach enables the study to capture cross-sectional variations among individual banks while also considering temporal dynamics across the study period. The analysis focuses on dual banking systems, examining the capital decision-making of both Islamic and conventional banks. This focus is particularly relevant as Islamic banks operate within financial systems predominantly shaped by conventional banking practices. The study seeks to provide empirical support for three (3) theoretical perspectives that are, the bad luck theory, the resource-based theory and the too-big-to-fail theory. The bad luck theory suggests that banks may experience declines in efficiency and performance due to external shocks or adverse economic conditions that are beyond their control, emphasizing the role of uncontrollable risks in shaping outcomes. The resource-based theory highlights that banks with stronger internal capabilities such as intellectual capital, technology, or managerial expertise are better positioned to achieve superior cost efficiency and sustain competitive advantage. Meanwhile, the too-big-to-fail theory argues that larger banks may enjoy implicit guarantees, scale advantages, and market power that allow them to operate more efficiently, but also raises concerns about risk-taking behavior and systemic implications. By examining cost efficiency across Islamic and conventional banks in HIMI countries, this study tests the relevance and explanatory power of these theories within a dual-banking and cross-country context.

For the sample selection, the study identifies ten (10) countries offering both Islamic and conventional banking services from high- and middle-income (HIMI) economies. The countries were selected to ensure meaningful representation of Islamic banking within the financial system. Specifically, only countries where Islamic banking assets constitute at least 15 percent of the total domestic banking assets, as reported by the Islamic Financial Services Board (2025), were included. This criterion ensures that both banking systems contribute significantly to the industry, allowing for a more balanced comparison between the two groups of banks. The middle-income countries include Bangladesh, Jordan, Malaysia, and Pakistan, while the high-income countries comprise Bahrain, Brunei, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. The HIMI classification follows the World Bank's criteria, where middle-income economies are defined as those with a Gross National Income (GNI) per capita between USD1,136 and USD13,935, while high-income economies are defined as those with GNI per capita exceeding USD13,935. Table 2 presents the income group classification based on GNI per capita (USD).

Table 2. Income Group Based on Gross National Income (GNI) per capita (USD)

Income Group	GNI per Capita (2024, USD)	Definition
Low-income	≤ 1,135	Economies with a GNI per capita of $1,135 or less
Lower middle-income	1,136 – 4,495	Economies with a GNI per capita between $1,136 and $4,495
Upper middle-income	4,496 – 13,935	Economies with a GNI per capita between $4,496 and $13,935
High-income	≥ 13,936	Economies with a GNI per capita of more than $13,935

Source: The World Bank Group (World Bank Group, 2025)

The dependent variable in this study is cost efficiency (CE), which refers to banks' ability to manage operating expenses effectively in generating earnings. Inefficient cost management reduces profitability

and weakens overall performance. Following Yin (2021), cost efficiency is measured using the ratio of non-interest expenses to average total assets, which serves as an inverse proxy (i.e., higher value indicates lower efficiency). A lower ratio indicates that a bank generates greater value relative to its operating costs. To improve interpretability, this proxy is transformed by multiplying the ratio by -1, so that higher values now represent greater cost efficiency. This adjustment ensures a more intuitive understanding of the estimation results and facilitates clearer interpretation in the findings and discussion. The independent variables include credit risk, intellectual capital (VAIC), bank size, crisis period, bank specialization, country group, economy, and profitability.

