



## Measuring the performance of conventional and Islamic banks in MENA countries: Recommendations for Libya

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**ABSTRACT:** One of the obstacles to economic development in MENA countries is the low quality of institutions. A significant factor for the long-term development of Islamic finance is the relative performance of Islamic banks compared to conventional banks. Indeed, if Islamic banks suffer from a weaker performance than traditional banks, their development is likely to be limited. The objective of this article is to analyze the role of institutional quality in the development of Islamic finance. This study aims to examine the association between the performance indicators of conventional banks and Islamic banks, as well as their efficiency scores, in a panel of Middle East and North Africa (MENA) countries from 2000 to 2023. To do so, we will test how the cost efficiency gap between Islamic and conventional banks is influenced by institutional quality. As we have explained, this question is crucial for the future of Islamic finance, due to the significant implications that the discovery of a role for institutional quality in the performance of Islamic banks would have. Instead, it can be said that contemporary economic conditions have led to the renaissance, expansion, and growth of Islamic banking, which has proven its ability to withstand numerous financial crises, thanks to its specific approach to managing financial assets, which directs them towards real investment.

**Keywords:** Performance, Conventional banking, Islamic banking, MENA, Libya, DEA, GMM.

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### 1. Introduction

The banking system is the heart and lifeblood of any economy, serving as the key to economic growth and development. We agree that commercial banks play an essential role in a country's economy. As a key part of the financial system, banks efficiently allocate funds from savers to borrowers, set prices, value financial securities, and manage inherent risks. They provide specialized financial services, which reduce the cost of obtaining information on saving and borrowing opportunities (Eyih & Bouchetara, 2020).

The last quarter of the twentieth century saw the emergence of a new banking system based on compliance with the provisions and controls of the Islamic Sharia, which prohibits banks from engaging in any usurious practices. The emergence of Islamic banks is an event of great importance, not only for the Arab-Muslim world, but also on an international scale. Islamic banks offer a fundamentally different concept from conventional banks.

Some traditional banks have adopted the concept of operating under the Islamic banking system, offering products and services that comply with the principles of Islamic Sharia. Others have opened Islamic branches that operate alongside their traditional branches. In some countries, the phenomenon has not been limited to the opening of Islamic branches and counters: countries such as Pakistan, Iran, and Sudan have completely Islamized their banking systems.

Islamic finance is a fast-growing segment of the financial system. It offers both alternative and complementary products to traditional finance and is expected to contribute to economic growth. The literature on the impact of Islamic finance on economic growth remains scarce. The majority of research corroborates the existence of a positive causal relationship between Islamic finance and economic growth (Hasan & Dridi, 2010; Mtiraoui & Gabsi, 2019), with some authors even evoking a strong causality (Alqahtani & Mayes, 2016; Boukhatem & Ben Moussa, 2018; Furqani & Mulyany, 2009; Gani & Bahari, 2021; Majidi, 2006; Srairi, 2010; M. Tabash & Anagreh, 2017; Tabash & Dhankar, 2014). However, a minority of the literature, represented by Weill (2013), remains skeptical and questions the existence of this causality.

Against this backdrop, many countries have taken an interest in the Islamic financial system. For example, the US administration commissioned a team of researchers from the Federal Reserve Bank and the US Treasury Department to conduct a study of the Islamic banking industry. The aim was to formulate recommendations on how to capitalize on the advantages in the Islamic banking sector to address the crisis at the time and prevent similar crises in the future. The second example concerns Japan, which passed a law granting Japanese banks licenses to open Islamic branches or counters. Today, it can be said that the Islamic banking industry has evolved into a mature sector, offering products and services that cater to the diverse needs of a global audience.

In light of the above, we aimed to investigate the potential for converting traditional banks into Islamic banks in the MENA region through a case study of a series of Islamic and conventional banks in the region. Our objective is to understand the reality of this phenomenon and identify the obstacles that influence the transformation of traditional banks into Islamic banks. Our study aims to answer the central question: What are the primary barriers preventing banks in the Middle East and North Africa from transitioning from interest-based (usurious) banks to profit-and-loss-sharing banks (Islamic banks)?

This study aims to identify the nature of Islamic banks, the financing formulas they use, their sources of funding, the risks they may face, the factors that motivate conventional banks to convert to Islamic banking, the requirements necessary for the conversion process, and the methods by which it can be achieved. It also aims to understand governance from the perspective of Islamic banks and their standards, and to identify the main obstacles that may hinder a bank in the Middle East and North Africa region from converting to an Islamic bank between 2000 and 2023, using the methodologies of Deep Data Analysis (DEA) and Global Metrics (GMM).

This article explores Islamic banking characteristics. Ironically, this comparison will show key commonalities between the two bank types. This paper reviews empirical research on the efficiency of Islamic and conventional banks in Section 2. We discuss the approach and sample in Section 3. One of the biggest concerns for banking policymakers is converting traditional banks into Islamic Shariah-compliant institutions. Section 4 further states that the country's internal and external conditions must be taken into account. It must also follow a well-planned schedule that adheres to legal and administrative restrictions. Section 5 uses distributed data analysis for benchmarking. Section 6 summarizes our primary findings. Thus, the Libyan Republic Bank must identify its biggest impediments to becoming an Islamic bank.

## **2. Theoretical Overview of the Main Concepts**

### **2.1. Review of theoretical literature**

The internationalization and globalization of economies are producing changes of various kinds. We are witnessing the free exchange of capital, materials, and people. Borders are being broken down and barriers eliminated, contributing to the emergence of new suppliers in a market that has become global, in a world that has become a global village. Competitive advantage was once achieved primarily through financial resources and material investments (such as equipment, IT hardware, etc.). As a result, the economic environment has undergone significant and complex changes, which have contributed to the emergence of a new approach to finance known as 'Islamic finance'.

We observe that Islamic banking, which serves as the metronome of the Islamic finance industry (in terms

of assets mobilized), plans to evolve alongside conventional banks, while promoting financial inclusion and economic development, to target mainly certain Muslims who, for religious reasons, do not frequent conventional banks (Meslier et al., 2020). The place and especially the role of Islamic banking in the process of development of Islamic finance are receiving much more attention than other Islamic institutions (insurance, regulatory bodies, or even Sukuk management institutions) in the academic world. Aside from asset size (which accounts for 72% of total Islamic finance assets), Islamic banking has the highest level of regulatory standards among other Islamic finance sectors. This is one of the reasons why most of the literature on Islamic finance is devoted to Islamic banking.

Currently, the Islamic banking industry has evolved into a mature sector, offering products and services that cater to the diverse needs of a global audience (Bensaid & Bennis, 2022). Islamic finance is a system developed based on universal religious and moral principles, which is growing rapidly in Asia and is now expanding into the West. It is a component of ethical finance, which is finance that does not adhere solely to the law of profit, but also meets criteria such as sustainable development, environmental considerations, and good governance.

The banking scene in many countries of the world, particularly Arab and Islamic countries, shows the willingness of many conventional banks to provide Islamic banking products, through partial transformation by opening branches with independent financial institutions or participation in specific transactions handled by Islamic banking, or by total transformation of a conventional bank into an Islamic bank. As a result, we find that most countries have included a chapter or part in their money and banking laws that addresses Islamic finance (Komilov, 2022).

According to Rakotonirainy (2020), financial stability is characterized by the financial system's capacity to absorb and respond to major shocks originating from outside or within the system, thereby mitigating the repercussions for the system itself and the economy. (Padoa-Schioppa, 2002) focuses on the ability of the financial system to absorb shocks, ensuring it continues to perform its primary functions of allocating resources optimally, redistributing risks satisfactorily, and maintaining a safe and efficient payment system. Rouiessi (2016) stresses that a financial system is stable 'if it maintains its resilience and continues to perform its main function of channeling savings towards investment even in the face of unexpected shocks.' Schinasi (2004) argues that the stability of a financial system depends on its ability to foster rather than hinder economic performance and to ward off financial imbalances of endogenous origin or resulting from unforeseen adverse events.

According to Gandanez and Jayaram (2009), a financial system is considered stable when there is no excessive volatility, stress, or crisis. According to them, broader definitions of financial stability encompass the smooth functioning of a complex set of relationships between financial markets, infrastructures, and institutions operating within given legal, fiscal, and accounting frameworks. (Belouafi et al., 2015) emphasize that financial stability is associated with multidimensional conditions that are primarily linked to the smooth functioning of complex financial systems.

Despite this, traditional banks continue to maintain a strong presence in the banking scene. They are seen as a competitor with long experience when compared to Islamic banks, which has forced the latter to develop financing and investment products to attract the largest segment of customers by adopting the concept of Islamic banking, and this is what calls for research into its importance and role in the development of the global Islamic economy.

## 2.2 Review of empirical literature

During the 2007-2008 financial crisis, Islamic banks were not affected, unlike conventional banks (Eyih & Bouchetara, 2020). Rahim and Zakaria (2013) argue that Islamic banks were relatively spared by the financial crisis compared to conventional banks. They note that this finding underscores the resilience of the Islamic banking system as a viable alternative to the interest-based system. According to Wahid and Dar (2016), the recent global financial crisis has led to a surge in international interest in utilizing the Islamic banking system as an alternative to the conventional banking system. (Bitar et al., 2015) note that

since the 2007-2008 financial crisis, numerous banks have failed. They add that the crisis revealed not only the weaknesses of the traditional financial system but also the strength of Islamic banks, which have not experienced losses or solvency problems, unlike their conventional counterparts.

