

The Impacts of Intellectual Capital Efficiency on Credit Risk and Financial Stability of Islamic Banks in Middle East and North Africa Countries

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Abstract: The objective of this study is to evaluate how Islamic banks' risk-taking behavior. This study used a panel generalized method of moments estimator from 2011 to 2022 to scrutinize the vibrant link between intellectual capital adeptness, bank performance, and risk for 972 bank observations in ten Middle East and North Africa economies. The findings revealed that intellectual capital efficiency and elements of intellectual capital such as human capital efficiency, rational capital efficiency, and structural capital efficiency are significantly associated with risk. Islamic bank performance indicators are undesirably allied with credit risk-taking. The results suggest that intellectual capital proficiency encourages banks to condense credit risk and upsurge their performance, ultimately leading to greater financial stability. The banks under study must prioritize enhancing the efficiency of the intellectual capital of the aforementioned countries. Financial stability and the risk of Islamic banks in the MENA regions are the focus of this novel study, which examines the relationship between intellectual capital and risk-taking behavior in these nations. To help lawmakers and financial institutions improve corporate governance policies and procedures in support of sustainable financial reporting, this paper provides significant insights. Scholars, politicians, and financial institutions will all be intrigued by this groundbreaking study.

Keywords: Intellectual Capital Efficiency, Credit risk, Financial Stability, Islamic Banks

Introduction

International banking has undoubtedly transformed into a knowledge business (Oppong & Pattanayak, 2019) that recognizes the crucial role of intellectual capital in achieving corporate competitiveness and monetarist sustainability (Rehman et al., 2022). Financial transactions are made easier by the banking industry, which is very much essential for the growth and success of developing nations (Al-Obaidan, 2008). Banking is dualistic in the 10 Muslim-majority countries of the Middle East and North Africa (MENA) region, with a traditional sector coexisting with an Islamic one in each country namely; Qatar, Iraq, Jordan, Bahrain, Saudi Arabia, Egypt, Lebanon, Morocco, Kuwait, Oman (Al-Obaidan, 2008). Both industries coexist and contribute to the economic development of the countries in which they operate. Banks are now required to prioritize the depth of their knowledge rather than the expansion of their asset base. They have been putting bank resources into IC in ten countries where the environment is

competitive in part because of globalization. Such banking activities are in line with the policy goals that the governments of the selected countries have said they want to reach, which are to diversify their economies and become less dependent on crude oil and natural gas exports (Buallay et al., 2019; Kismawadi, 2023). Intellectual capital has emerged as a significant contributor to the economy and companies, but the Middle East lags behind other regions in this contribution (Ali et al., 2022). The banking industry is no exception to this trend, and recognizing the importance of IC is crucial for its continued growth and prosperity (Buallay et al., 2019). Islamic banks' global assets have grown steadily during the past few years. According to a report by Global Islamic Finance Markets, the overall assets of Islamic banks in 2019 were \$1.72 trillion, a fraction of the \$123.7tn (2017) total assets of the world's top 1000 banks (Alqahtani & Mayes, 2018). However, this considerable gap does not occur in the MENA countries in particular (Alqahtani & Mayes, 2018; Villalba-Eguiluz et al., 2023).

The principles of the Islamic faith, interpreted in light of their applicability to financial dealings, are the basis of Islamic banking. The holy Quran, which is considered the most important book in Islam, is where foundational ideas behind Islamic banking can be found. Such laws as the prohibition of interest (riba) and compulsion to partake in risk-taking are reflected in the Islamic bank's provision of financial goods, which are governed by Shariah principles (Ariff & Rosly, 2011; Ashraf et al., 2016). Speculation is prohibited under Shari'ah, hence financial derivatives are out of bounds for banks (Mollah et al., 2017)

Islamic banking products do not charge interest. In the case of Musharakah, the bank provides a client with business equity, which is different from traditional loans that typically have variable interest rates and involve charging interest. The borrower's eligibility for a loan is determined based on the level of default risk (Saidu et al., 2018). Islamic banks primarily offer these products in areas outside the typical realm of commercial banking, such as investment banks and venture capital firms, where the firm's equity can be utilized for profitable investments (Saidu et al., 2018). However, few scholars have examined how laws, such as capital requirements and supervisory authority, affect the risk-taking behavior of Islamic financial institutions (Smolo et al., 2020). There is growing interest among national regulators, policymakers, and scholars in the area of Islamic financial intermediation (Grais & Kulathunga, 2007). Capital regulation is designed to ensure that banks maintain sufficient funds to manage their risks, with decisions based on changes in risk arising from both internal and external factors (Ayuso et al., 2004). However, if capital requirements are not well-planned, they can lead to negative outcomes. Specifically, they may encourage banks to take excessive risks due to issues such as moral hazard and information asymmetry (Nasir et al., 2023).

The previous studies mostly focus on intellectual capital and banking performance (Al-Musali & Ku Ismail, 2016; Buallay et al., 2019; Innayah et al., 2020; Ting et al., 2020; Gupta & Raman, 2021;). Whereas intellectual capital and risk were examined by (Cahyaningrum and Atahau, 2020 Nazir et al., 2021 Nguyen et al., 2021 Xu et al., 2022), and economic catastrophe and intellectual capital enactment were examined by (El-Bannany, 2012).