Credit risk (CR) arises when borrowers fail to meet their repayment obligations in full or on time. Following Fukuyama and Tan (2024) and Maji and Saha (2023), credit risk is measured using the ratio of financing loss allowance to gross financing. A higher ratio reflects greater provisions for potential defaults, indicating higher exposure to financing losses. Value Added Intellectual Capital (VAIC) measures the intellectual capital (IC) of banks as the sum of human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE). An increase in this ratio reflects stronger intellectual capital. Similar measurements were employed by Onumah and Duho (2020). Bank size (SIZE) reflects the scale of operations and resources. Larger banks typically hold greater total assets. This study measures bank size using the natural logarithm of total assets, consistent with Obadire et al. (2023) and Do Van (2022). The crisis period (CP) variable accounts for the effects of financial and economic crises during the study time frame. It is measured using a dummy variable, where 1 denotes a crisis year and 0 otherwise (Adem, 2022). Table 3 exhibits the list of crises involved throughout the study period. In this study, a single dummy variable was employed to capture the effects of crisis periods, including the Covid-19 pandemic, the Oil Price Crisis, and the Pakistani Economic Crisis. Although these crises differ in origin, their effects on banks typically converge through similar transmission mechanisms such as heightened uncertainty, reduced profitability, deteriorating asset quality, and efficiency constraints (Berger & Bouwman, 2013; Ruzzante, 2018). Moreover, using a single dummy enhances and simplifies estimation while avoiding excessive dummy proliferation that can cause multicollinearity. In HIMI countries, crises such as the Covid-19 pandemic, oil price shocks, and localized economic crises, all triggered cost-side pressures include higher NPLs, lower revenues and efficiency constraints. Since all of the effects converge together, for the context of this study, using one dummy to capture the crisis environment is sufficient to reflect their aggregate effect on cost efficiency.

Table 3. List of Crises

No.	Crisis	Year	Country
1.	Covid-19	2020-2022	All countries
2.	Oil Price Crisis	2014-2016	GCC
3.	Pakistani Economic Crisis	2022-2024	Pakistan

To capture institutional and regional differences, the study incorporates bank specialization (B) and country group (CG) classifications. Bank specialization distinguishes between Islamic and conventional banks, where 1 represents Islamic banks and 0 represents conventional banks (Chazi et al., 2024). Country group classification differentiates between HIMI economies, where 1 represents high-income countries and 0 represents middle-income countries (Klein & Turk-Ariss, 2022). The economy (ECO) variable controls for cross-country variations in macroeconomic conditions. Following Kanago (2023), the study uses the GDP deflator to capture inflation, calculated as the ratio of current-price GDP to constant-price GDP, expressed in the base year of each country's national accounts. The study further hypothesizes that profitability (PROFIT) significantly influences the relationship between bank size and cost efficiency. Profitability is therefore incorporated as an interaction variable. It is measured by the ratio of operating profit to average total assets, commonly known as operating return on assets (operating ROA), following Abbas et al. (2021). All variables are measured as percentages, except for dummy variable.

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The study employs dynamic panel data analysis to achieve its objectives and utilizes Stata 12 for the statistical estimations. The preliminary tests include outlier detection using Cook's Distance, descriptive statistics, Pearson correlation analysis, multicollinearity diagnostics through the Variance Inflation Factor (VIF), heteroscedasticity testing with the Modified Wald Test, and unit root testing using the Fisher-type Phillips-Perron approach. The study uses the Weighted CD test by Juodis and Reese (2022) to detect cross-sectional dependence (CD) in the panel, which may arise from unobserved common shocks affecting multiple banks simultaneously. Ignoring such dependence can bias towards standard errors and invalidate inference. The test is robust to latent factors and suitable for the panel with a small time dimension (T = 10), ensuring that subsequent estimations account for interdependencies and produce reliable results. Identified issues, if any, are addressed prior to estimation.

Recognizing potential endogeneity in banks' cost efficiency, the study conducts endogeneity tests to establish the dynamic nature of cost efficiency management. Diagnostic tests for dynamic panel regression using GMM are also performed to ensure parameter consistency. Serial correlation is examined using the Arellano-Bond test for AR(1) and AR(2) in first differences. The study expects to reject the null hypothesis for AR(1) and fail to reject it for AR(2). Instrument validity is assessed using the difference-in-Hansen test, where rejection of the null hypothesis indicates that the system GMM estimator is preferable. Furthermore, the study ensures that the number of instruments remains below the number of observation groups to avoid over-identification bias. To ensure representativeness, each panel group contains at least three (3) observations.

