

# FinTech adoption and tail risk in MENA Islamic and conventional banks: evidence from expectile-based causality analysis

Yousra Trichilli, Sahbi Gaadane and Mouna Boujelbène Abbes  
*Faculty of Economics and Management of Sfax, LEG Laboratory, University of Sfax, Sfax, Tunisia*

Received 7 August 2025  
Revised 11 October 2025  
11 November 2025  
Accepted 16 November 2025

## Abstract

**Purpose** – This study examines the bidirectional and asymmetric relationship between FinTech adoption and downside banking risk for Islamic and conventional banks across ten MENA countries. It explores whether FinTech development exacerbates or mitigates financial fragility during market stress and whether financial risk, in turn, drives digital innovation. By comparing both banking systems, the study captures how FinTech interacts with different business models, risk-sharing principles and regulatory environments.

**Design/methodology/approach** – A novel FinTech index is constructed using a text-mining approach, while downside banking risk is captured through the expectile value-at-risk (EVaR), a tail-sensitive risk measure. The study employs an expectile-based Granger causality model to detect nonlinear and asymmetric predictive relationships between FinTech and risk under varying levels of market stress ( $t = 0.01, 0.05$  and  $0.10$ ).

**Findings** – Results reveal that the FinTech–risk nexus is heterogeneous across MENA countries and bank types. For conventional banks, FinTech tends to amplify downside risk under severe stress in Egypt, Bahrain and Turkey, while in Saudi Arabia and Kuwait it acts adaptively. For Islamic banks, stronger two-way causality emerges in Pakistan and Tunisia, reflecting their asset-backed, participatory structure and sensitivity to technological shocks.

**Practical implications** – The study suggests that policymakers and regulators should adopt flexible, risk-based frameworks that account for the dual nature of FinTech as both a stabilizing and destabilizing force. For Islamic banks, this implies enhancing Sharia-compliant digital governance and cybersecurity standards, while for conventional banks, it underscores the need for improved risk analytics and crisis-response mechanisms.

**Social implications** – Policymakers should adopt flexible, risk-based frameworks recognizing FinTech’s dual role as stabilizer and disruptor. For Islamic banks, enhancing Sharia-compliant digital governance is essential, while conventional banks require stronger analytics and crisis-response tools.

**Originality/value** – This paper is among the first to jointly assess Islamic and conventional banks’ FinTech–stability dynamics in the MENA region using an expectile causality approach.

**Keywords** FinTech adoption, Downside risk, Text mining, MENA Islamic and conventional banks, Granger causality

**Paper type** Research article

## 1. Introduction

The proliferation of financial technology (FinTech) continues to reshape the global banking landscape, particularly within emerging economies such as those in the Middle East and North Africa (MENA) region. Conventional banks are increasingly integrating FinTech solutions to enhance operational efficiency, expand financial inclusion, and remain competitive in an evolving digital ecosystem (Amer, Barberis, & Buckley, 2016; Gomber, Koch, & Siering, 2018a; Gomber, Kauffman, Parker, & Weber, 2018b).

In parallel, Islamic banks have also embarked on their own digital transformation journey, aiming to align technological innovation with Shariah-compliant principles. These institutions

© Yousra Trichilli, Sahbi Gaadane and Mouna Boujelbène Abbes. Published in *Digital Transformation and Society*. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) licence. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this licence may be seen at [Link to the terms of the CC BY 4.0 licence](#).



leverage FinTech to enhance transparency, automate compliance screening, and expand access to Islamic financial products through digital channels (Abedifar, Molyneux, & Tarazi, 2015; Hassan, Aliyu, & Paltrinieri, 2020).

In recent years, the MENA region has witnessed a significant surge in digital banking initiatives, with institutions leveraging big data analytics to offer tailored financial products (Qatar Financial Centre, 2024). This trend underscores the region's commitment to embracing technological advancements. For Islamic banks, digitalization not only facilitates operational efficiency but also strengthens their ability to meet the ethical and participatory principles of Islamic finance by promoting inclusion and social equity (Hanif, 2019; Alqahtani & Mayes, 2018). However, this accelerating digital transformation introduces new dimensions of financial risk, especially downside risk, which traditional measurement tools may fail to capture effectively. The collapse of Synapse Financial Technologies in 2024, which left over 100,000 Americans unable to access more than a quarter of a billion dollars in deposits, highlights the vulnerabilities inherent in some FinTech models (Investopedia, 2024).