IC efficiency allows banks to achieve stability and avoid insolvency in a complicated competitive environment, and thus, investing in IC may minimize credit risk and ensure bank and economic growth (Nawaz et al., 2019). A bank may make substantial revenues, but without proper risk management, loan losses can lead to reduced profits. Moreover, banks can significantly reduce credit risk by effectively managing their intellectual capital. The ability of banks to manage their intellectual capital efficiently can result in minimizing their risk exposure (Cahyaningrum & Atahau, 2020). A global investigation on the effectiveness of IC and its association with banks' profitability is yielding much proof (Sormin & Manona, 2023). The effect of IC Efficiency (ICE) on steady performance (stability) is significant, especially in the banking sector (Ting et al., 2020). Banks that have higher ICE tend to perform better financially. This is because they can develop new and innovative products, improve their customer service, reduce their costs, and minimize their risks. The primary motive for this research is that MENA is the fastest-expanding economic region in the world. Previous studies investigated one or two aspects of IC's effect on risk-taking without considering IC's overall efficiency on risk. This research aims to address that hole by showing how different types and levels of intellectual capital, as well as overall IC efficiency, affect banks' propensity to take risks (financial stability). Using the MENA as a case study of growing economies, this article delves into five fundamental questions:

1. How does Islamic Banking's intellectual capital influence credit risk and financial stability in the MENA nations?
2. How does human capital (HC) impact on Islamic banks' financial stability?
3. What impact does Rational Capital (RC) have on the economic trustworthiness of Islamic banks?
4. What impact does structural capital (SC) have on Islamic banks' financial soundness?
5. What effect does modify value-added intellectual capital (MVAIC) have on Islamic banks' economic soundness?

This paper aims to appraise how the performance of Islamic banks' IC affects risk-taking behavior (financial stability) in MENA nations from 2011 to 2022. Specifically, the study will focus on financial stability and credit risk, analyzing data from 2011 to 2022 to thoroughly understand the relationship between intellectual capital and risk-taking behavior within the Islamic banking industry. The results revealed that IC efficiency and elements of IC (HCE, RCE, and SCE) are negatively (positively) and significantly correlated to risk (financial stability) using the system GMM estimator. The performance indicators of Islamic banks exhibit a negative (positive) correlation with credit risk-taking. According to the findings of the study, improved financial stability can be achieved by encouraging banks to take less credit risk and boost their performance through a focus on intellectual capital efficiency. Thus, Islamic banks should put extra effort into boosting the effectiveness of intellectual capital in these countries.

It has become a popular framework for managers to identify critical properties a firm needs to gain a sustainable competitive benefit (Utami, 2023). As per the resource-based theory, firms' strategic assets help achieve better performance (Grant, 1996) and neutralize threats and risks (Barney, 1991). The resource-based theory suggests that companies should focus inward to identify how they can best utilize their internal resources to achieve their goals. However,

Demartini and Beretta (2022) suggest that there is a significant need to deepen our understanding of how IC impacts organizational financial performance and how higher intellectual capital efficiency reduces credit risk (Cahyaningrum & Atahau, 2020). If it aids in the development or implementation of strategies that boost productivity and profitability inside an organization, then it is likely to be considered a valuable resource (Barney, 1991). The core variables of this study are IC, performance, and risk. The variables mentioned above provide insights into specific aspects of resources and their impact on bank performance within the context of the bank. It is important to note that while these variables can be associated with resource-based theory, the theory itself primarily focuses on the firm's internal resources and capabilities (Battisti et al., 2022; Gerhart & Feng, 2021). The study's explanation of the impact of ICE on bank performance and risk is strongly supported by resource-based theory. We have applied this theory in this dissertation because it provides a crucial framework to understand and anticipate the basics of a company's performance and competitive advantage.

An organization with high levels of intangible capital (IC) is better able to engender, apply, and measure imperceptible resources to increase its operations and performance (Dean & Kretschmer, 2007). The term "IC" has changed over time. It now refers to things like intellectual material, knowledge that can be used to make money, intellectual belongings, information, etc., that can be used to make money (Dumay et al., 2015). Human capital is the ability to behave in a broad range of situations to generate tangible and intangible resources (Sveiby, 1997). An organization's ties with clients, resource providers, banks, and shareholders are denoted as "rational capital." Rational capital can also be defined as an organization's capability to produce significance for its patrons through its interactions with them (Inkinen, 2015). Sveiby (1997) says that relationships with customers and suppliers are what make up rational capital (Sveiby, 1997). Structural capital is considered as the knowledge that accumulates over time, and that cannot be eliminated from the organization. The non-physical infrastructure that supports human capital's operation is referred to as structural capital. Organizational procedures, structures, systems, routines, hardware, databases, and organizational cultures are all examples of what is referred to as structural capital (SC). Inventions, procedures, copyrights, technologies, strategies, patents, and systems are all examples of structural capital. The above-mentioned three parts of IC are used. With this model, HC, SC, and RC are looked at as a whole. Laing et al. (2010) described the MVAIC approach as a reliable evaluation method that can give IC different values (Barak & Sharma, 2023; Laing et al., 2010). The quantity of products produced in a specific period is used to indicate productivity for manual workers. Similarly, the quantity of value added per invested monetary unit (also recognized as the IC efficiency) is now used as a pointer of the yield of knowledge employees (Pulic, 2008).

While there may not be an extensive number of studies exploring the connection between overall efficiency and risk, this study offers a valuable summary of several prior studies on the subject. It is expected that IC efficiency is inversely correlated with risk. However, it implies that risk can be managed effectively by improving IC efficiency. As a result, this study anticipated a negative association, yet previous research on this topic has revealed a different result (Alrashidi & Alarfaj, 2020; Innayah, Nawaz et al., 2019; Zheng et al., 2017). Zheng et al. (2022) found a positive connotation between bank credit risk and IC efficiency. Using the

VAIC model and regression analysis of Indian commercial banks, Ghosh and Maji (2014) discovered an inverse relationship between IC efficiency and credit risk. The research indicates that credit risk in public banks is more strongly influenced by IC efficiency compared to private banks. The paper did not make any decisions on the relationship between IC and insolvency risk (Ghosh & Maji, 2014). However, a study by Sarmiento and Galán (2014); and Sun and Chang (2011) showed the contrary, claiming that IC can reduce credit risk by assisting in the evaluation of institutional competitiveness as well as providing a good picture of the organization's managing team (Sarmiento & Galán, 2014; Sun & Chang, 2011). Efficiency and risk have a negative relationship (Deelchand & Padgett, 2009; Fiordelisi et al., 2011). Prior investigations have identified positive associations (Isshaq et al., 2012; Tan & Floros, 2013). According to Tan and Floros (2013), the risk is increased as a result of fewer loan monitoring and screening, yet technical efficiency improves bank loan volume (Tan & Floros, 2013). Furthermore, Altunbas, et al. (2007) claimed that efficiency and risk have no significant link (Altunbas et al., 2007). El-Bannany (2012) has shown a noteworthy impact on UAE bank's IC performance (El-Bannany, 2012). Hence, the following hypothesis has been formulated:

H₁: There is a negative relationship between IC efficiency and credit risk of Islamic banks of MENA countries.