Given the dynamic nature of cost efficiency, the study applies the two-step system GMM estimation technique proposed by Arellano and Bover (1995) and Blundell and Bond (1998). This method is more suitable than traditional static panel models when a lagged dependent variable is present. The system GMM approach is particularly effective in addressing autocorrelation, heteroscedasticity, and endogeneity in short panel datasets. The study specifies the following econometric model to achieve the proposed objectives:

$$CE_{it} = \beta_0 + \beta_1 CE_{it-1} + \beta_2 CR_{it} + \beta_3 IC_{it} + \beta_4 PROFIT_{it} + \beta_5 SIZE_{it} + \beta_6 ECO_{it} + \beta_7 CP_{it} + \beta_8 B_{it} + \beta_9 CG_{it} + \beta_{10}(SIZE_{it} * PROFIT_{it}) + e_{it} \quad (1)$$

Where, CE denotes cost efficiency, CR represents credit risk, IC refers to intellectual capital, PROFIT captures profitability, SIZE represents bank size, ECO is the GDP deflator used to control for economy-wide price levels, CP indicates the crisis period, B represents bank specialization (Islamic or conventional), and CG denotes the country group (high-income or middle-income economies).

4. Findings and Discussion

The final estimations include Islamic and conventional banks from ten high- and middle-income (HIMI) countries. The study covers a 10-year period from 2015 to 2024 and comprises 102 banks with 778 observations. Prior to model estimation, the study conducts diagnostic tests to ensure the use of an appropriate methodology with consistent and unbiased estimators. The diagnostics begin with outlier detection, multicollinearity testing, heterogeneity testing, and unit root testing. The results indicate no serious multicollinearity issues as the mean VIF is below 5. However, heteroscedasticity is present as shown by the Modified Wald test for groupwise heteroscedasticity. With the exception of bank size, all variables are stationary which exhibit no unit root concerns. Extreme values are removed, and the bank size variable is log-transformed to resolve the unit root issue. The Weighted CD test following Juodis and Reese (2022) is applied to examine cross-sectional dependence in the panel data. The CDw statistic is 0.33 with a p-value of 0.744, suggesting no statistically significant evidence of cross-sectional dependence among the banks in the sample. This indicates that potential interdependencies are limited, allowing for standard panel

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estimation techniques to be applied. The endogeneity test confirms the presence of endogeneity, suggesting that a dynamic model is more suitable than a static model for hypothesis testing. Post-estimation specification tests are then performed. The Arellano-Bond test for autocorrelation in first-differenced errors rejects the null hypothesis of no first-order serial correlation but fails to reject the null of no second-order serial correlation, consistent with AR(1) and AR(2) expectations. The Hansen test of over-identification is insignificant, implying that the instruments are valid. To determine the most appropriate model between first-difference GMM and system GMM, the difference-in-Hansen test of exogeneity fails to reject the null, confirming that system GMM is the preferred estimator. The model also satisfies the condition that the number of instruments (89) is less than the number of groups (102), ensuring instrument validity. The lagged cost efficiency variable is significant at the 1 percent level with a positive coefficient, indicating persistence and validating the dynamic specification of the model. Moreover, the lagged cost efficiency estimates from the two-step system GMM which falls within the range of the coefficient produced by the Pooled Ordinary Least Squares (POLS) and Fixed Effect Model (FEM) estimators across all specifications. For comparison, Table 4 reports the coefficient of lag cost efficiency under POLS, FEM and the two-step system GMM. To ensure representativeness of the unbalanced short panel dataset, each bank contributes a minimum of three (3) observations and a maximum of ten (10).