In this context, quantifying the degree of FinTech adoption across banking institutions has become essential for both academic inquiry and regulatory oversight. Conventional indicators of technological innovation such as R&D expenditure or binary adoption variables are often insufficient to reflect the multidimensional and dynamic nature of FinTech integration. Recent advances in computational techniques have enabled more nuanced approaches. Notably, Chen, Liu, Li, and Yang (2022a), Chen, Wu, and Yang (2022b), Chen, Hou, and Zhang (2022c) and Tang, Zhang, Riaz, and Gubareva (2021a) propose FinTech indices constructed using text mining and natural language processing (NLP) applied to banks' public disclosures. Building on this line of research, this study employs the methodology developed by Kharrat, Trichilli, and Boujelbène Abbas (2023), which extracts FinTech-related terminology from annual reports and press releases to construct a robust, scalable, and objective index of FinTech engagement at the bank level.

In contrast to conventional banks, Islamic financial institutions face specific challenges in adopting FinTech, such as ensuring Shariah compliance in digital contracts and addressing the absence of interest-based mechanisms. These distinctions justify a comparative analysis of FinTech's impact across both Islamic and conventional banking systems (Rosman, Wahab, & Zainol, 2021; Toumi & Louhichi, 2023).

While much of the existing literature has examined the impact of FinTech on bank performance metrics such as profitability, efficiency, and competitiveness (Thakor, 2020; Li, Spigt, & Swinkels, 2021), relatively little attention has been devoted to its influence on financial risk—particularly tail risk. Traditional risk measures like Value-at-Risk (VaR), although widely used, are often criticized for their lack of subadditivity and limited sensitivity to extreme events. To address these limitations, the Expectile Value-at-Risk (EVaR) has gained attention as a coherent, elicitable, and asymmetric risk metric that offers a more granular view of downside exposures (Taylor, 2008; Ziegel, 2016).

This paper pursues three core objectives. First, it develops a novel FinTech engagement index for a sample of Islamic and conventional banks operating in ten MENA countries over the period 2010–2023, applying a text-mining approach to annual reports and press releases. Second, it evaluates the downside risk exposure of these banks using the Expectile Value-at-Risk (EVaR), thereby capturing extreme left-tail dynamics more effectively than traditional measures. Third, it investigates the bidirectional and asymmetric causal relationship between FinTech development and downside banking risk using a Bivariate Expectile Granger Causality model.

To better capture the asymmetric risk characteristics of FinTech adoption in MENA banks, this study applies expectile-based methods, which provide a nuanced view of distributional extremes beyond standard quantiles. Expectiles allow for the measurement of both the magnitude and direction of extreme variations in FinTech indices and bank stock returns. Using expectile regression techniques, the study explores how digital transformation and macroeconomic factors influence tail risk exposure across countries, thereby offering insights into the vulnerability and resilience of financial innovation dynamics in the MENA region.

---

This paper contributes to the literature in several ways. First, it introduces an innovative and scalable method for measuring FinTech adoption using bank-level textual data, improving upon existing approaches based on static or binary indicators. Second, it extends this framework to Islamic banking, offering one of the few empirical analyses of FinTech-induced risk under Shariah-compliant financial systems. Third, it provides new empirical evidence on the relationship between FinTech engagement and financial risk in emerging markets, emphasizing heterogeneity across countries. Fourth, it applies EVaR and expectile-based causality tests, offering a methodological advance in measuring asymmetric and dynamic financial risk. Finally, the study shifts the focus of FinTech research from performance-oriented analysis to a risk-centered perspective, particularly relevant for financial stability considerations in technologically evolving economies.

The remainder of this paper is organized as follows. The next section reviews the related literature on FinTech adoption and banking risk. [Section 3](#) presents the data and the methodology for constructing the FinTech index and computing EVaR. [Section 4](#) describes the data and variables. [Section 5](#) reports and discusses the empirical findings. [Section 6](#) concludes by offering policy implications and suggesting avenues for future research.

## 2. Review of previous studies

Over the past decade, financial technology (FinTech) has profoundly reshaped the global banking landscape, and the Middle East and North Africa (MENA) region is no exception. The integration of digital payments, blockchain, artificial intelligence (AI), and big data analytics has accelerated the digital transformation of both Islamic and conventional banks. While numerous studies underscore the performance-related advantages of FinTech such as enhanced financial inclusion, improved operational efficiency, and superior customer experience, comparative evidence between Islamic and conventional banking systems remains limited and fragmented. Moreover, research on the risk implications of FinTech development within the MENA context is still relatively scarce.