On the other hand, several research studies show that Islam can stimulate growth, emphasizing that there is no opposition between the precepts of Islam and the conditions necessary for economic growth. Religious teachings can even have a positive impact on economic development (Ahmad, 2003). For his part, Chapra (2008) challenges the idea that the Islamic religion and its institutions are responsible for the decline of Muslim countries. A study examining the relationship between Islamic teachings and economic growth, considering the fundamental principles of Islam, reveals that the Islamic economy can foster stable, sustainable, and equitable growth and development, thereby addressing issues such as inflation, poverty, and unemployment. (Morabit & Boussetta, 2022).

The most recent studies on the economic impact of Islamic finance can be categorized into two main areas. The first focuses on analyzing the ratios of Islamic banks. (Iqbal, 2005; Aboualfadel, 2009; Bader et al., 2008; Kabir Hassan, 1999; Samad & Hassan, 2000). These studies examine various aspects of Islamic banks, including their performance, effectiveness, efficiency, and economic impact, often with a focus on comparisons with conventional banking systems. The second category uses econometric methods to assess the macroeconomic effects of Islamic finance (Boukhatem & Ben Moussa, 2018; Furqani & Mulyany, 2009; Kassim, 2016; Ledhem & Mekidiche, 2021; MAJIDI, 2006; Mtiraoui & Gabsi, 2019; Sakinah et al., 2022; Tabash & Dhankar, 2014).

In the context of Indonesia, Anwar et al. (2020) explored the impact of Islamic finance on economic growth from Q1 2009 to Q4 2019. The results of this study admit a strong link between Islamic finance and Indonesian economic growth. In the same context (Sakinah et al., 2022), they demonstrated the existence of a bidirectional causal link between the two variables in Indonesia. On the one hand, economic growth favors the development of the Islamic financial system, and on the other hand, this monetary system stimulates economic growth. In addition, Ledhem and Mekidiche (2021a) empirically investigated the nature of the relationship between Islamic finance and economic growth in Turkey, utilizing the endogenous growth model. The results suggest that Islamic finance plays a significant role in driving economic growth in Turkey.

Cheikh (2017) conducted a comparative analysis between the efficiency of conventional and Islamic banks using the mathematical method Data Envelopment Analysis (DEA). The sample of this study comprises 1,425 conventional banks and 85 Islamic banks, drawn from the Bank Scope database. The study shows that Islamic banks are statistically more efficient than traditional banks. In addition, the study found that the return on average assets, the ratio of net loans to total assets, the net interest margin, and the ratio of equity to total assets have a significant impact on performance.

Saeed et al. (2013) employed two approaches to evaluate the efficiency of Islamic and conventional banks in Pakistan, utilizing a ratio analysis technique and non-parametric Data Envelopment Analysis (DEA) analysis. This study encompasses 19 banks over the period from 2007 to 2011. The results reveal that, in both methods, conventional banks are more efficient than Islamic banks. In this strategy, Al-Muharrami (2008) used DEA techniques to estimate technical, pure technical, and scale efficiency, using an input orientation for Gulf Cooperation Council (GCC) banks for the period 1993-2002. The sample comprises 52 banks, including 7 Islamic banks. The inputs in this study are the number of employees, fixed assets, and total deposits. The outputs are total loans, other operating income, other earning assets, and off-balance sheet activities. The study yielded several interesting results concerning the GCC banking market, including the following: Islamic banks are significantly more efficient than conventional banks.

The banking sector in the Middle East and North Africa (MENA) region has experienced rapid growth over the last two decades. MENA has undergone significant transformations in its environment. An efficient banking system remains essential to promote growth and sustainable development in this politically and economically vital part of the world. Although the efficiency of the banking sectors in North America and Europe has been carefully analyzed, less is known about the determinants of bank profitability and

efficiency in developing countries.

[Hassan et al. \(2009\)](#) employed the DEA method to analyze the efficiency of Islamic and conventional banks. This study evaluates cross-country data compiled from the financial statements of 40 banks in 11 MENA countries over the period from 1990 to 2005. Data was collected for each year available in the Bank Scope database. The results suggest no significant difference between the efficiency of conventional and Islamic banks.

[Shamser et al. \(2007\)](#) conducted a comparative study between Islamic and conventional banks in terms of cost efficiency and income efficiency using the DEA method. The sample comprised 43 Islamic banks and 37 conventional banks in 21 countries in Africa and the Middle East in 2005. They evaluated the average overtime and efficiency of these banks as a function of size, age, and region. The result was that there was no significant difference in the efficiency of the different banks. The study also confirmed that large banks are more efficient than small banks.

The study by [Bekakria and Azzouz \(2020\)](#) compares the technical efficiency of Islamic banks and conventional banks operating in the MENA region using the DEA (Data Envelopment Analysis) method during the period 2016-2018. The study is based on a sample of twenty (20) banks, including ten (10) Islamic banks from eight (8) countries: Algeria, Tunisia, Egypt, Morocco, Qatar, Saudi Arabia, UAE, and Jordan. To achieve this, we adopted the financial intermediation approach, which combines inputs—total deposits, staff costs, and fixed assets—with outputs: total loans and net banking income. An examination of the results obtained over the entire period reveals no significant difference in the efficiency of Islamic banks and conventional banks. Over the three years, the two types of banks recorded levels of efficiency that were very close to each other, with Islamic banks achieving a relatively high level of efficiency.

Islamic banks are increasingly attracting the interest of professionals and academics alike, firstly because of their resilience during the subprime crisis, and secondly because of their participatory financial intermediation, which is yielding significant results. This stems from their founding principle of sharing. The specific financial intermediation of Islamic banks is subject to information asymmetry, which is crucial to their market survival ([Abid & Douari, 2023](#)).

Numerous studies have recently compared and analyzed the performance of Islamic and conventional banks. These studies were mainly aimed at explaining the impact of various crises or events on these banks ([Adekoya, 2022](#); [Budiman, 2021](#); [Elnahass et al., 2021](#); [Baran, 2022](#); [D'Orazio & Löwenstein, 2022](#); [Nouman et al., 2022](#); [Nyikos & Kondor, 2022](#); [Hassan & Rabbani, 2022](#)).

[Salman and Nawaz \(2018\)](#) found differences between Islamic and conventional banks in terms of liquidity, profitability, and efficiency using secondary data from both sectors. The authors used ratio analysis and the one-sample t-test to determine key characteristics, while regression analysis examined the factors that influenced customer confidence in these banks. The results showed that there was little difference between the two types of banks.

[Adekoya et al. \(2022\)](#) examined the risk spillover between the Islamic and conventional sectors regarding the operation of stock markets. Islamic markets are less sensitive to fluctuations than conventional banks and stock markets in their respective countries, and a transfer of risk occurs between the two types of markets. [Naeem et al. \(2022\)](#) examined the intra- and inter-country associations between stock markets in Islamic economies during the COVID-19 period. The COVID-19 sample reveals a significant link in the way ethical investments are structured. The emergence of COVID-19 has led to the transmission of a high level of information between major cryptocurrencies ([Yousaf & Ali, 2020](#)).

In 2021, [Elnahass et al.](#) studied the performance of Islamic banking systems in comparison to conventional banking systems during the COVID-19 pandemic. The study examines the impact of diversification and Sukuk investment on the performance of Islamic banks based on a sample of 24 countries between Q4 2013 and Q4 2020. Overall, this study demonstrates that Islamic banks can perform well in challenging economic times, highlighting the importance of diversification and Sukuk investment in their success. Additionally, Islamic banks may have certain advantages over conventional banks, including better capital adequacy and

lower non-performing loans. She finds that Islamic banks that are more diversified and invest more in Sukuk tend to perform better during the COVID-19 pandemic.

Bitar et al. (2020) found, using conditional quantile regressions, that higher liquidity and capital ratios increase the efficiency of both Islamic and conventional banks. The authors noted that more capitalized and liquid banks performed better during the Great Financial Crisis of 2008-2009 and the “Arab Spring” movement of 2011.

Fakhri and Darmawan (2021) identified the financial performance factors affected by the COVID-19 pandemic in both Islamic and conventional banks in Indonesia, stating that the pandemic did not reveal significant differences in terms of funding/deposit ratio, short-term mismatch, and net operating margin.

To answer the questions raised in the study problem, the following hypotheses can be formulated:

H1 - Islamic banking principles impact the process of converting MENA Republic Bank into an Islamic bank.

H2- Islamic financing formulas have a negative impact on the process of converting MENA banks into Islamic banks.

H3- Islamic banks' sources of financing contribute to preventing the conversion of MENA banks into Islamic banks.

H4- The risks to which Islamic banks are exposed are considered obstacles that prevent the process of converting the Bank of the Republic of Libya into an Islamic bank.

H5- The consequences of the methods used to convert traditional banks into Islamic banks have a negative impact on the process of converting MENA banks into Islamic banks.

H6- The requirements necessary for the process of converting a conventional bank into an Islamic bank have a negative impact on the process of converting into an Islamic bank.

H7- The policies applied by the Central Bank to commercial banks, including Islamic banks, hinder the process of converting conventional banks into Islamic banks.