Table 4. Coefficient of lag Cost Efficiency

Basic Model			Interaction Model		
POLS	FEM	GMM	POLS	FEM	GMM
0.7890	0.3133	0.5771	0.7890	0.3099	0.5676

The study offers two models of bank cost efficiency which are the basic model to investigate the direct relationship between potential drivers and the interaction model that incorporate profitability to moderate the relationship between bank size and cost efficiency. Table 5 presents the estimation results for both models using the system GMM estimator. It is worth noting that the study uses inverse proxies for cost efficiency. However, the estimation results presented in this section have already been transformed in the opposite direction to align higher values with greater efficiency, thereby ensuring convenient reading and clearer interpretation.

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Table 5. Basic and Interaction Estimations using System GMM

Model/Variables	Basic Regression	Interaction Regression
Lag Cost Efficiency	0.57716***	0.56765***
	(0.05899)	(0.06070)
Credit Risk	-0.004426**	-0.04741**
	(0.01799)	(0.01925)
Intellectual Capital	-0.12901**	-0.13796**
	(0.05688)	(0.05966)
Profitability	0.27049***	0.17297*
	(0.08432)	(0.09104)
Bank Size	0.19206***	0.10680
	(0.06237)	(0.08547)
Economy	0.00026	0.00004
	(0.00144)	(0.00147)
Crisis Period	0.13214***	0.14486***
	(0.02978)	(0.02820)
Bank	0.12364	0.07453
	(009403)	(0.09988)
Country	-0.00326	0.00813
	(0.13469)	(0.13307)
Bank Size*Profitability		0.06194***
		(0.03072)
Constant	-1.04754	-0.85132
	(0.27744)	(0.28833)
Number Observation	778	778
Number of Group	102	102
Number of Instruments	89	89
Min Observation per Group	3	3
Max Observation per Group	9	9
Average Observation per Group	7.63	7.63
Mean VIF	1.63	
Modified Wald Chi2	487.29***	
CDw	0.33	
Wald Chi-Squared	6101.61***	5716.58***
AR (1)	-4.77***	-4.68***
AR (2)	-0.31	-0.40
Sargan-Hansen Test	83.38	89.42
Difference-in-Hansen	41.16	49.02

Notes: *** is significant at 1% level, ** is significant at 5% level, * is significant at 10% level. Standard errors are in parentheses.

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The GMM estimations produce robust results for both basic and interaction models, with strong consistency across most findings. However, differences emerge with respect to bank size and country group. In the basic model, bank size demonstrates a significant direct relationship with cost efficiency. In contrast, this effect becomes insignificant in the interaction model, as the impact of bank size is captured through the interaction term (size and profitability). Another key difference is observed in the country group variable, where the coefficient changes sign from negative in the basic model to positive coefficient in the interaction model. Given its robustness and alignment with the stated research objectives, the discussion in this study primarily focuses on the interaction model.

The dynamic panel-data estimation using two-step system GMM is statistically a fit model with Wald Chi-Squared significant at 1 percent level. The result reveals that lagged cost efficiency is significant at 1 percent level and positively related to cost efficiency. This dynamic relationship implies banks operations, practices and governance have a lasting effect on the upcoming year cost efficiency (Sultana & Rahman, 2020). Banks with good practices and governance will have a positive effect on future cost efficiency whereas poor practices and weak governance reduce efficiency over time. For instance, strategic planning and good governance promote long-term investment to support cost efficiency in the current as well as future operation results.

Credit risk, as one of the most prominent risks in banking, significantly affects the cost efficiency of Islamic and conventional banks in HIMI countries. The negative coefficient indicates that banks with higher credit risk exhibit lower cost efficiency, as they incur substantial monitoring costs to administer non-performing financing. Conversely, banks with higher asset quality have the ability to maintain lower monitoring costs and improve cost efficiency. Regulatory requirements for managing high-risk portfolios also raise operational costs by necessitating investments in risk management infrastructure, such as hiring additional credit analysts, risk specialists, and compliance officers. Moreover, a persistent rise in credit risk damages a bank's image and reputation, adversely affects its credit rating, and reduces access to low-cost deposit funding. This finding is consistent with the bad luck hypothesis introduced by Berger and DeYoung (1997), which argues that banks with higher credit risk inevitably face increased costs due to unforeseen defaults and monitoring requirements, leading to lower efficiency.