Recent literature has started to address these gaps. For instance, [Kharrat et al. \(2023\)](#) conducted a comparative study showing that Islamic banks often adopt FinTech solutions more rapidly due to their asset-backed models, largely due to their asset-backed financing models and ethical investment principles, which naturally support transparency and digital recordkeeping. Their findings confirm that FinTech enhances efficiency and customer satisfaction, notably through mobile banking and e-wallet applications. Similarly, [Chinoda and Kapingura \(2024\)](#) analyzed how regulation moderates the relationship between FinTech-based financial inclusion and bank risk-taking in Sub-Saharan Africa. They demonstrated that although FinTech initially raises risk exposure, strong regulatory oversight significantly mitigates this effect. In the same vein, [Mothobi, Makina, and Mutsonziwa \(2022\)](#) found a positive and significant link between the duration of banks' involvement in mobile money services and their profitability, efficiency, and stability confirming that sustained engagement in FinTech ecosystems contributes to long-term resilience.

In the specific context of Islamic finance, several studies have examined how Shariah principles shape digital transformation. [Hasan et al. \(2020\)](#) observed that Islamic banks' adoption of FinTech is driven not only by efficiency motives but also by the need to enhance Shariah compliance through transparent, traceable, and automated digital platforms. Similarly, [Srairi and Kouki \(2021\)](#) found that digitalization supports Islamic banks' goal of promoting financial inclusion, especially for unbanked populations, through mobile and peer-to-peer (P2P) financing channels consistent with Islamic ethics. [Naifar and Mseddi \(2023\)](#) further argued that FinTech can strengthen Islamic banks' competitiveness by reducing agency problems in profit-and-loss-sharing contracts and facilitating real-time monitoring of investment activities. However, they also warned that insufficient digital governance may expose these banks to reputational and operational risks if Shariah-based contracts are not adequately digitized.

On the risk side, the conversation is gaining momentum. [Alharthi and Aljohani \(2024\)](#) emphasized the vulnerabilities of Saudi banks to cybersecurity threats, especially in digital payment ecosystems, where exposure to fraud and data breaches may offset FinTech's performance gains. Likewise, [Benslama and Guesmi \(2022\)](#) highlighted that Shariah-compliant banks, while structurally more risk-averse, may face heightened operational risks when adopting FinTech solutions without appropriate Shariah-compliant risk frameworks. Moreover, [Gomber, Kauffman, Parker, and Weber \(2023\)](#) discussed the systemic implications of AI-driven credit models, pointing out the opacity of algorithmic decision-making and the danger of reinforcing biases without adequate regulatory safeguards. In this context, [Ziegler and Ongena \(2024\)](#) further argued that regulatory arbitrage across countries could amplify systemic risk, especially when FinTech startups operate cross-border under fragmented rules.

The regulatory framework across the MENA region remains uneven. While countries such as the UAE and Saudi Arabia have pioneered comprehensive cybersecurity and FinTech regulations, others lag behind. [Mhmod \(2024\)](#) mapped these disparities, showing that although regulators are becoming more proactive, they are still catching up with the rapid pace of digital innovation. This regulatory heterogeneity poses an even greater challenge for Islamic banks, which must comply simultaneously with conventional prudential standards and Shariah governance principles. As highlighted by [Alam and Rizvi \(2022\)](#), the absence of unified digital Shariah standards across jurisdictions often slows down the scaling of Islamic FinTech solutions, thereby affecting their integration within regional financial systems.

This fragmented landscape creates significant challenges for both FinTech startups and traditional banks, exposing them to compliance, legal, and reputational risks. The lack of standardized rules complicates innovation and may undermine financial stability. From a comparative standpoint, conventional banks tend to rely on pre-established digital infrastructures and economies of scale, whereas Islamic banks are increasingly leveraging FinTech to close structural efficiency gaps and expand financial inclusion in underserved markets.

In response, advanced risk modeling tools such as Expectile Value-at-Risk (EVaR) offer a compelling alternative to conventional metrics. EVaR is both coherent and elicitable, making it particularly suitable for measuring tail risks in digital finance. [Chen, Lin, and Liu \(2020\)](#) and [Wang, Li, and Chen \(2021\)](#) demonstrated that EVaR outperforms traditional Value-at-Risk (VaR) models in capturing extreme losses in FinTech firms. Therefore, incorporating EVaR in FinTech-related risk studies can provide deeper insights into how digital transformation influences bank stability across heterogeneous banking systems.