### 3. Methodology

Accounting data on conventional and Islamic banks were collected from the Data Stream database and the banks' annual reports available on their websites from 2000 to 2023. The general form in Eq. 1 of a linear dynamic panel model is assumed for the relationship in question:

$$Efficiency - Score_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 OER_{it} + \beta_3 ICR_{it} + \beta_4 Capital_{it} + \beta_5 FATA_{it} + \beta_6 GDPG_{it} + \beta_7 Inflation_{it} + \beta_8 Islamic_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (1)$$

where “t” and “i” denote country and time respectively. All variables are summarized in Table 1.

**Table 1.** Description of variables

Variable	Symbol	Nature	Definition	Source
Efficiency-Score	Efficiency-Score	Dependent	Index calculated using the DEA method	DATASTREAM
Return on assets	ROA	Explanatory	Measures a bank's profitability relative to its total assets, indicating how efficiently assets generate profits	DATASTREAM
Operating Expense Ratio	OER	Explanatory	The operating expense ratio (OER) measures the cost of operating a property against the income generated by it.	DATASTREAM
The Interest Coverage Ratio	ICR	Explanatory	Measures a company's ability to meet required interest expense payments related to its outstanding debt obligations on time.	DATASTREAM

Capital Expenditures	Capital	Explanatory	Investments made by the bank in physical assets such as buildings, technology, and infrastructure.	DATASTREAM
Foreign Assets % Total Assets	FATA	Explanatory	The proportion of a bank's total assets that are held in foreign investments or international markets	DATASTREAM
Economic growth	GDPG	Control	The percentage changes in the value of all goods and services produced in a country over a given period, compared with a previous period.	World Bank
Inflation	Inflation	Control	Economic imbalance resulting in price rises due to an increase in the volume of money in circulation, budget deficits, and an excess of people's purchasing power over the goods available to them.	World Bank
ISLAMIC	ISLAMIC	Control	Measures the efficiency index for Islamic banks	DATASTREAM

Technical efficiency represents a company's ability to obtain maximum output from a set of inputs (Farrell, 1957). Efficiency is easily calculated when a company uses a single input to produce a single output:

$$\text{Efficiency} = \text{output} / \text{input}$$

However, the calculation of efficiency becomes more complicated when a company produces multiple outputs using various inputs. For this reason, measuring relative efficiency that involves numerous variables can be disproportionate. The use of data envelopment analysis (DEA) allows us to construct a frontier based on the most efficient entrepreneurial decisions (DMU) and then measure the distance separating the least efficient companies from this frontier. Relative efficiency can be calculated as follows:

$$\text{Efficiency relative } (\emptyset) = \text{weighted sum of outputs} / \text{weighted sum of inputs}$$

The efficiency measured by data envelopment analysis is relative in the sense that the measured efficiency of a bank depends on all the DMU decision units, which are taken as references, and whose efficiency is assessed at the same time. The DEA analysis, therefore, measures the efficiency of a DMU by calculating its relative deviation from target DMUs, thus constructing an empirical production frontier. The results obtained in this way can serve as a starting point for a benchmarking procedure (Bouzouita, 2005).

Formally, we consider N microfinance institutions ( $n = 1$  to N) that produce M outputs Y with inputs X. Each MFI uses K variable inputs ( $k = 1$  to K) to create M outputs ( $m = 1$  to M). The aim is to determine the relative efficiency of the target microfinance institution (MFI). This efficiency can be measured in terms of output orientation or input orientation. In the first case, the aim is to maximize output under input constraints, and in the second case, to minimize the quantity of input required under the constraints of a given output level.

The  $K \times N$  matrix of inputs and the  $M \times N$  matrix of outputs represent the data from the MFI set. The formulation of the objective function as a ratio (equation 1) is the most common form, as it is easier to process. In this case, for each MFI we seek to obtain the ratio of total output to total input, i.e. the ratio  $\left(\frac{u'y_i}{v'x_i}\right)$  where u' is the  $M \times 1$  vector of output weights and v' is the  $K \times 1$  vector of input weights.

Constructing the production frontier and measuring the efficiency of each unit concerning this frontier means finding the value of u and v that maximizes the output of each productive unit under the constraint that all efficiency measures are less than or equal to 1, i.e., the efficiency frontier. This involves solving the following program (Eq. 2):

$$\text{Max } \left(\frac{u'y_i}{v'x_i}\right) \text{ s.t. } \frac{u'y_j}{v'x_j} \leq 1, j = 1, \dots, N \text{ and } u, v \geq 0 \quad (2)$$

The multiplicative form of the program (Coelli 1996) is shown below with the transformation of u and v:

$$\text{Max } (u'y_i) \text{ s.t. } v'x_i = 1; u'y_j - v'x_j \leq 0, j = 1, \dots, N \text{ and } u, v \geq 0 \quad (3)$$

We derive an equivalent form:

$$\text{Max} \theta S/C - \theta y_j + y_\lambda \geq 0; x_i - x_\lambda \geq 0; N1'\lambda = 1; \lambda \geq 0 \quad (4)$$

Eq. 2 represents the objective function to be maximized, expressed differently. Also, Eq. 3 expresses the constraints in different ways. Eq.4 expresses the constraint on firm i's output, which cannot exceed the efficiency frontier. This reflects the constraint on input use (firm i's consumption of inputs is at best equal to that of the efficient firm), as well as the convexity constraint, which introduces the assumption of variable returns to scale, rather than constant returns.

$\theta$  is the measure of a firm's inefficiency. It is such that  $1 \leq \theta < \infty$  and in effect represents the factor by which firm i's output would have to be multiplied (a factor that is at least equal to firm i's output, i.e. equal to 1) so that, with the same level of inputs, it could produce an output equal to that of the efficient firm. It follows that  $\theta-1$  is the proportion by which output can be increased for the reference MFI while keeping the level of inputs constant. Considering the definition of  $\theta$ , which is a measure of the reference firm's inefficiency, the technical efficiency score (desired result) of the reference firm is measured by the inverse of  $\theta$ , i.e.,  $1/\theta$ . This efficiency ratio ranges from 0 to 1. When  $1/\theta < 1$ , the reference firm is not on the efficient frontier. When  $1/\theta = 1$ ,  $\theta = 1$ , the reference firm is efficient and lies on the efficient frontier.

We employ the Generalized Method of Moments (GMM), developed for time series models by Holtz-Eakin et al. (1988), Arellano and Bond (1991), and Arellano and Bover (1995). The empirical model used can be presented as follows:

$$y_{it} - y_{i,t-1} = \gamma y_{i,t-1} + \beta' X_{it} + \lambda_t + \varepsilon_{it} \quad (5)$$

with  $i = 1, \dots, N; t = 1, \dots, T$  and  $y_{it} - y_{i,t-1}$  is the dependent variable for interval t,  $y_{it}$  is the natural logarithm of the variable at time t,  $X_{it}$  is a vector of control variables. These elements constitute the economic determinants of growth.  $\lambda_t$  and  $\varepsilon_{it}$  denote, respectively, time-specific effects and an error term. With  $\alpha = 1 + \gamma$ , Eq. 5 becomes (Eq. 6):

$$y_{it} = \alpha y_{i,t-1} + \beta' X_{it} + \lambda_t + \varepsilon_{it} \quad (6)$$

In the case of a time series, it is not appropriate to use the ordinary least squares method, as it may give biased estimates due to the presence of the lagged dependent variable on the right-hand side of the equation. OLS estimates would be inconsistent because  $y_{it-1}$  is correlated with the error term (Arellano & Bond, 1991; Baltagi, 2008). If the study period is sufficiently long, the bias becomes negligible and the problem is resolved (Aisen & Veiga, 2013). Thus, given the relatively short period of our study, the problem persists. Eq. 7, in its first difference form, removes the individual  $V_i$  effects and therefore eliminates the potential source of this bias.

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \beta' \Delta X_{it} + \Delta \lambda_t + \Delta \varepsilon_{it} \quad (7)$$

However, when all exogenous variables are expressed as a first difference, they become endogenous, since the first difference is correlated with the error term. Following Holtz-Eakin et al. (1988), Arellano and Bond (1991) develop the GMM estimation method for data models, which solves the endogeneity problem by instrumenting the lagged endogenous variable by its past values of two or more periods, and the predetermined or weakly exogenous variables (variables which may be influenced by the past values of the dependent variable, but which remain uncorrelated with future realizations of the error term) by their values lagged by at least one period. For exogenous variables, their current values are used as instruments.

However, this method fails to identify the effect of time-invariant factors. In addition, Blundell and Bond (1998) demonstrate, using Monte Carlo simulations, that the first-difference GMM estimator yields biased results in finite samples when the instruments are weak. To address these issues, they propose utilizing the system GMM approach, which estimates the difference model in conjunction with the level equation, as suggested by Arellano and Bover (1995). Using the Monte Carlo experiment, Blundell and Bond (1998) show that this system estimator reduces the potential bias in finite samples and the asymptotic imprecision

associated with the difference estimator. According to this approach, if the first differences of an explanatory variable are not correlated with the individual effects, the lagged values of the first differences can be used as instruments in the level equation. Additionally, lagged first differences of the dependent variable can serve as valid instruments for level equations. Although system GMM is asymptotically more efficient than first-difference GMM, it produces biased results. To overcome this problem, we use the two-stage estimation method proposed by Windmeijer (2005) for finite-sample variance correction (Roodman, 2009). The effectiveness of the GMM estimator relies on the validity of the following assumptions: (i) the instruments are well validated, and (ii) the error terms are not autocorrelated.