In this study, intellectual capital focuses on the traditional components of the Value-Added Intellectual Coefficient (VAIC): human capital, capital employed, and structural capital. The results reveal a negative and significant relationship between intellectual capital and cost efficiency, indicating that higher investment in intellectual capital is associated with lower cost efficiency. This outcome is plausible, as banks often promote intellectual capital through staff training to strengthen human capital and system upgrades to enhance structural capital (Aslam et al., 2024; Pîslaru et al., 2023). These strategies, however, increase operating expenses in the short term, leading to less efficient cost management. This is consistent with the Resource-Based Theory (RBT) perspective, which emphasizes that while internal capabilities are valuable, they require effective management and time to generate productive outcomes. Nevertheless, with proper planning and long-term strategies, intellectual capital can create a sustainable competitive advantage for banks, which may eventually improve efficiency. Banks with lower cost efficiency may trade off these long-term benefits in pursuit of short-term gains by cutting training expenditures or limiting system investments, thereby compromising future operational improvements.

Cost efficiency is found to be significantly affected by crisis periods, with differences that are statistically significant at the 1 percent level. The results reveal that cost efficiency is higher during crises than in non-crisis periods. This pattern is most consistent with the bad luck theory, which emphasizes the role of external shocks in shaping bank performance. Crises, whether global, regional, or country-specific create pressures that force banks to optimize operations, reduce costs, and improve efficiency as a survival mechanism. This outcome reflects the fact that during difficult times, banks operate with limited resources, fewer business opportunities, and reduced profitability, which force them to become more efficient (Minh Sang, 2022). For instance, during the COVID-19 crisis, remote working and online meetings became the new norm. In this context, the enhanced cost efficiency during crises reflects banks' adaptive responses to

adverse economic conditions, supporting the relevance of the bad luck theory in explaining performance fluctuations under external shocks. When strategically managed, these practices reduce operational expenses and improve cost efficiency. In contrast, during non-crisis periods, the absence of external pressures reduces the urgency for banks to optimize costs, often leading to lower efficiency. Although banking is a critical sector that receives strong government and regulatory support, history shows that even large banks can fail during crises when they are unprepared or complacent in strategy execution particularly during economic booms.

Recall the earlier discussion on the bank size in the basic model that is positively and significantly related to cost efficiency. Larger banks achieve higher cost efficiency because they typically possess more resources and operate under economies of scale, enabling them to optimize resource use (Narawish et al., 2022). On the contrary, smaller banks face limited resources and weaker economies of scale, which reduce their ability to achieve efficiency. In the interaction model, however, the study does not find significant support for the hypothesis, although the positive relationship remains. This suggests that the effect of size on cost efficiency is largely absorbed through the interaction between size and profitability, where profitability mediates how size translates into efficiency gains.

Profitability emerges as another important determinant of cost efficiency for Islamic and conventional banks in the ten (10) HIMI economies. Banks that improve profitability are more likely to enhance cost efficiency, whereas banks with declining profitability tend to experience efficiency losses. The study rejects the null hypothesis, confirming a significant relationship between profitability and cost efficiency. Consistent with the Resource-Based Theory (RBT), profitable banks possess greater capacity to invest in technology and automation (Lotto, 2019). Such investments strengthen optimization strategies and enable banks to achieve higher levels of cost efficiency in managing operations. By contrast, less profitable banks lack resources to invest in energy-saving initiatives or advanced technological systems, which results in lower efficiency levels. Beyond its direct impact, profitability also plays a moderating role in the interaction model, shaping the relationship between bank size and cost efficiency.