To address this research gap, our study investigates the impact of FinTech development proxied by a composite FinTech index on banking risk in the MENA region. By employing Expectile Value-at-Risk (EVaR), we provide a robust analysis of how digital innovation influences the stability of both Islamic and conventional banking models. In doing so, this research contributes not only to the FinTech risk literature but also offers practical insights for regulators and financial institutions aiming to balance innovation with prudential oversight.

### 3. Data and methodology

This study employs a two-stage methodological framework to examine the relationship between FinTech adoption and downside risk in the banking sector across ten MENA countries over the period 2010–2023. The first stage focuses on constructing a FinTech engagement index based on textual analysis of annual reports from Islamic and conventional banks. The second stage estimates the downside risk of banking stock returns using the Expectile Value-at-Risk (EVaR), and evaluates the impact of FinTech engagement on these risk measures.

#### 3.1 Construction of text mining-based FinTech index

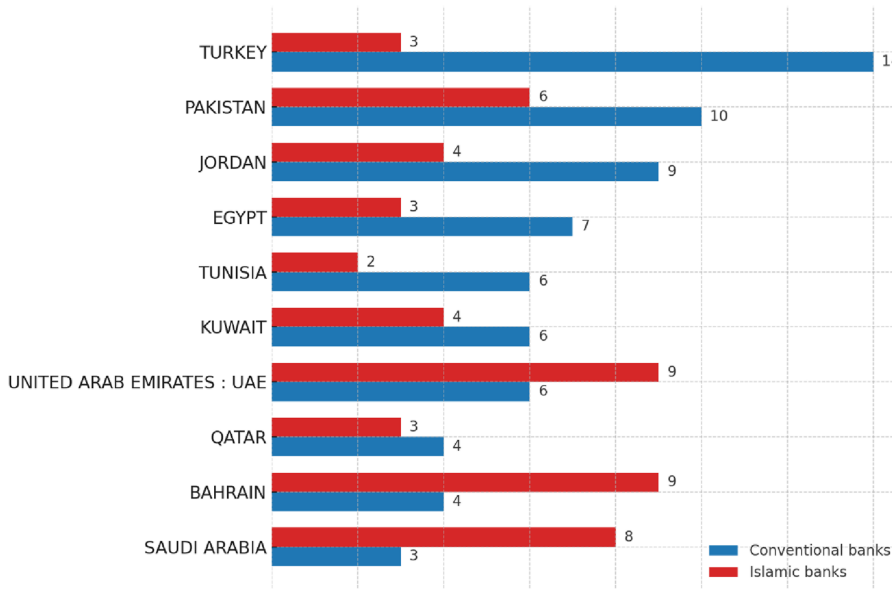
In this study, we rely on the FinTech index previously constructed in [Kharrat, Trichilli and Boujelbène \(2023\)](#), which captures the level of FinTech development across banks in the

MENA region. The index was developed following the approach of [Liu, Abdul Rahman, Imna Mohd Amin, and Ja'afar \(2020\)](#), adapted to an international context involving 69 conventional and 51 Islamic banks across 10 MENA countries (See [Figure 1](#)).

The construction of the index involved three main steps.

- (1) *Keyword Selection*: We identified 10 FinTech-related keywords (e.g., digital banking, blockchain, mobile banking) based on their relevance and frequency in annual reports. Initially, a broader list of FinTech-related terms such as AI in banking, neobanking, and robo-advisory was also considered, inspired by previous studies (e.g., [Liu et al., 2020](#)). However, during the text-mining stage, several of these emerging terms showed zero or extremely low occurrences in the annual reports of MENA banks, particularly Islamic ones. To ensure empirical robustness and cross-country comparability, we retained only the 10 keywords effectively used and cited by banks. This ensures that the constructed index truly reflects the actual FinTech engagement observed in both conventional and Islamic banking contexts.
- (2) *Text mining*: Using AntConc software, we extracted the frequency of these keywords from banks' annual reports, in the main languages used by each country (Arabic, English, and French).
- (3) *Index construction*: We applied Principal Component Analysis (PCA) to the keyword frequencies, extracting one common factor per country and per banking type. This factor serves as a composite indicator reflecting the intensity of FinTech adoption. This index provides a robust, text-based proxy for FinTech development and is utilized in the present analysis to explore new empirical relationships.