To test the validity of lagged variables as instruments, Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) suggest the Hansen/Sargan over-identification tests. In this work, we employ the Hansen test because it is effective in addressing problems of autocorrelation and heteroscedasticity (Roodman, 2007; Neanidis & Varvarigos, 2009). To test the hypothesis of non-correlation between the error terms, we perform a second-order autocorrelation test, as the first-difference error term is, by construction, first-order correlated (Levine et al., 2000). Estimation of growth models using the difference GMM estimator for linear data models was introduced by Caselli et al. (1996). Subsequently, Levine et al. (2000) employed the system GMM estimator, which is now standard practice in the literature (Durlauf et al., 2005; Beck, 2008).

This work uses the GMM system estimator to estimate growth models, in line with the work of Levine et al. (2000). Instrument validity is tested using the Hansen test, which is preferable to the Sargan test in the presence of heteroscedasticity. Error autocorrelation is examined via a second-order autocorrelation test, which is necessary because first-order autocorrelation is expected by construction. The system GMM approach, developed after the difference GMM estimator (Caselli et al., 1996), has become a standard due to its greater efficiency and the inclusion of additional instruments (Durlauf et al., 2005; Beck, 2008).

## 4. Empirical analysis

### 4.1. Measuring the efficiency of Islamic and conventional banks

The variables selected in this study are the most appropriate input variables in the DEA applications presented in the previous section and have been used by several earlier studies. Our study examines the relationship between output and input variables in 50 banks across MENA countries from 2000 to 2023. To describe their relationship in the next section, we will present the different variables statistically. First, we will interpret the main descriptive statistics for the other variables presented in Table 2.

**Table 2.** Summary of key descriptive statistics for variables

Designations	Efficiency-Score	Conventional-Efficiency	Islamic-Efficiency
Average	0.462	0.458	0.467
Standard deviation	0.274	0.270	0.278
Maximum	1.000	0.999	1.000
Minimum	0.003	0.003	0.004
Median	0.205	0.415	0.429
Coefficient of variation (CV)	0.592	0.589	0.596
Skewness	0.380	0.422	0.338
Kurtosis	1.980	2.040	1.925
Jarque-Bera test (JB)	80.91	69.23	72.56
JB p-value	0.000	0.000	0.000
Born & Breitung test (BB)	28.97	56.24	63.87
BB p-value	0.000	0.000	0.000

Indeed, after viewing the data, we can see that most of them are asymmetrically spread to the right and have a leptokurtic shape. Furthermore, we reject the hypothesis of normality in the series using the Jarque-Bera test. Referring to the autocorrelation test on the Panel data by Born and Breitung (2016), it is clear

that all variables exhibit serial autocorrelation problems.

From Table 2, our series of variable Efficiency-Score (see Figure 1) presents an overall mean of 0.462 with a standard deviation of 0.274, indicating substantial heterogeneity among the observations (coefficient of variation = 0.592). The 1,200 observations are bounded between 1,000 (SAFWA ISLAMIC BANK, QATAR ISLAMIC BANK) and 0.003 (AHLI TRUST), with a high concentration around 0.205. The sample distribution of Efficiency-Score is slightly non-symmetrical to the right (Skewness = 0.380) and leptokurtic (Kurtosis = 1.980). Overall, this variable rejects the normality hypothesis, since the probability of the Jarque-Bera statistic is less than 5%. Similarly, regarding Born and Breitung (2016), we reject the null hypothesis at the 1% significance level for the presence of a serial autocorrelation problem.

As a second step in our analysis, our sample is divided into two sub-samples: 25 Islamic banks and 25 conventional banks. For each set of banks, we calculated an efficiency score. For this model, we use the variable Conventional-Efficiency (see Figure 2). According to Table 2, our series has an overall mean of 0.458 with a standard deviation of 0.270. Total values range from 0.003 to 0.999, with a high concentration of approximately 0.415. There is considerable heterogeneity (CV = 0.589). The sample distribution of the Conventional-Efficiency variable is asymmetrically spread to the right (skewness = 0.422) and leptokurtic (kurtosis = 2.040).

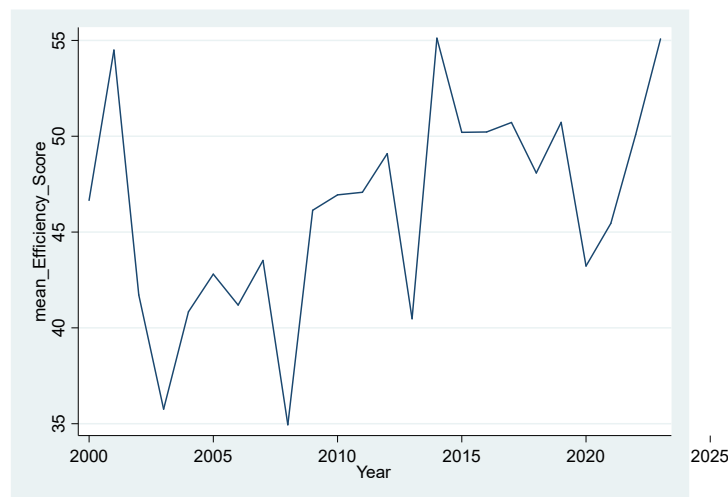


Figure 1. Evolution of the Mean Global Efficiency Score

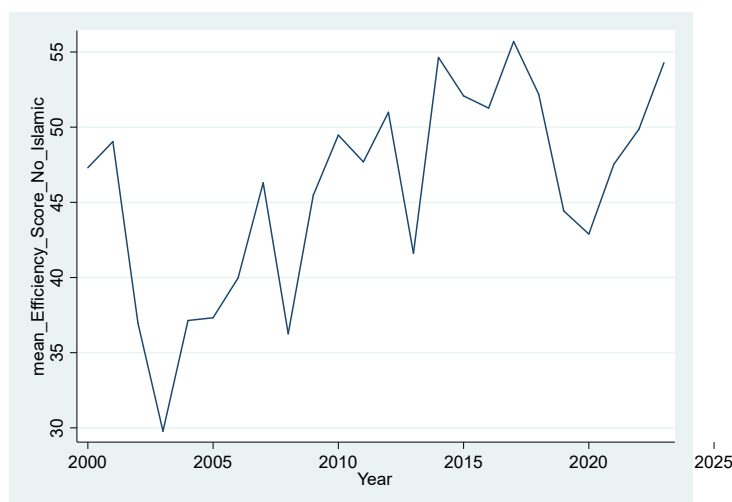
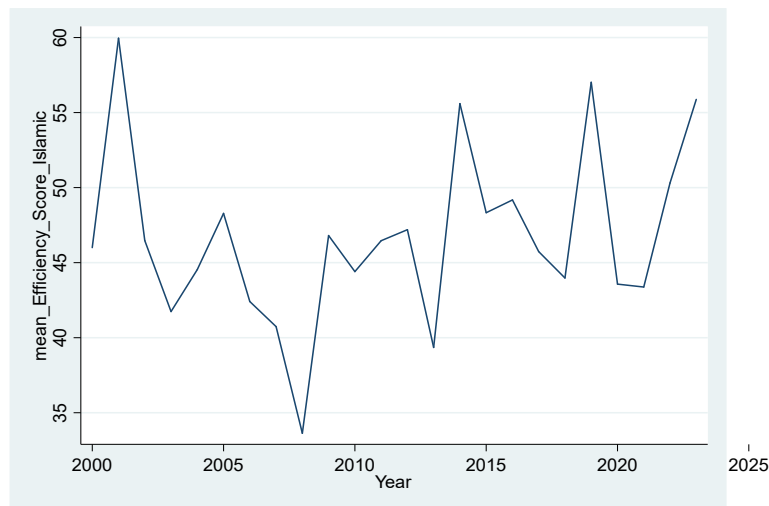


Figure 2. Evolution of Mean Conventional Efficiency Scores



**Figure 3.** Evolution of Mean Islamic-Efficiency Scores

For the Islamic-Efficiency variable (see Figure 3), our series shows an overall mean of 0.467 with a standard deviation of 0.278. Total values range from 0.004 to 1.000, with a high concentration of approximately 0.429. There is considerable heterogeneity (CV = 0.596). The sample distribution of the Efficiency-Islamic variable is asymmetrically spread to the right (Skewness = 0.338) and leptokurtic (Kurtosis = 1.925). In general, all series present autocorrelation problems and the persistence of substantial heterogeneity, which will affect subsequent estimation results.

#### 4.1. Dynamic GMM estimation

According to Eq. 1, we will interpret the main descriptive statistics of the different variables presented in Table 3. According to the diagnosis in this table, our Efficiency-Score variable has an overall mean of 46.273 with a substantial standard deviation of 27.439, indicating low heterogeneity among the observations. The 1,200 observations are bounded between 0.309 and 100, with a high concentration around 42.376. The sampling distribution is slightly non-symmetrical to the right (Skewness = 0.380 > 0) and leptokurtic (Kurtosis = 1.980 > 0). Overall, this variable rejects the normality hypothesis, as the probability of the Jarque-Bera statistic is less than 5%.