The bank's performance and intellectual capital impact on bank performance is a plain and simple phenomenon. Various researchers have found significant correlations between IC components and bank performance when measuring their primary components. A surfeit of studies addressing the measuring of the effect of numerous elements of IC on performance abounds in literature (Hamdan et al., 2017; Inkinen, 2015; Zheng et al., 2022). Other research showed the interrelationship of combined IC components with bank performance. Numerous empirical investigations on the affiliation between the IC and corporate performance have indicated a positive connotation (Bataineh et al., 2022; Buallay et al., 2019; Gupta & Raman, 2021; Inayah et al., 2020; Nguyen et al., 2023). On the other hand, the evidence from two studies, namely (Muhammad, 2009; Ting et al., 2020) unequivocally demonstrates a significant negative correlation between ICE and performance. Kaupelytė and Kairyte (2016) presented contrasting views on the relationship between IC and bank performance. They acknowledged that while IC affects bank performance, the impact differs between large and small banks in Europe. The findings indicate that the stability of Islamic banks is positively impacted by ICE components, specifically SCE and RCE (Aslam et al., 2024). The majority of the time; however, the judgments gained are inconsistent in their outcomes and conclusions. The merging of financial sectors has obscured the differences between Islamic and conventional banking operations. As a result, there is a significant gap in the literature regarding the impact of IC on bank performance. This work aims to fill that gap. Al-Musali and Ismail (2016) found that Intellectual Capital (IC) had a positive impact on the Return on Assets (ROA) and Return on Equity (ROE) of Saudi banks from 2008 to 2010. However, they also found that the IC performance of these banks was low. Based on the above discussion, we have developed the following hypothesis:

H₂: There is a positive relationship between IC efficiency and the financial stability of Islamic banks of MENA countries.

Materials and Methods

The study is conducted to examine the correlations among intellectual capital efficiency, performance, and risk-taking comporment (financial stability) in the MENA-10 nations, including (Egypt, Iraq, Kuwait, Lebanon, Oman, Qatar, Bahrain, Jordan, Morocco, and Saudi Arabia).After deleting missing data, the database for this study has 972 observations from ten countries and 89 banks. There are other ownership systems in MENA countries; however, this study exclusively considers Islamic banks. The study is concentrated on these countries to explore the effect of IC efficiency, performance, and risk-taking comporment (stability). Based on data availability, the study will run for ten years, from 2011 to 2022. The information is drawn entirely from secondary sources.

Variable section

Credit risk (non-performing loans)

This study used two dependable risk variables named non-performing loans and Z-score. Non-performing loans represent credit risk and financial stability is measured with Z-score. According to the findings of this research, the ratio of non-performing loans to total loans is the key indicator of risk, and the loan loss provision ratio serves as an additional indicator of risk. The ratio of non-performing loans to total loans (NPLTL) has been used to measure credit risk, and a bigger ratio specifies a higher likelihood of loan default losses Chaibi and Ftiti (2015); (Moudud-UI-Huq et al., 2021; Moudud-UI-Huq et al., 2020). Moudud-UI-Huq, Zheng, and Gupta (2018) all employ this ratio. Loan loss provision to overall loan (LLPTL) captures historical and future performance (Moudud-UI-Huq et al., 2018). Abedifar ey al., (2013) and Tan and Floros (2013) also utilized this variable to quantify total risk.

Financial Stability (Z-score)

The Z-score has been calculated by dividing the standard deviation of ROA by the ratio of ROA + equity (E) / (TA) total assets. The stability of a bank can be evaluated using the Z-score. A greater Z-score indicates more stability of banks (Moudud-UI-Huq et al., 2021; Moudud-UI-Huq et al., 2020). The Z-score is considered a reverse measure of bank financial stability (Jeon & Lim, 2013; Moudud-UI-Huq et al., 2021; Moudud-UI-Huq et al., 2020).

$$Z\text{-score} = \frac{ROA + E/TA}{\sigma ROA}$$

Intellectual capital

Intellectual assets (IA) are the greatest valued resource in today's organizations, and most organizations are unable to identify what creates an IA (Andreou et al., 2007). Simply put, intellectual capital refers to the brain's or mind's ability to be creative. IC has to do with the value and intangibility of assets (Andreou et al., 2007).