The study hypothesizes that profitability affects the relationship between bank size and cost efficiency significantly. Table 6 and Figure 1 present the marginal effects of bank size on cost efficiency at varying levels of profitability. The results show that highly profitable Islamic and conventional banks in the ten (10) HIMI countries achieve greater cost efficiency as their size increases. This occurs because these banks have sufficient resources to exploit economies of scale and undertake productive investments (Alkhider, 2025). Similarly, low profitability banks also record improvements in cost efficiency as their size increases, for the same economies-of-scale reasons. However, the marginal effect for low profitability banks is substantially smaller compared to highly profitable banks, largely due to resource limitations and restricted investment capacity. In contrast, when bank size decreases, highly profitable banks experience a significant decline in cost efficiency because they can no longer optimize resources effectively. Low profitability banks are also negatively affected by size reductions, but the marginal effect is smaller relative to highly profitable banks. Interestingly, this finding does not fully support the too-big-to-fail theory, as banks enhance cost efficiency even as they grow larger. This also indicates that there is less likelihood of moral hazard among large banks, as the increase in size does not lead to complacency or excessive risk-taking that would reduce cost efficiency.

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Table 6. Marginal Effect of Bank Size on Cost Efficiency at Different Level of Profitability

Profitability	Cost Efficiency/Bank Size	Delta-method Standard Error	95% Confidence Interval	
-1	0.04486	0.10760	-0.16603	0.25576
0	0.10680	0.08547	-0.06072	0.27433
1	0.16874	0.07015	0.03125	0.30623
2	0.23068	0.06652	0.10031	0.36105
3	0.29262	0.07626	0.14316	0.44208
4	0.35456	0.09536	0.16765	0.54146
5	0.41650	0.11942	0.18244	0.65055
6	0.47844	0.14600	0.19229	0.76458
7	0.54038	0.17395	0.19945	0.88130

The results indicate that Islamic banks appear, on average, to be slightly more cost efficient than their conventional counterparts. However, this difference is not statistically significant. The finding suggests that both banking systems operate under broadly similar regulatory, supervisory, and macroeconomic environments which limit the extent of efficiency divergence (Ahmad & Luo, 2010). Moreover, while Islamic banks are often highlighted for their governance mechanisms and ethical principles, these potential advantages may be offset by higher compliance and monitoring costs, as well as their generally smaller size relative to conventional banks (Hisham Yahya et al., 2012). Consequently, the absence of statistical significance in the results implies that any efficiency advantage of Islamic banks is marginal and context-dependent, rather than systematic.

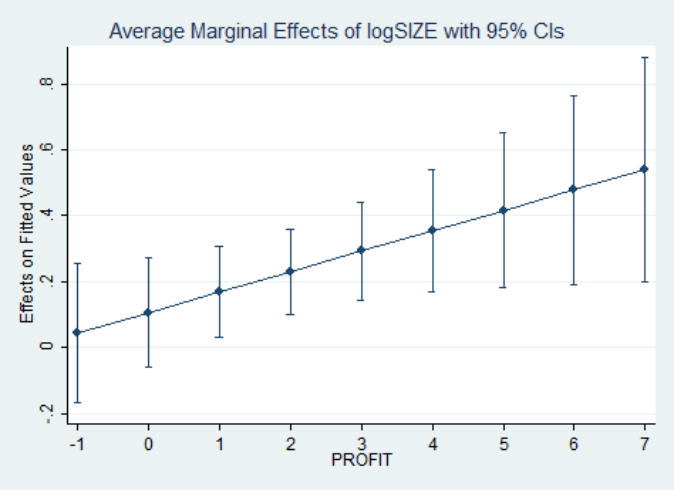

Figure 1: Marginal Effect of Bank Size on Cost Efficiency at Different Level of Profitability

Although banks in high-income countries show a slightly higher mean cost efficiency in our sample, the difference relative to banks in middle-income countries is not statistically significant. This result is consistent with recent literature showing that regulatory convergence, institutional quality and bank-specific characteristics often explain most of the variation in cost efficiency, reducing the explanatory power of a simple income-group dummy. This suggests that income group alone does not systematically determine efficiency outcomes. One possible explanation is due to the convergence of regulatory and

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supervisory frameworks across many middle-income countries, which has narrowed operational gaps with high-income peers (Veyrune et al., 2023).