Indeed, Table 3 shows an overall average of our second variable, ROA, at 4.436 with a substantial standard deviation of 4.984, demonstrating the high homogeneity of the observations. The latter are bounded between -17.253 and 47.162, where the sampling distribution is weakly skewed to the right (Skewness = 1.844 > 0) and leptokurtic (Kurtosis = 11.764 > 0). Concerning the probability of the Jarque-Bera statistic, which is less than 5%, this distribution rejects the null hypothesis of normality.

Turning now to the OER analysis, this too is characterized by an overall mean of 4.134 with a substantial standard deviation of 11.012. Observations range from -80.797 to 73.629, where the sampling distribution is non-symmetrical, slightly skewed to the right (Skewness = 1.971 > 0) and leptokurtic (Kurtosis = 25.627 > 0). Overall, this distribution rejects the normality hypothesis, since the probability of the Jarque-Bera statistic is less than 5%.

We now turn to the presentation of the ICR variable, which has an overall mean of 7,329 with a significant standard deviation of 32,941. The 1,200 observations range from 0.000 to 433,390, with a high concentration around 2.405. The sample distribution is asymmetrically skewed to the right (Skewness = 11.243 > 0) and more acute than a normal distribution, with a Kurtosis of 141.611 > 0. However, according to the probability of the Jarque-Bera statistic, which is less than 5%, this distribution rejects the null hypothesis of normality at the 5% significance level.

However, observation of the variable Capital reveals an overall mean of  $1.21 \times 10^7$  with a standard deviation of  $3.95 \times 10^7$ . The 1,200 observations are bounded between 0 and  $4.99 \times 10^8$ , where the sample

distribution is right-asymmetric (Skewness = 5.286 > 0) and leptokurtic (Kurtosis = 39.742 > 0). Based on the probability of the Jarque-Bera statistics, which are greater than 5%, we accept the null hypothesis of normality for this distribution.

**Table 3.** Descriptive analysis

Designation	Efficiency-Score	ROA	OER	ICR	Capital	FATA	GDPG	INFL	ISLAMIC
Mean	46.273	4.436	4.134	7.329	1.21e+07	15.585	4.051	7.420	0.5
Median	42.376	3.257	1.710	2.405	118697.2	9.725	3.803	6.777	0.5
Standard Deviation	27.439	4.984	11.012	32.941	3.95e+07	22.417	9.021	16.574	0.500
Minimum	0.309	-17.253	-80.797	0.000	0.000	-25.879	-36.656	-28.760	0.000
Maximum	100.000	47.162	73.629	433.390	4.99e+08	261.687	53.385	118.274	1.000
Skewness	0.380	1.844	1.971	11.243	5.286	4.632	0.758	1.927	0.000
Kurtosis	1.980	11.764	25.627	141.611	39.742	35.805	17.639	14.447	1.000
JB value	80.91	4522	2.6e+04	9.9e+05	7.3e+04	5.8e+04	1.1e+04	7295	-----
JB probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----
BB value	28.97	27.83	10.12	14.85	9.65	7.77	22.81	56.32	-----
BB probability	0.000	0.000	0.006	0.001	0.008	0.021	0.000	0.000	-----
Correlation (p-value)	Efficiency-Score	ROA	OER	ICR	Capital	FATA	GDPG	INFL	ISLAMIC
Efficiency-Score	1.000								
ROA	0.047 (0.003)	1.000							
OER	-0.009 (0.050)	-0.192 (0.000)	1.000						
ICR	-0.109 (0.000)	0.118 (0.000)	-0.068 (0.018)	1.000					
Capital	-0.095 (0.000)	0.033 (0.243)	0.054 (0.060)	-0.006 (0.810)	1.000				
FATA	0.091 (0.001)	0.570 (-0.208)	-0.049 (0.085)	0.036 (0.201)	-0.086 (0.002)	1.000			
GDPG	-0.006 (0.035)	0.047 (0.103)	-0.006 (0.819)	0.024 (0.398)	0.030 (0.284)	0.035 (0.213)	1.000		
INFL	-0.004 (0.071)	0.010 (0.716)	-0.012 (0.670)	0.055 (0.053)	0.108 (0.000)	0.035 (0.225)	0.066 (0.02)	1.000	
VIF					1.18				

Notes: JB refers to [Jarque and Bera \(1987\)](#) Statistic. BB refers to [Born and Breitung \(2016\)](#) Statistic. VIF refers to the Variance Inflation Factor of [Marquardt \(1970\)](#).

However, observation of the variable Capital reveals an overall mean of  $1.21 \times 10^7$  with a standard deviation of  $3.95 \times 10^7$ . The 1,200 observations are bounded between 0 and 4.99e+08, where the sample distribution is right-asymmetric (Skewness = 5.286 > 0) and leptokurtic (Kurtosis = 39.742 > 0). Based on the probability of the Jarque-Bera statistics, which are greater than 5%, we accept the null hypothesis of normality for this distribution.

Turning now to the analysis of the FATA variable, this has an overall mean of 15.585 with a mean standard deviation of 22.417. The 1,200 observations are bounded between -25.879 and 261.687, where the sample distribution is right-skewed (Skewness = 4.632 > 0) and leptokurtic (Kurtosis = 35.805 > 0). Based on the probability of the Jarque-Bera statistics, which are greater than 5%, we accept the null hypothesis of normality for this distribution.

However, observation of the control variable GDPG reveals an overall mean of 4.051 with a standard deviation of 9.021. The 1,200 observations are bounded between -36.656 and 53.385, where the sample distribution is right-skewed (Skewness = 0.758 > 0) and leptokurtic (Kurtosis = 17.639 > 0). Based on the probability of the Jarque-Bera statistics, which are greater than 5%, we accept the null hypothesis of normality for this distribution.

We now turn to the Inflation control variable, which has an overall mean of 7,420 with a significant standard deviation of 16,574. The 1,200 observations range from -28,760 to 118,274, with a high concentration around 6,777. The sample distribution is asymmetrically skewed to the right (Skewness = 1.927 > 0) and more acute than a normal distribution, with a Kurtosis of 14.447 > 0. However, according to

the probability of the Jarque-Bera statistic, which is less than 5%, this distribution rejects the null hypothesis of normality at the 5% significance level.

Finally, we describe the third Islamic control variable, which shows an overall mean of 0.5 with a significant standard deviation of 0.5. The 1200 observations are restricted to the range of 0 to 1, where the sampling distribution is weakly symmetrical (Skewness = 0) and averagely leptokurtic (Kurtosis = 1 > 0). Overall, we can conclude that all variables are non-stationary over time, indicating that they are approximately non-stationary.

From the second panel of Table 3, the test of simple correlation coefficients cannot be considered conclusive for the study of Islamic and conventional bank efficiency scores; however, it does provide an overall view of the various relationships, which we can subsequently detail. The simple correlation coefficients detailed in Table 3 show that:

- The Efficiency-Score is positively, significantly, and strongly correlated with the two variables ROA and FATA;
- The Efficiency-Score is negatively, significantly, and strongly correlated with the other variables in our study.

Similarly, the lower part of Table 3 shows that the independent variables are highly correlated. Consequently, the question of multicollinearity does not arise in our scenario. The measurement of the variance inflation factor (VIF) yields a value of precisely 1.18.

One of the central issues in panel unit root testing is the form of heterogeneity in the model used to test the unit root. The simplest form of heterogeneity is that which postulates the existence of constants specific to each individual. This is, of course, the model with individual effects (specified in a fixed or random manner), which reflects heterogeneity only in the mean level, but retains the assumption of homogeneity in the other model parameters, and in particular, in the autoregressive root. Levin and Lin's (1992) first unit root tests used this type of modeling. However, this concept of heterogeneity, which is limited to individual effects or deterministic trends, soon proved implausible in macroeconomic applications. However, given the various problems observed in the different series, it is sensible to investigate a dynamic relationship between the variables. For all these reasons, we have tested for the presence of a unit root using the LLC and IPS tests in both level and first-difference forms, as shown in Table 4. According to this table, all runs failed the unit root tests. Hadri's (2000) test is the most relevant, as all series show the existence of unit roots at the level ( $H_0$  rejection). On the contrary, the same series accepts the hypothesis that the first-order difference is stationary. Consequently, we can consider all series to be integrated of first order (I(1)).

**Table 4.** First-generation unit root test results

Variables	LLC				IPS			
	In level		In first difference		In level		In first difference	
	C	C & T	C	C & T	C	C & T	C	C & T
Efficiency-Score	-9.941**	-9.473**	-25.488**	-20.231**	-13.996**	-15.649**	-22.483**	-22.559**
ROA	-3.104***	-3.104**	-14.037**	-10.916**	-6.397**	-8.455**	-19.388**	-19.773**
OER	-27.894**	-15.694**	-31.183**	-41.783**	-12.122**	-13.352**	-20.675**	-21.144**
ICR	-2.326**	2.329*	-8.838**	-10.579**	-4.087**	-2.966**	-17.387**	-19.094**
Capital	-0.702***	-6.284**	-25.423**	-19.929**	----	----	----	----
FATA	-8.784**	-1.499***	-19.929**	-5.392**	-2.718**	----	----	----
GDPG	-10.349**	-10.537**	-24.713**	-18.254**	-14.741**	-16.297**	-22.483**	-22.496**
INFL	-10.509**	-11.643**	-26.721**	-19.358**	-14.150**	-15.870**	-21.228**	-21.183**

Notes: \* significant at 10%, \*\* significant at 5%, \*\*\* significant at 1%. C refers to the constant model. C & T refers to the constant and trend model.