"This study will evaluate the effectiveness of IC by considering human and structural capital as IC elements, with customer/relational capital included in SC investing in employees' skills, knowledge, and experiences through effective training programs is an essential step towards enhancing human capital and driving organizational success (Duho & Onumah, 2019).Structural capital refers to a company's supporting capital, which includes everything that helps staff and allows human capital to perform correctly (Mondal & Ghosh, 2012). Structural capital is the knowledge that a company creates and owns, and it stays with the

company even after employees leave. The elements of Structural capital include structures, routines, and systems, cultures of the entity, hardware, procedures, and database. It also includes processes, patents, inventions, technology, and strategy, copyright (Joshi et al., 2013; Rehman et al., 2011). Pulic (200, 2004) provided the formula for calculating Structural Capital is $S_C = VA - HC$ (Pulic, 2000, 2004) (Pulic, 2000; Pulic, 2004). According to Pulic (2000), the value accumulated from current-year assets is called VA, which is computed as

$$V_A = \text{Output (total sales)} - \text{Input (cost of materials, components, and services)}$$

Public (2000) Also provided the following alternate formula for measuring V_A :

$$V_A = OP \text{ (Operating profit)} + EC \text{ (Employee Cost)} + D \text{ (Depreciation)} + A \text{ (Amortization)} \dots \dots \dots \text{(i)}$$

Bontis (2001) suggested the following equation for calculating Economic Value-added (EVA) for analyzing the performance of a full business (Bontis, 2001):

$$E_{VA} = \text{Net sales} - \text{operating expenses} - \text{taxes} - \text{capital charges} \dots \dots \dots \text{(ii)}$$

The relationships with all of a company's stakeholders are denoted to as its relational capital (Choong, 2008). Relational capital, according to Mondal and Ghosh (2012), is the worth of an entity's bonds with which it performs business (Mondal & Ghosh, 2012).

Determination of Intellectual Capital Efficiency Using Stochastic Frontier Analysis (SFA) Adhering to the guidelines (Nițoi & Spulbar, 2015; Zheng et al., 2017), SFA is used in this study for quantity efficiency as well as for the production function of SFA to inhibit ICE.

The study used Aigner et al, (1977) stochastic frontier production methodology to calculate each bank's efficiency.

For the i th Bank,

$$\ln IC_i = f(\ln Q_o, P_j) + \epsilon_i \dots \dots \dots \text{(iii)}$$

Where IC_i denotes the Intellectual capital of bank, Q_o postulates three outputs, i.e., Q_1 = Total operating income, Q_2 = Loan and advances, Q_3 = Non-interest income, P_j indicates three inputs, i.e., P_1 = Fixed assets, P_2 = Personal expenses, and P_3 = Non-performing loan. A bank's real intellectual capital that departs from the efficient frontier of intellectual capital, which has two disturbance terms, is denoted by the symbol ϵ_i :

$$\epsilon_i = V_i - U_i \dots \dots \dots \text{(iv)}$$

Where, V_i is a random error term? it is supposed that $I(o, \sigma_v^2)$ is distributed independently and uniformly. U_i denotes inefficiency in intellectual capital and is considered to be disseminated individualistically of V_i and with a half-normal distribution i.e. $I(o, \sigma_u^2)$.

The following multiproduct trans log production function was constructed utilizing an intermediation approach to specify the Intellectual Capital function in this study (Sealey et al., 1977):

$$\ln IC_i = \alpha + \sum_o \alpha_o \ln Q_o + \sum_j \beta_j \ln P_j + 1/2 \sum_o \sum_k \gamma_{ok} \ln Q_o \ln Q_k + 1/2 \sum_j \sum_h \delta_{jh} \ln P_j \ln P_h + \sum_o \sum_j \lambda_{oj} \ln Q_o \ln P_j + \epsilon \dots \dots (v)$$

Specifically, the expected value of U_i conditional on ϵ_i as determined by (Jondrow et al., 1982), exposes the inefficiency of bank i's intellectual capital (also known as C_i), according to (Jondrow et al., 1982).

$$C_i = E U_i / \epsilon_i = [\sigma \lambda / (1 + \lambda^2)] [\phi(\epsilon_i \lambda / \sigma) / \Phi(\epsilon_i \lambda / \sigma) + \epsilon_i \lambda / \sigma] \dots \dots \dots (vi)$$

Where λ used for the ratio of the standard deviation of U_i to the standard deviation of V_i . ϕ and Φ used for the normal density function of incremental standard and standard usual compactness function, respectively.

Using the equation (vi), C_i can be inferred. This study calculated the efficiency derived from the Frontier production function using computer software called Frontier Version 4.1 (Coelli, 1996).

Econometric model

In the realm of Islamic banking, a strong correlation can be observed between capital efficiency and risk-taking, as well as between performance and risk-taking (Abedifar et al., 2013; Azad et al., 2021). No evidence emphasizing three things (bank performance, capital efficiency, and risk-taking) together in a regression baseline produces any results. Nadeem et al. (2017) used GMM to show the ICE and Bank performance of BRICS banks. The GMM estimator, originally presented by Arellano and Bover (1995), is utilized due to the panel data structure of this inquiry. GMM helps to address unobserved heterogeneity and endogeneity issues ((Arellano, 2002). Its estimator considers the persistence of the variable being estimated, resulting in reliable parameter estimates. As a result of utilizing a vast array of instruments, the coefficients that are derived have a greater degree of accuracy (Nguyen et al., 2021).

The GMM estimator uses lagged values of dependent variables and additional regressors as instruments to address endogeneity issues. This account for the possibility that these regressors may be affected by endogeneity (Bond, 2002). We implement Bond's (2002) methodology by using lagged values of endogenous variables as instruments. In the table that

displays the results, these values are written in italics. We use instruments for all of the regressors in our model, with the exception of the ones that are considered to be exogenous. This is the strategy that we take. Apart from these examinations, the count of delays can be evaluated by performing Arellano-Bond autocorrelation (AR) tests and the over-identifying constraints test (Hansen, 1982). It should be noted that if the null hypothesis of the Hansen test is rejected, the orthogonality constraints of the tested instruments will not be fulfilled. A cross-country database makes it clearer to see how banks' risk-taking behavior and intellectual capital efficiency affect their overall financial results. The empirical relationship between intellectual capital efficiency and risk-taking (stability) and the various effects of banks' performance is tested using the simultaneous equations model and the generalized method of moments (GMM) to close this gap. Both the variables intellectual Capital and risk are naturally endogenous and due to their correlation, they have been used as explanatory variables in the simultaneous equation. The prior period's tendency has influenced today's banking practice. In the current period, banks have adjusted their portfolio risk in the equivalent mode. At times of rising risk levels, banks are obligated to lower the risk in their portfolio. Therefore, it is to be projected that risk and lagged risk are negatively correlated.