The empirical results show no statistically significant relationship between macroeconomic performance and cost efficiency. This aligns with findings in Tunisia, where economic growth has little impact on bank technical efficiency because the supply of credit remained inelastic and banks rely heavily on collateral (Jelassi & Delhoumi, 2021). As noted by (Luo et al., 2024), the impact of economic fluctuations can be moderated by institutional factors such as governance and bank management practices. The insignificant effect of the economy measured by the GDP deflator on bank cost efficiency suggests that macroeconomic conditions alone do not uniformly determine efficiency. This indicates that banks may sustain cost efficiency despite changes in general price levels.

5. Conclusion and Recommendations

The results of this study show that cost efficiency in Islamic and conventional banks is influenced not only by current operational decisions but also by past practices, governance structures, and strategic choices. The persistence of cost efficiency over time underscores the importance of long-term commitment to effective cost management. High credit risk remains a critical challenge, as it diverts resources toward monitoring and compliance, thereby reducing efficiency. By contrast, intellectual capital is identified as a key determinant of long-term performance, though it may temporarily reduce short-term efficiency if not strategically managed.

The findings further reveal that banks tend to become more cost-efficient during crises, suggesting that resource optimization practices adopted in difficult times can provide valuable lessons for stable periods. Profitability is also shown to play a significant role in determining cost efficiency. The findings highlight that profitability is a critical enabler of cost efficiency, particularly when banks expand in size. Profitable banks in particular, should leverage their financial strength to invest in automation, digital infrastructure, and innovation, while also maintaining the operational discipline which often demonstrated during crises. Policymakers need to create supportive regulatory and competitive environments that foster sustainable profitability while safeguarding financial stability. Bank managers should emphasize strengthening profitability through sound governance and innovation before pursuing aggressive expansion. By aligning growth strategies with profitability, both Islamic and conventional banks can achieve sustainable improvements in cost efficiency. The findings also emphasize the need for the banks to invest in robust credit risk management systems including advanced analytics and proactive monitoring to limit the cost impact of risky lending. Intellectual capital development should be pursued with a long-term perspective to ensure that training and technology investments are aligned with efficiency goals and deliver measurable returns.

For policymakers and regulators, the findings call for policies that promote cost efficiency without discouraging innovation and compliance. This is especially relevant for Islamic banks, which face additional Shariah compliance requirements that increase operating costs. A balanced approach between efficiency and innovation can help to ensure that banks remain competitive while upholding regulatory standards. Finally, cross-country collaboration and knowledge exchange between high- and middle-income economies could facilitate greater efficiency by enabling banks to learn from each other's strategies and best practices.

Future research could extend these findings by exploring other dimensions of efficiency, such as technical and allocative efficiency. Qualitative insights from bank executives and managers would also enrich understanding of the organizational and cultural factors that shape efficiency decisions. Expanding the sample size and study period to include more banks across diverse regions would further improve generalizability and capture how banks adapt their efficiency strategies during expansions, recessions, and crises.

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Conflict of Interest

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts.

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Authors' contributions

All authors contributed substantially to this work. Wahida and Hazimah conceptualized the study, while Sarah and Syahirah were responsible for data curation. Formal analysis was conducted by Wahida, Sarah, and Hazimah, and the methodology was developed by Hazimah and Sarah. Hazimah and Sarah provided the research resources, while supervision and validation were carried out by Wahida and Hazimah. Visualization was prepared by Sarah and Hazimah. All authors contributed to writing the original draft, with Wahida, Hazimah, and Syahirah responsible for revising, updating, and editing the manuscript in

accordance with reviewer comments. All authors have read and approved the final version of the manuscript. Wahida, as the corresponding author, is responsible for manuscript submission.