In statistical and econometric models, dependence refers to the idea that observed variables are not independent of one another. Dependence can be temporal (autocorrelation), spatial, or between different series. Identifying dependence is crucial for specifying a correct model and conducting hypothesis testing.

If the data set consists of panel observations from a small number of cross-sectional units, then the LM test of Breusch and Pagan (1980) is recognized as the best choice. On the other hand, as the Breusch and Pagan

(1980) LM test is not suitable for panel datasets with a large number of cross-sectional units, Pesaran (2004) has proposed a standardized version of the LM test. The scaled LM test applies to panels with ample time and cross-sectional contexts. However, suppose the number of cross-sectional units is significant, while the time dimension is not. In that case, the size distortion arising from the expected value of correlation coefficients obtained from unobserved individual effects exacerbates the issue.

According to Table 5, the optimal estimation strategy for panels with heterogeneous slope coefficients remains an open question in econometric literature. The presence of cross-sectional dependence (CSD) complicates the choice between available estimators. In this paper, we focus on identifying optimal estimation methods in linear panel data models with random slope coefficients that exhibit common dependence. However, given the different problems observed in the other series, it is sensible to investigate a dynamic relationship between the variables. For all these reasons, we tested for the presence of a unit root in both the level and first difference to account for the problem of heterogeneity between the selected countries.

**Table 5.** Cross-sectional dependence & homogeneity tests

Tests	References	Statistics	p-value	Decision
Cross-sectional dependence	Breusch & Pagan (1980)	2114.999	0.000	Dependence
	Frees (1995 & 2004)	1.393	0.000	Dependence
	Fan et al. (2015)	1031.97	0.000	Dependence
	Pesaran (2006)	4.163	0.000	Dependence
	Juodis & Reese (2021)	-1.52	0.130	Dependence
	Pesaran (2015, 2021)	5.35	0.000	Dependence
Homogeneity	Pesaran & Yamagata (2008)	5.621	0.000	Heterogeneity
		7.110	0.000	

The results are shown in Table 6. According to this table, all series failed the unit root tests. The second-generation tests of Pesaran (2003) and Pesaran (2007) are the most relevant, as all series show the existence of unit roots in level (rejection of  $H_0$ ). On the contrary, the same series accepts the hypothesis that the first-order difference is stationary. Consequently, we can consider all series to be integrated of order 1 (I(1)).

**Table 6.** Second-generation unit root test results

Pesaran (2003)	In level		In first difference	
	Constant	Constant & trend	Constant	Constant & trend
Efficiency-Score	-3.802	-3.974*	-5.696*	-5.787*
ROA	-2.193	-2.927	-5.084*	-5.167*
OER	-3.126	-3.412	-4.215*	-5.191*
ICR	-2.287*	-2.602*	-4.686*	-5.104*
Capital	-2.236*	-2.376*	-4.431*	-4.876*
FATA	-2.203	-2.077*	-3.955*	-4.005*
GDPG	-3.023*	-3.443	-5.578*	-5.569*
INFL	-1.672	-3.341	-5.343*	-5.541*
Pesaran (2007)	In level		In first difference	

	Constant	Constant & trend	Constant	Constant & trend
Efficiency-Score	-8.812**	-5.013**	-20.299**	-17.096**
ROA	-2.069**	-2.510**	-14.311**	-11.549**
OER	-7.226**	-6.795**	-19.549**	-16.578**
ICR	0.077***	4.356***	-8.094**	-6.068**
Capital	0.087***	2.869***	-6.206**	-2.487**
FATA	-2.370**	2.540***	-5.621**	-1.664**
GDPG	-4.355**	-5.431**	-19.939**	-15.703**
INFL	4.624***	0.108***	-16.092**	-13.631**

Notes: \* significant at 10%, \*\* significant at 5%, \*\*\* significant at 1%.

Break unit root tests, as proposed by Karavias and Tzavalis (2014), are powerful tools for testing stationarity in complex panel data. They can handle dependencies between cross-sectional units, structural breaks, and heterogeneities, offering a more robust and accurate analysis of multidimensional time series. According to Table 7, the interpretation of results depends primarily on p-values but must be complemented by consideration of data-specificities (dependency, heterogeneity, breaks).

Crisis years (such as the 2001 financial crisis, global economic crises, or country- or region-specific crises) can lead to structural breaks in time series. These events can significantly alter underlying economic relationships, the behavior of economic agents, or economic policies, making time series non-stationary before and after the event. The COVID-19 pandemic's impact caused a structural break in many economic series, including those related to financial markets for Islamic and conventional banks. The Karavias and Tzavalis (2014) test could help identify pre- and post-crisis dynamics. Second-generation cointegration tests are specifically designed to handle problems of cross-dependence (i.e., when cross-sectional units in panel data are interdependent), as well as structural breaks and unobserved effects. These tests are essential in contexts where time series present correlations between units, as in country panels or regional economic data.

**Table 7.** Results of the unit root with a break

Variables	In Level	In first difference
Efficiency-Score	-37.029***(2001)	-68.396** (2001)
ROA	-21.703** (2001)	-61.224** (2001)
OER	-37.701** (2002)	-71.880** (2001)
ICR	-27.058** (2022)	-58.772** (2022)
Capital	0.000** (2001)	-70.864** (2020)
FATA	-16.735** (2007)	-42.361** (2022)
GDPG	-51.364** (2001)	-63.894** (2001)
INFL	-34.225** (2020)	-49.369** (2022)

Another advantage of adding the individual dimension to the time dimension is that the asymptotic distributions of unit root tests on panel data are asymptotically normal. In contrast, they are non-standard when only the time dimension is considered. Finally, the new generations of unit root and cointegration tests in panel data enable us to account for possible interdependencies among individuals in the panel in various forms. The panel is no longer simply a collection of independent individuals, but a structure that may be subject to the influence of common observable or unobservable factors. In this context, using a

panel model instead of time series is no longer a matter of choice, but rather a necessity linked to the consideration and modeling of these common factors.

Cointegration between common factors can be examined by standard time series tests such as Johansen's reduced rank approach. As idiosyncratic components are independent by construction, their analysis is carried out using standard panel tests, such as those developed by Pedroni (1999). It should be noted, however, that the existence of cointegrating relationships that annihilate both common and idiosyncratic trends is improbable. Two cointegrating vectors exist when both wealth variables are considered. This implies that there is no cointegration between the standard parts of the Efficiency-Score. Moreover, some tests by Pedroni (1999, 2001) indicate cointegration even between idiosyncratic components, as shown in Table 8. This is particularly true for PP, but not for ADF-type statistics.

**Table 8.** First-generation cointegration test

Tests	Statistic	p-value
Kao (1999)	-7.994**	0.000
Pedroni (2001)	Constant	Constant & Trend
Panel v-statistic	-1.542**	-4.238**
Panel rho-statistic	-1.44	0.757***
Panel PP-statistic	-16.12**	-17.04***
Panel ADF-statistic	-12.81**	-14.41**
Group rho-statistic	0.959***	3.158**
Group PP-statistic	-19.59***	-19.53**
Group ADF-statistic	-14.53**	-15.33**

Notes: All test statistics are distributed  $N(0,1)$ , under a null hypothesis of no cointegration. \*\*, and \*\*\* refer to significant at 5%, and 1%, respectively.

Based on the above analysis, Persyn and Westerlund (2008) have developed a new generation of cointegration tests that are valid even when the cross-sectional correlation of the variables is not zero. Like the previous tests, there are two forms: the first, based on firm-based convergence ( $G_t$  and  $G_a$ ), and the second, based on homogeneous convergence ( $P_t$  and  $P_a$ ). Second-generation cointegration tests, such as those proposed by Persyn and Westerlund (2008), are powerful tools for testing cointegration in panel data while taking into account cross-dependencies between units and structural breaks. From Table 9, these tests are particularly relevant for analyzing long-term relationships in complex economic contexts, such as those marked by financial crises or changes in monetary policy.

**Table 9.** Second-generation cointegration test

Persyn & Westerlund (2008)	Constant	Constant & Trend
$G_t$	-3.262**	-2.744**
$G_a$	-6.816***	-7.115**
$P_t$	-18.571**	-17.015**
$P_a$	-15.797***	-7.054**

Note: \*, \*\*, \*\*\* significant at 10%, 5%, and 1%, respectively.

Dynamic panel data estimation using the two-stage GMM system is a robust method for addressing endogeneity and autocorrelation issues in dynamic effects models. It is beneficial in models where explanatory variables are correlated with errors and offers efficient estimation in the presence of heteroscedasticity and autocorrelation. The method utilizes instruments to obtain consistent estimates,

enabling in-depth analysis of dynamic relationships in panel data.