As a result, Equations (vii-a) and (vii-b); and (viii-a) and (viii-b), which are as follows, including the independent variables and lagged periods:

$$Risk_{i,t} = \alpha_0 + \alpha_1 Risk_{i,t-1} + \alpha_2 ICE_{i,t} + \alpha_3 \sum_{K=3}^4 PI_{i,t} + \alpha_4 \sum_{j=5}^6 CV_{i,t} + \alpha_5 \sum_{h=7}^8 MEV_{i,t} + \epsilon_{i,t} \dots \dots \dots (vii - a)$$

$$Risk_{i,t} = \alpha_0 + \alpha_1 Risk_{i,t-1} + \alpha_2 \sum_{l=2}^5 EIC_{i,t} + \alpha_3 \sum_{K=6}^7 PI_{i,t} + \alpha_4 \sum_{j=8}^9 CV_{i,t} + \alpha_5 \sum_{h=10}^{11} MEV_{i,t} + \epsilon_{i,t} \dots \dots \dots (vii - b)$$

$$Fstab_{i,t} = \alpha_0 + \alpha_1 Fstab_{i,t-1} + \alpha_2 ICE_{i,t} + \alpha_3 \sum_{K=3}^4 PI_{i,t} + \alpha_4 \sum_{j=5}^6 CV_{i,t} + \alpha_5 \sum_{h=7}^8 MEV_{i,t} + \epsilon_{i,t} \dots \dots \dots (viii - a)$$

$$Fstab_{i,t} = \alpha_0 + \alpha_1 Fstab_{i,t-1} + \alpha_2 \sum_{l=2}^5 EIC_{i,t} + \alpha_3 \sum_{K=6}^7 PI_{i,t} + \alpha_4 \sum_{j=8}^9 CV_{i,t} + \alpha_5 \sum_{h=10}^{11} MEV_{i,t} + \epsilon_{i,t} \dots \dots \dots (viii - b)$$

Where the i subscript denotes the number of banks observed, whereas subscript t denotes the number of years. $t-1$ indicates the lag variable of the dependent variable.

Risk denotes the credit risks (NPL) in equation (vii-a), equation (vii-b). Fstab indicates the financial stability (z-score) in equation (viii-a) and equation (viii-b). For the equation (vii-a) the dependable variable is risk and equation (vii-b). Fstab (Financial stability) uses as the dependent variable in case of equation (viii-a) and equation (viii-b). ICE indicates the intellectual capital efficiency that determines by Using Stochastic Frontier Analysis [please see section 3.1.4 or equation (iii-vi)]. ICE is used as the independent variable for equations (vii-a) and (viii-a). EIC indicates the element of intellectual capital i.e. HCE, RCE, SCE, MVAIC. EIC is used as the independent variable for equations (vii-b) and (viii-b). PI and subscript K indicate the bank performance variables that are termed return on assets (ROA) and return on equity (ROE). CV and subscript j indicate the bank control variables, for example, bank size and leverage. MEV and subscript h indicate the country's macroeconomic variables, i.e., GGDP and Inflation rate. α uses as estimator parameter. ϵ indicates the error term.

Table 1 shows the variables that have been used in this study and its sources.

Table 1. Summary of all variables

Variables	Formula	Sources
Non-performing loans (NPL) or Credit risk	$\frac{\text{Non - performing loans}}{\text{to total loans}}$	(Moudud-UI-Huq et al., 2021; Zheng, Moudud-UI-Huq, et al., 2017)
Financial Stability (Z-score)	$\frac{ROA + E/TA}{\sigma ROA}$	(Moudud-UI-Huq et al., 2021); (Moudud-UI-Huq, 2020); (Moudud-UI-Huq et al., 2020; Zheng, Moudud-UI-Huq, et al., 2017)
Intellectual Capital Efficiency (ICE)	Please see the equation [iii-vi]	(Alrashidi & Alarfaj, 2020; Buallay et al., 2019; Ghosh & Maji, 2014; Guerrini, Romano, & Leardini, 2014)
Human capital efficiency (HCE)	The ratio of value-added (VA) is divided by HCE. Where, VA= Operating profit+employee cost+ Depreciation. Where: HCE = Total costs invested on employees.	(Buallay et al., 2019)
Relational capital efficiency (RCE)	The ratio of value-added divided by RC. Where: RC = marketing and sales expense	(Buallay et al., 2019)
Structural capital efficiency (SCE)	The ratio of SCE is divided by value-added. Where: SCE = Value added - HCE	(Buallay et al., 2019)

Modified value-added Intellectual Capital (MVAIC)	The index of IC components. Where, MVAIC = HCE + RCE + SCE	(Buallay et al., 2019)
Return on Assets (ROA)	$\frac{\text{Net Income}}{\text{total Assets}}$	(Buallay et al., 2019; Moudud-Ul-Huq et al., 2020)
Return on Equity (ROE)	$\frac{\text{Net Income}}{\text{Shareholder's Equity}}$	(Buallay et al., 2019; Moudud-Ul-Huq et al., 2020)
Bank size	Natural logarithm of total assets	(Moudud-Ul-Huq et al., 2021; Moudud-Ul-Huq et al., 2020; Zheng et al., 2017)
Leverage	The ratio of total debt to total assets	(Zhenget al., 2017)
Growth in GDP	Annual growth in real gross domestic product	(Moudud-Ul-Huq et al., 2021)
Inflation rate	Annual inflation rate	(Moudud-Ul-Huq et al., 2021)

Source: Author’s calculation by studying literature

Result Analysis

Descriptive Statistics and Pearson’s Correlations

Table 2 displays the descriptive statistics covering all variables that were considered. The average risk value (z-score) is .063 (25.012). It suggests that the risk (stability) market in these countries is in good shape. ICE has a mean value of 17.943 (HCE, RCE, SCE, MVAIC) (6.318, .940, 4.521, and 12.903). It means that ICE and IC elements can contribute to financial stability by lowering risk, which leads to improved performance.