To make comparisons with the above estimates and justify the effect of performance indicators for Islamic and conventional banks (see Eq. 1) on the efficiency score of our study across MENA countries over the period 2000 to 2023, we present in Table 10 below the results of these estimates of our model by the GMM dynamic panel system. The results report the regression of the model with the variables, estimated separately to limit difficulties due to the problem of multicollinearity. The inclusion of one or more lagged values of the endogenous variable in the model is necessary, as this is a dynamic autoregressive model. In this situation, our model can be presented as follows (Eq. 8):

$$Efficiency - Score_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 OER_{it} + \beta_3 ICR_{it} + \beta_4 Capital_{it} + \beta_5 FATA_{it} + \beta_6 GDPG_{it} + \beta_7 Inflation_{it} + \beta_8 Islamic_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (8)$$

GMM (Generalized Method of Moments) estimation of the quadratic model refers to the use of the GMM method to estimate a regression model where the relationship between the dependent and explanatory variables follows a quadratic form. This model is often used when it is assumed that there is a non-linear relationship between the variables, i.e., that the effect of the explanatory variable on the dependent variable is not constant but varies according to the level of the explanatory variable. As a final step in estimating our GMM model, we will decompose our endogenous variables, linked to the Efficiency Score, using ROA to control for endogeneity problems. We start with the system variable Efficiency-Score with the other variables in our model (Eq. 9), which is presented as follows:

$$Efficiency - Score_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_{12} ROA_{it}^2 + \beta_2 OER_{it} + \beta_3 ICR_{it} + \beta_4 Capital_{it} + \beta_5 FATA_{it} + \beta_6 GDPG_{it} + \beta_7 Inflation_{it} + \beta_8 Islamic_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (9)$$

Concerning this method (GMM system), Arrellano and Bond's (1992) first-difference and second-difference autocorrelation tests of residuals, as well as Sargan and Hansen's over-identification test, shown in the third panel of Table 10, provide important information. As can be seen, the serial autocorrelation test of Arrellano and Bond residuals in first difference (p-value of AR(1) = 0.000 and P-value of AR(2) = 0.814) validates the GMM specification of the models, hence the absence of second-order autocorrelation. The statistics of the Sargan and Hansen tests validate the choice of instruments, with a p-value of 0.004 for the first and greater than 5% for the second (0.473), thus confirming that the instruments used are significant and valid. The GMM system model can then be used to analyze the relationship between the performance indicators of Islamic and conventional banks and the efficiency score for banks in the MENA countries in our study, spanning the period from 2000 to 2023.

**Table 10.** Dynamic panel data estimation, two-stage GMM system

Efficiency-Score <sub>it</sub>	Linear model	Quadratic model
Efficiency-Score <sub>it-1</sub>	0.070**	0.067**
ROA <sub>it</sub>	0.451*	0.904**
ROA <sub>it</sub> <sup>2</sup>	-----	-0.025**
OER <sub>it</sub>	0.162**	0.142**
ICR <sub>it</sub>	0.001	-0.001
Capital <sub>it</sub>	-4.04e-08**	-3.77e-08**
FATA <sub>it</sub>	-0.120**	-0.159**
GDPG <sub>it</sub>	0.097**	0.102**
Inflation <sub>it</sub>	-0.156***	-0.159**
ISLAMC <sub>it</sub>	41.314**	39.887**

Constant	20.010	20.632
Diagnostic tests		
Arellano-Bond test for AR(1)	-5.67***	-5.08***
Arellano-Bond test for AR(2)	0.24	0.17
Sargan test	43.97***	46.47***
Hansen Test	21.77	22.84

Note: \*, \*\*, \*\*\* significant at 10%, 5%, and 1%, respectively.

Overall, the estimation results indicate that the effects of our explanatory variables align with theoretical predictions. The coefficient of the lagged Efficiency-Score is positive (and statistically significant). Similarly, we find a positive and significant effect on the ROA, OER, GDPG, and Islamic variables. However, the results of the Generalized Moment Model (GMM) estimation indicate a negative and statistically significant effect of the variables Capital, FATA, and INFL on the Efficiency Score in our study. Furthermore, the results of the Generalized Moment Model (GMM) estimation indicate a positive and statistically insignificant effect of the variable ICR on the Efficiency Score. This result is consistent with most theoretical and empirical analyses carried out in this context. These results confirm the findings of several studies and our hypotheses on the subject.

As can be seen, Hansen's over-identification restriction test validates the GMM model specification and can be used as a standard diagnostic in any estimation of over-identified instrumental variables. The statistics of Hansen's chi-squared test validate the choice of instruments: a p-value greater than 0.05, which is equal to 0.000, indicates that the instruments used are significant and valid. The GMM model can then be used to analyze the relationship between the equation system and the Efficiency-Score and ROA.

Overall, the estimation results indicate that the effects of our explanatory variables align with theoretical predictions. For the first linked Efficiency-Score equation with lagged Efficiency-Score in our study, the coefficients of the latter are positive (and statistically significant). Similarly, we find a positive and significant effect of this equation system on variables such as ROA, OER, GDPG, and Islamic, but a negative and insignificant sign for the ICR term, thus highlighting the existence of a complementarity effect. The other variables are also negative and significant. The impact of the relationship provision in our model gives a negative (significant) effect on the whole ROA<sup>2</sup> equation. In other words, the relationship between the Efficiency Score and the ROA of the system of equations for Islamic and conventional banks in the MENA countries in our study is one of complementarity, as they contribute simultaneously to the output of all countries in our sample.

GMM estimation of the quadratic model is instrumental when there are endogeneity problems and you want to obtain consistent and efficient estimates. This approach is commonly used in situations where the relationship between the dependent and explanatory variables is non-linear, and where there is time dependence in the panel data. The use of the two-stage GMM model corrects potential biases due to endogeneity and provides robust estimates, even in the presence of heteroscedasticity and autocorrelation. This result is consistent with most theoretical and empirical analyses carried out in this context. This result confirms the conclusions of several studies conducted on the subject.

## 5. Discussion

The subprime crisis has shaken the banking systems of many countries. The collapse of major banks, such as Lehman Brothers, IndyMac, and Washington Mutual (now known as City Group), is a perfect illustration. Without the rescue plans put in place by the regulatory authorities, the consequences would undoubtedly have been more disastrous. This crisis has called into question the way conventional banks operate, highlighting the need for a profound overhaul of their business model (Pollin, 2009; Matherat, 2013).

The meteoric rise of Islamic finance and its banking component over the same period has naturally aroused

the interest of researchers. Some authors consider that Islamic banks have shown greater resilience to the financial crisis, attributing this resilience to the specific characteristics of this category of banks (Chapra, 2011; Chong & Liu, 2009; Hassan & Kayed, 2009). Indeed, the obligation to comply with the “Shariah” imposes a different business model on Islamic banks, in which practices such as securitization, speculation, and excessive risk-taking are entirely prohibited.

Since then, a substantial body of literature has been devoted to comparative analyses of conventional and Islamic banks. This work has two main strands. The first seeks to ascertain which of the two categories of banks has proved more resilient in times of financial crisis. The second is dedicated to the study of efficiency. The results of work on these two axes are quite divergent, and there is no consensus in the literature as to the supremacy of one of the two categories of banks (Bader et al., 2009).

These principles obligate Islamic banks to innovate to reconcile the needs of their customers with the constraints imposed by Shariah law. With this in mind, two categories of financial instruments have been developed and approved by the relevant Shariah authorities (Sundarajan & Errico, 2002). The first includes financing instruments such as Murabaha, Ijara, Salam, and Istisnaa contracts. The Murabaha contract is by far the flagship product in this category. This instrument is analogous to a conventional loan, with the difference that ownership of the asset covered by the contract first passes into the hands of the banking establishment, before being transferred to the customer at maturity. Islamic banks thus circumvent the prohibition on interest by transforming it into a commercial margin on the resale of goods to their customers. Reference interest rates such as Libor are often used as a benchmark to set the margin in question (Supriyanto, 2016), reinforcing the similarity between this category of instrument and conventional credit.

The second category concerns so-called participative instruments, based on the principle of profit and loss sharing, such as Moudharaba and Moucharakah contracts. The income generated by this type of contract is uncertain, requiring the bank to exercise control through project selection to limit its exposure to the risks of adverse selection and moral hazard. In the case of Moudharaba contracts, the risk of moral hazard is accentuated by the fact that banks lack the means to exercise rigorous control over project managers (Dar & Presley, 2000; Sundarajan & Errico, 2002).

The complexity of setting up participatory contracts and the associated risks have led to a clear preference among Islamic banks for financing instruments (Aggarwal & Yousef, 2000). In this respect, Chong and Liu (2009) reveal that instruments applying the profit and loss sharing principle account for only 0.5% of financing contracts in Malaysia. Mills and Presley (1999) report similar results for Bangladesh, Egypt, Iran, Pakistan, the Philippines, and Sudan. Dar and Presley (2000) make a similar finding for Pakistan. The same authors offer an exhaustive review of the factors motivating such a strategy on the part of Islamic banks. Islamic banks tend to opt for security, preferring financing instruments over equity instruments. However, this solution has its limitations (Sundarajan & Errico, 2002). Financing instruments require complex financial arrangements and the involvement of banks in the acquisition and preservation of the underlying assets. Banks are thus exposed to a new category of risk: holding these same assets until maturity. As a result, these contracts are considerably more expensive than a conventional loan.

The creation of the first Islamic Bank (IB), Mit Ghamr Saving Bank, in 1963 in Egypt, marked the birth of Islamic finance. In 2013, IBs accounted for almost half of the market share in the petro-monarchies (Saudi Arabia, Kuwait, Bahrain, Qatar, and the United Arab Emirates). They account for less than 5% of the market in Egypt, Jordan, Palestine, and Yemen, but 100% in Iran, and less than 1% worldwide (Ernst & Young, 2015). IBs offer products that comply with Islamic economic laws (Sharia), which prohibit uncertainty, speculation, and the use of interest-bearing loans, and require transactions to be backed by a tangible asset as well as profit and loss sharing. The Shariah Compliance Board ensures the legality and validity of activities. Investor and co-owner status justifies a BI's participation in the results of profit and loss sharing (PLS) projects, venture capital (Mudarabah), or a joint venture (Mucharakah). BIs also offer buy-sell (Murabahah) and leasing (Ijara) contracts, corresponding to short-term financing that accounted for 90% of BI intermediation in 2008 (Ali, 2012).