Table 2. Descriptive statistics of the variables

Variables	N	Minimum	Maximum	Mean	Std. Deviation
NPL	972	-.072	32.65	.063	9.459
Z-score	972	-.194	81.91	25.012	17.193
ICE	972	-.271	32.932	17.943	3.201
HCE	972	-.042	23.073	6.318	2.448
RCE	972	-3.063	8.002	.940	1.038
SCE	972	-5.010	10.820	4.521	.132
MVAIC	972	-8.271	33.001	12.903	3.007
ROA	972	-.003	12.182	4.116	.092
ROE	972	-.001	9.005	3.211	.803
Size	972	9.052	51.74	15.650	5.615
Leverage	972	.102	41.871	17.741	11.441
GGDP	972	-7.44	13.40	3.071	2.748
Inflation	972	-3.73	39.27	5.247	5.003

Source: Author’s Calculation.

The following Table 3 shows the Pearson correlation analysis of variables. The correlation matrix has reached a maximum of 0.560 for showing the relationship between the in dependable variables (Table 3). As a result, the models are devoid of major multicollinearity issues.

Table 3. Pearson correlation analysis

S.N	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	NPL	1												
2	Z-SCORE	.103	1											
3	ICE	.184*	-.260	1										
4	HCE	.121	-.051	.107*	1									
5	RCE	-.026	.043	.121	-.004	1								
6	SCE	.008	.211	-.159	-.009	-.160	1							
7	MVAIC	-.079	.121	.025	.162	.231	-.090**	1						
8	ROA	.031	-.169	.168	.229	.158	-.130**	-.335**	1					
9	ROE	-.013	.074	-.094*	.129*	-.026	.045	-.127	-.278	1				
10	Size	.095*	-.150	.123	.221	.042	-.004	.067	-.354	-.504	1			
11	Leverage	-.068	.303	-.209**	-.131	.065	.219	-.402	-.436	.126**	.126**	1		
12	GGDP	-.038	.300	.411	-.061	.015	.145	-.560	.037	.138	-.137	-.212	1	
13	Inflation	-.106	-.154	.027	-.007	.029	.004	-.031	.039	-.053	.206*	.432	-.102	1

*. Correlation is significant at the 0.05 level (2-tailed).

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Author’s Calculation

Results of GMM

This study used nonperforming loans to total loans ratio and the Z-score as dependent variables. The ICE (Using Stochastic Frontier Analysis) is the essential exogenous variable, but this study also contains classic parts of intellectual capital efficiency such as the HCE, RCE, SCE, and MVAIC indices to ensure the main findings. The results of IC efficiency using SFA following **equation (vii-a) and equation (viii-a)** are shown in **Table 4. Table 5**, on the other hand, shows the findings of **equation (vii-b) and equation (viii-b)** component of intellectual capital efficiency. The null hypothesis is not accepted by the Lagrange Multiplier Test (LM test). Errors can be found in bank-specific variables. The white test (White, 1980) was used to assess the study's cross-sectional heteroskedasticity. The homoscedasticity test's null hypothesis was rejected (at a 5% significant level) (White, 1980). So, the conclusions are not tested by applying the ordinary least square (OLS) approach for the study. Hence, we attempt to handle this result using a GMM approach.

GMM regressions were used, along with robust standard error clustering. The study also employed the Breush-Pagan/Cook-Weisberg statistic to identify heteroskedasticity in the data. The importance (using the First Stage F-test) and validity (using Hansen's J test) of the instruments measuring the grade of market intellectual capital efficiency are also tested in this study. The findings corroborate the occurrence of heteroskedasticity as well as thus the usage of the GMM estimator as well as the relevance and validity of our instruments. **Table 4** shows the regression findings from Islamic banks on the impact of IC efficiency and performance on

risk-taking behavior (stability). The effects of intellectual capital efficiency and performance on credit risk (NPL), as well as bank and macroeconomic variables, are reflected in the credit risk (NPL) of selected Islamic banks. NPL shows a significant negative coefficient between credit risk and intellectual capital efficiency (ICE), the findings similar to those (Alrashidi & Alarfaj, 2020). The relation is positive in the financial firmness (z-score) of Islamic banks when replacing financial stability (z-score) as the dependable variable instead of NPL.

According to the findings, a 1% rise in ICE reduces credit risk by 0.33 percent for NPL while increasing financial stability (z-score) by 0.18 percent. These findings (**Table 4**) are in line with **Table 5**, according to the findings, a 1% increase in HCE, RCE, SCE, and MVAIC reduces credit risk by 11 percent, 12 percent, 6 percent and 19 percent for Islamic banks, respectively, while enhancing financial stability (z-score) by 8 percent, 4 percent, 3 percent, and 16 percent. The findings of this study are similar to Ullah, Pinglu, Ullah, Qian, and Zaman (2021) in the long run, but they show an inverse relationship in the short run. They examined the 20 commercial Pakistani banks (Ullah et al., 2021). The association of IC efficiency with risk (stability) of Islamic banks in these MENA countries suggests that improved IC efficiency will help in risk management. As a result, Islamic banks should pay special consideration to improving the efficiency of intellectual capital of selected MENA countries. In terms of performance, Islamic bank performance indicators are negatively (positively) connected with credit risk-taking (financial stability), which indicates a 1% increase in Islamic bank performance ROA (ROE), credit risk will be decreased by 0.71 percent (0.44 percent) and stability increasing by 21 percent (2 percent). These findings (**Table 4**) are in line with **Table 5**. **Table 5** shows that a 1% increase in Islamic bank performance ROA (ROE) would result in credit risk decreasing by 0.31 percent (0.27 percent) and stability increasing by 10 percent (4 percent). For the rest of the results, **Table 5** maintains the persistence of **Table 4** results.

When considering bank-level control variables, there is no significant association between a bank's size and the risk of insolvency. However, credit risk models show an optimistic coefficient, indicating that large banks tend to take on more credit risk, which is inconsistent with the results (Zheng et al., 2017). Leverage and risk have a positive correlation towards achieving financial stability. This suggests more unrestrained bank conduct and, maybe more intriguingly, increased leverage, which decreases bankruptcy but increases credit risk. The macroeconomic factors' findings are likewise noteworthy. High GGDP boosts bank risk-taking because banks spend additional during economic development, resulting in more risk, as (Haq & Heaney, 2012); Zheng, Moudud-Ul-Huq, et al. (2017) found the same results, but contrary to Laeven and Levine (2009) findings.

Table 4. The effect of intellectual capital efficiency on credit risk and financial stability

Variable	Credit Risk (NPL)	Financial Stability (Z-score)
NPL ₍₋₁₎	.004* (2.021)	
Z-score ₍₋₁₎		.007* (2.029)
ICE	-.331*** (3.691)	.180*** (4.072)
ROA	-.710*** (-3.137)	.213*** (3.011)
ROE	-.441*** (-4.031)	.023*** (3.091)
Size	.031** (4.144)	-.013 (-.091)
Leverage	.017** (4.284)	.243* (2.005)
GGDP	.007** (4.124)	-.042** (-4.321)
Inflation	-.018** (-2.024)	.006*** (3.191)
C	.004** (4.019)	.061*** (2.711)
R-squared	0.706	0.490
First Stage F-test (Prob >F)	24.184 (0.000)	28.820 (0.000)
Hansen's J χ^2 (P-value)	5.482 (23.183)	4.001 (16.319)
χ^2 test of heteroskedasticity P-value	1100 (0.000)	1500 (0.000)
LM test (p-value)	(0.000)	(0.000)
AR (1)	0.000	0.000
AR (2)	0.610	0.471
Number of observations	972	972
Number of banks	89	89

Note that empirical findings obtain by the Generalized Method of Moments. The First Stage F statistic assesses the relevance of the instrumental factors, with the null hypothesis being rejected implying that the variables are not exogenous. The χ^2 test of heteroskedasticity includes the Breusch-Pagan/Cook-Weisberg test. The Hansen's J statistic evaluates the validity of the instruments utilized, with rejection implying that they are not valid. AR1 (AR2) = Arellano–Bond first-order (second-order) autocorrelation. *, **, *** specify significance at $p < .10$, $p < .05$ and $p < .01$ (2-tailed) respectively. t values are shown in parentheses.

Source: Author's calculation

Table 5. The effect of the elements of intellectual capital efficiency on credit risk and financial stability

Variable	Credit Risk (NPL)	Financial Stability (Z-score)
NPL ₍₋₁₎	.072*** (4.217)	
Z-score ₍₋₁₎		.019* (4.001)
HCE	-.117** (-3.281)	.083* (2.108)
RCE	-.120* (-2.026)	.045* (2.152)
SCE	-.060** (-3.000)	.030*** (1.107)
MVAIC	-.287*** (-2.026)	.161*** (4.931)
ROA	-.310*** (-3.237)	.102*** (4.041)
ROE	-.271*** (-3.093)	.048*** (2.034)
Size	.051** (3.094)	-.044** (-2.072)
Leverage	.000** (3.002)	.047 (1.701)
GGDP	.025** (3.174)	-.012** (-3.501)
Inflation	-.102 (-.604)	.082 (.101)
C	.003** (3.104)	.005*** (5.006)
R-squared	0.783	0.637
First Stage F-test (Prob >F)	21.002 (0.000)	29.125 (0.000)
Hansen's J χ^2 (P-value)	3.973 (26.602)	5.074(12.080)
χ^2 test of heteroskedasticity		1400 (0.000)
P-value	1000 (0.000)	
LM test (p-value)	(0.000)	(0.000)
AR (1)	0.000	0.000
AR (2)	0.451	0.375
Number of observations	972	972
Number of banks	89	89

Note that empirical findings were obtained by the Generalized Method of Moments. The First Stage F statistic assesses the relevance of the instrumental factors, with the null hypothesis being rejected implying that the variables are not exogenous. The χ^2 test of heteroskedasticity includes the Breusch-Pagan/Cook-Weisberg test. The Hansen's J statistic evaluates the validity of the instruments utilized, with rejection implying that they are not valid. AR1 (AR2) = Arellano–Bond first-order (second-order) autocorrelation. *, **, *** specify significance at $p < .10$, $p < .05$ and $p < .01$ (2-tailed) respectively. t values are shown in parentheses.

Source: Authors calculation.

Robustness Check

Table 6 displays the robustness results when a different formula is applied. However, the same estimator, GMM, is used here. This study used the loans to deposit ratio (LTDR) as a risk metric instead of credit risk for testing the robustness of the regression results (NPL). As Chalermchatvichien, Zheng et al., (2017) explained, the loan-to-deposit ratio is also employed as a substitute for credit risk (Chalermchatvichien et al., 2014; Zhenget al., 2017).

Here, this study also uses a different formula for credit risk (NPL). Credit risk is also calculated as loan loss reserves to total loans (LLRTTL) to test the robustness (Tanet al., 2020).