The subprime crisis demonstrated the instability of the conventional banking system (Minsky, 1986) and fueled interest in BI, which is characterized by greater resilience and even enhanced performance (Hassan & Kayed, 2009). However, BIs are not only subject to conventional risks, but also to specific risks related to the nature of the contracts, which their entanglement may reinforce. These specificities pose a problem in effectively managing BI's vulnerability to risk and its impact on profitability (Nadia Zrelli et al., 2017).

Is the risk-performance relationship of a BI comparable to that of a conventional bank? A bank's objective is always to perform better, given its environment and the risks it has to manage. BI is no exception, encountering risks common to CBs at different levels of exposure (Ariffin et al., 2009; Al-Tamimi & Al-Mazrooei, 2007). The most significant business risks are liquidity, credit, and operational risks (Hussain & Al-Ajmi, 2012). Liquidity risk, the most prevalent in BI, stems from the inability to cover commitments or increase assets (Idries, 2012). BI experiences difficulties in managing liquidity, particularly in investing cash, refinancing, and converting bank assets into cash (El-Gamal, 2006). BIs seem to master maturity mismatch, which can generate a liquidity problem when the bank lends long-term and borrows short-term. According to Bourakba and Belouafi (2015), over the period 2000-2012, Gulf BIs practiced positive maturity transformation, creating more money than they destroyed.

Credit risk is a source of instability in the banking system (McNeil et al., 2005). Ferhi and Chkoundali (2015) suggest that CBs have significant credit risks relative to IBs. According to Berger et al. (1997), poor management of internal costs intensifies credit risk. Abedifar et al. (2013) show that, relative to CBs, over the period 1999-2009, the risk of insolvency is lower in small BIs.

Operational risk, resulting from insufficient or unproven internal practices, influences decision-making in several ways, notably through a lack of experience and unfamiliarity with financial instruments (Ray & Cashman, 1999; Srairi, 2010).

A bank's solidity depends on its ability to finance profitable investment projects and on its reputation. In addition to conventional risks, BIs face specific risks, including translational commercial risk, religious compliance risk, specific investment risk, and risk entanglement. The risk of religious non-compliance arises from differing interpretations of the legitimacy of a product by different schools of thought and, by extension, by members of the Sharia committee. This risk particularly affects the reputation of a BI, which may result in a massive withdrawal of deposits and non-acceptance of its products by other Islamic financial institutions. Risks are specific to certain activities. Ijara contracts typically require property management and maintenance services. PLS contracts require costly monitoring and negotiation of profit- or loss-sharing rates, in addition to the volatility of returns linked to the underlying projects financed.

BIs differ from BCs in terms of contracts and risks, as well as in the way they are intertwined. To date, the analysis of BI-specific risks has not been addressed. Our study aims to quantify this type of risk and its impact on business intelligence (BI) performance. The development of indicators—efficiency-revenue, ROAA, and ICR—which are subjected to correlation analysis and non-parametric rank tests, leads us to formulate three main conclusions. The results show a positive correlation between efficiency-income and specific risk, a divergence in the impact of partial indicators of particular risk and performance indicators depending on the country studied, and a vulnerability of Islamic banks in terms of their ability to manage specific risk through the Sharia committee and asset allocation for particular contracts. Ongoing research is testing these initial findings through cross-sectional analysis followed by panel data analysis (Berguiga et al., 2017).

In recent years, Libya has adopted the Islamic banking system, with several conferences, seminars, and workshops organized in this field. On August 12, 2021, the Central Bank of Libya organized a conference on the Islamic banking system in Libya, under the title “The reality of Islamic Banking in Libya and its development paths”, aiming to raise awareness of the reality of the Islamic banking experience in Libya, the challenges of investing funds in Islamic forms, the nature of legitimate supervisory work in banks operating in Libya, in addition to examining the role of Islamic banking in the field of economic development. Specialist researchers from all regions of Libya attended the conference. Speaking on the sidelines, Mr. Imad Boukhaal, Head of the Islamic Finance Development Department at the Central Bank of

Libya, said that “this approach is based on studies and research carried out by the bank”; he also pointed out that “studies have proved that there is a distance between the concept of Islamic banking, its tools and methods, and the prevailing thinking in society”.

## **6. Conclusions and Policy Implications**

In terms of banking efficiency and improving banking competition, Islamic banks have had a limited impact. This can be explained, firstly, by the high legal and supervisory costs associated with Islamic financial instruments, as well as the significant expenses incurred during the launch phase. Additionally, Islamic banks are reportedly more potent in the market than conventional banks. The main obstacles to banking efficiency and the promotion of competition by Islamic banks are that they operate in environments that are, on the whole, unfavorable to their activities. Sharia rules do not govern the legislative, economic, and political systems; they operate according to a different logic and vision, sometimes even opposed to what Islam requires, similar to trying to make a plant grow in soil that is not its natural environment.

We found that the risk/efficiency pairing is positively and significantly correlated. This finding encourages banks to manage credit risk effectively and on an optimal scale, thereby improving efficiency scores without the need for the central bank to intervene regularly to tighten collection operations and control the risk of rising bad debts, as seen in the case of the MENA region in our study. Similarly, we must be aware that risk-taking is self-limiting under Islamic financial principles. In this sense, we consider that banks must strike a balance between an acceptable degree of risk-taking and a bad debt ratio that does not raise concerns for financial regulators.

Additionally, we need to focus on a qualitative yet indispensable element: the availability and accessibility of financial information, as well as the promotion of effective communication channels. This aspect appears to be neglected by Moroccan participatory banks, which make insufficient efforts to communicate and promote their products and services. Furthermore, a simple analysis of their advertising policy reveals that participatory banks focus their strategies on financing products (uses) rather than deposit-taking (resources) and other ancillary missions, such as advice, support, and compliance with Islamic precepts, thereby turning this niche into credit companies rather than banks in their own right.

Having examined various aspects of Islamic banks in the chapters of this research, it is evident that they are a significant addition to the banking sector, as they play a crucial role in the economies of the countries in which they operate. This has prompted us to attempt to identify the obstacles preventing traditional banks in Libya from operating in accordance with the provisions of Islamic Sharia law.

In contrast, the financial reports of Islamic banks in the MENA region contain an exhaustive and precise analysis of the strengths and weaknesses of their accounts, a detailed examination of the accounts in the appendices to the financial statements, a report from the Shariah Committee, a report from the Audit Committee, as well as all financial and extra-financial information.

From this historical retrospective on the evolution of banking activity and the development of financial intermediation models, it is clear that banking liberalization is associated with bankruptcies and banking crises, prompting the authorities to rigorously regulate the sector, at the risk of causing widespread panic. Once the crisis is over, these same authorities call on the banking sector to contribute to financing the economy and call for deregulation of the financial system. This dichotomy of functions, which characterizes periods of economic growth and recession, gives rise to a contradiction, prompting banks to direct their activities towards high-risk financial operations on the financial markets, rather than focusing on their core role of financial intermediation.

The risk of bankruptcy is inherent in the banking activity, which is considered a financial intermediary. However, they are confronted with information asymmetry and greater uncertainty, which push them to develop lasting relationships with customers. It is therefore necessary to evoke models linked to the risk of moral hazard and adverse selection, which are sources of information asymmetry. The risk of adverse selection arises when the borrower possesses privileged and confidential information before signing the contract (ex-ante information asymmetry). This risk refers to the situation where banks opt for the riskiest

projects to generate high returns by applying a single rate to all projects. This situation arises from the banks' inability to accurately assess the risks associated with each project, leading them to crowd out low-risk (and low-yield) projects.

Finally, participatory banks in the MENA region will need to establish a clear and ambitious overall strategy to set up an industry that is independent of and not “ancillary” to conventional finance, focus on the elements discussed earlier such as the development of the Islamic ecosystem and the purification of these banks' equity capital to make these funds legitimate and “Halal”-labeled, at the risk of losing customers and large depositors who are well-informed and adept at Islamic financial principles. Nevertheless, these options remain complex and controversial as long as the conventional banks in the MENA region are the owners or co-owners of the participatory banks.

## Declaration

This article lacks any research conducted by the authors involving human subjects.

- **Conflicts of Interest:** The authors declare no conflicts of interest.
- **Consent to Participate:** This article contains no studies conducted by the authors with human participants.
- **Clinical trial number:** The Clinical trial is not applicable.
- **Funding:** The research leading to these results has not received funding.
- **Data Availability Statement:** The data supporting this study's findings are available from the corresponding author upon reasonable request.
- **Materials used:** Stata 17 software is used to run various programs.
- **Authors' Contributions:** All authors participated in the methodology and the writing of the different sections of the article. Professor Kamel HELALI carried out the experiment based on the data collected by Musa Ali Mohamed ERHOMA. All authors elaborate on the theoretical background and the redaction of the principal parts of the article, discuss the results, and contribute to the final manuscript. Professor Kamel HELALI and Musa Ali Mohamed ERHOMA supervised the article.

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