Table 6. Robustness Check

Variable	Credit Risk (LTDR)	Financial Stability (Z-score)
LTDR ₍₋₁₎	.020* (2.071)	
Z-score ₍₋₁₎		.400* (2.092)
ICE	-.060** (-4.043)	.245* (2.082)
HCE	-.090** (-2.041)	.020*** (5.001)
RCE	-.102*** (-4.006)	.061*** (4.001)
SCE	-.007*** (-5.007)	.001*** (7.001)
MVAIC	-.165*** (-7.004)	.271*** (4.001)
ROA	-.506** (-3.044)	.213** (2.021)
ROE	-.077** (-2.021)	.021 (.405)
Size	.853** (3.034)	-.201** (-2.041)
Leverage	.020 (1.224)	.010 (2.781)

GGDP	.014** (3.019)	-.001*** (-3.001)
Inflation	-.038* (-2.061)	.061* (2.902)
C	.032 (.537)	.007** (3.029)
R-squared	0.560	0.725
First Stage F-test (Prob >F)	28.083 (0.000)	37.502 (0.000)
Hansen's J χ^2 (P-value)	4.902 (21.032)	3.018 (17.274)
χ^2 test of heteroskedasticity		1200 (0.000)
P-value	800 (0.000)	
LM test (p-value)	(0.000)	(0.000)
AR (1)	0.000	0.000
AR (2)	0.278	0.318
Number of observations	972	972
Number of banks (N)	89	89

Note that empirical findings were obtained by the Generalized Method of Moments. The First Stage F statistic assesses the relevance of the instrumental factors, with the null hypothesis being rejected implying that the variables are not exogenous. The χ^2 test of heteroskedasticity includes the Breusch-Pagan/Cook-Weisberg test. The Hansen's J statistic evaluates the validity of the instruments utilized, with rejection implying that they are not valid. AR1 (AR2) = Arellano-Bond first-order (second-order) autocorrelation. *, **, *** specify significance at $p < .10$, $p < .05$ and $p < .01$ (2-tailed) respectively t values are shown in parentheses.

Source: Author's calculation

The data presented in Table 6 unequivocally establishes a strong negative correlation between credit risk and ICE, RCE, SCE, and MVAIC. Based on the p-values (-.043), (-.041), (-0.006), (-.007), and (-.004), which are all lower than the significance level of 0.05, and the negative coefficients, we can confidently conclude that the results are statistically significant. This indicates that there is a significant and negative relation between credit risk and ICE, RCE, SCE, and MVAIC in MENA Islamic banks, as shown by the following statistics: -.060, -.090, -.102, -.007, and -.165. It implies that if ICE, RCE, SCE, and MVAIC performance of banks in MENA nations are increased, credit risk will be minimized. When we make financial stability the dependent variable in **Table 6**, we see that there is a positive relationship between financial stability and ICE, RCE, SCE, and MVAIC. This is the case because these four factors influence financial stability in opposite ways, where credit risk shows a negative relationship among the variables. Where the p-values are (.082), (.001), (.001), and (.001), which are all lower than the significance level of 0.10. The coefficients are all negative results as follows: 245, .020, .061, .001, and .271. As per the findings the MENA countries have well-decorated banking systems with good monitoring and excellent management mechanisms in place. This assists in the detection of loans that are not being paid back, which can lead to a reduction in the amount of non-performing loans. In conclusion, it lessens the likelihood of credit risk, which ultimately results in increased financial stability. The remaining variables persist in the main findings of this study. This study kept the major results this time, but we

did not include the result of loan loss reserves to total loans in the robustness table. So, LTDR was employed to replace credit risk in this paper, and LTDR displays the persistent result for the Main results. The primary results are kept after the robustness checks.

Conclusion

In recent years, the banking business has had to contend with a competitive climate, and cross-border competition has forced the banking sector to achieve long-term success. Because of its knowledge-intensive character, bank employees are intellectually more indistinguishable and consistent than other services in a country. Hence, the banking industry is a decent sector for conducting ICE research. However, there have been few studies in the globe that link ICE efficiency to bank performance with risk (financial stability). Hence, this study utilizes unbalanced panel data to assess the impact of ICE on the performance and financial stability of 89 Islamic banks across 10 MENA countries from 2011 to 2022, using the GMM estimator with 972 observations. The study found significant negative (positive) correlations between ICE and intellectual capital elements HCE, RCE, and SCE with risk (financial stability) using the system GMM estimator. Islamic bank performance indicators are negatively (positively) linked with credit risk-taking (financial stability). The study results suggest that ICE encourages banks to lessen credit risk and upsurge the bank's performance, which will ultimately lead to greater financial stability. So, special attention needs to be provided by the selected Islamic banks to improve the efficiency of intellectual capital. Although the conclusions of this study are limited, by applying them, bigger scopes in these locations and the rest of the world can be developed. The policymaking of this study is as follows: In today's modern and risk-based banking industry, Islamic banks must efficiently retain and utilize their IC resources in every legal and practical way possible.

In light of the fact that many developing countries seek to spread the economies as well as moving to knowledge-based economies, IC will play an important role in increasing the performance of Islamic banks. So, Policymakers and the government should strengthen information openness and the regulatory context by taking into account the human development system in banks from MENA countries. Furthermore, Islamic banks must implement Shari'ah-compliant practices like prohibiting interest, enhancing the board and corporate governance, improving the timing and reliability of financial reporting, and focusing on the interests and rights of their employees and society at large.

Emerging banks should aware during the recession so that adverse / default events do not affect them negatively. Central banks, bank executives, and other stakeholders should pay more attention to improving HC, RC, and SC. As a result, bank management should focus not only on profit but also on risk management, both domestically and internationally. This study looks at the ICE, risk (stability), and performance of ten MENA nations in terms of Islamic banking. This study solely covers Islamic banks. However, it does not consider conventional banks in the selected nations, which is the study's fundamental shortcoming. Future studies could be conducted to investigate the impact of ICE, competition, and financial stability on the banking sectors of MENA countries such as Algeria, Tunisia, United Arab Emirates, Pakistan, Malaysia, and Indonesia.

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