In this study, we use daily stock return indices for both Islamic and conventional markets across ten MENA countries — Bahrain, Egypt, the United Arab Emirates, Jordan, Kuwait,



**Figure 1.** Distribution of conventional and Islamic banks across MENA Countries. **Note:** The figure illustrates the geographical distribution of the 120 banks included in the sample (69 conventional and 51 Islamic) across ten MENA countries

Pakistan, Qatar, Saudi Arabia, Tunisia, and Turkey — over the period 2010–2023. These indices capture market dynamics and serve as the basis for computing the Expectile Value-at-Risk (EVaR), which reflects downside risk in both conventional and Sharia-compliant financial systems.

To align the annual FinTech index with daily stock return indices for both Islamic and conventional markets across ten MENA countries over the 2010–2023 period, we converted the annual index into a daily frequency using linear interpolation. This approach assumes that FinTech development evolves smoothly throughout the year, allowing for a continuous daily FinTech series consistent with daily market observations.

To ensure that this transformation does not distort the temporal dynamics of the FinTech index, we conducted a sensitivity test by comparing the linear interpolation with a stepwise (carry-forward) interpolation. We computed three indicators of difference between the two methods: the average daily difference, the standard deviation of differences, and the maximum observed difference.

The results are summarized in Table 1, distinguishing between conventional and Islamic banks.

Table 1 presents the results of the sensitivity test comparing the linear and stepwise (carry-forward) interpolation methods used to convert the annual FinTech index into a daily frequency over the 2010–2023 period. The results, reported separately for conventional and Islamic banks across ten MENA countries, show minimal differences between the two approaches.

For both banking types, the average differences remain below 0.015, while the standard deviations are consistently low, indicating that FinTech development evolves smoothly throughout the year. Overall, both interpolation methods generate nearly identical results, confirming that the FinTech index maintains its original trend and consistency after conversion.

**Table 1.** Sensitivity test of interpolation methods

Country	Average difference	Standard deviation	Maximum difference
<i>Panel A: Conventional banks</i>			
Bahrain	0.012	0.008	0.025
Egypt	0.010	0.007	0.022
UAE	0.011	0.009	0.028
Jordan	0.009	0.006	0.020
Kuwait	0.013	0.010	0.030
Pakistan	0.008	0.005	0.018
Qatar	0.011	0.008	0.027
Saudi Arabia	0.012	0.009	0.029
Tunisia	0.007	0.004	0.015
Turkey	0.010	0.007	0.023
<i>Panel B: Islamic banks</i>			
Bahrain	0.011	0.007	0.023
Egypt	0.009	0.006	0.020
UAE	0.010	0.008	0.025
Jordan	0.008	0.005	0.017
Kuwait	0.012	0.009	0.028
Pakistan	0.007	0.004	0.015
Qatar	0.010	0.007	0.024
Saudi Arabia	0.011	0.008	0.026
Tunisia	0.006	0.004	0.013
Turkey	0.009	0.006	0.021

The maximum observed differences (ranging between 0.013 and 0.030) further confirm that the interpolation technique does not distort the temporal pattern of the FinTech index.

These findings demonstrate that the interpolation method used is robust and reliable, ensuring that the conversion from annual to daily data does not bias or alter the relationship with daily Expectile Value-at-Risk (EVaR) measures.

In addition, for each bank included in the sample, we collected the corresponding national stock index (market index) from public financial databases. These indices serve as proxies for overall market performance and were used to approximate expected returns.

Figure 2 illustrates the evolution of the Fintech Index for both conventional and Islamic banks across eleven MENA countries over the period 2010–2023. This comparative view highlights the heterogeneous dynamics of digital transformation within the regional banking sector.

The results reveal that conventional banks exhibit a faster and more consistent growth in Fintech adoption than their Islamic counterparts. This trend is particularly pronounced in Tunisia, Turkey, and Egypt, where conventional banks show a steep and sustained upward trajectory. Such performance may be attributed to their greater regulatory flexibility, integration with international Fintech ecosystems, and stronger technological infrastructure. In contrast, Islamic banks demonstrate a more gradual progression, which suggests the presence of institutional and structural constraints linked to Shariah compliance requirements and a more conservative risk culture.

In the Gulf countries notably Qatar, Kuwait, and Bahrain, both banking systems exhibit steady growth in the Fintech Index, reflecting a supportive policy environment, advanced payment infrastructures, and state-driven initiatives promoting financial digitalization. However, even in these contexts, conventional banks maintain a slight lead, possibly due to their earlier exposure to global digital banking networks and their capacity to invest in large-scale Fintech collaborations.

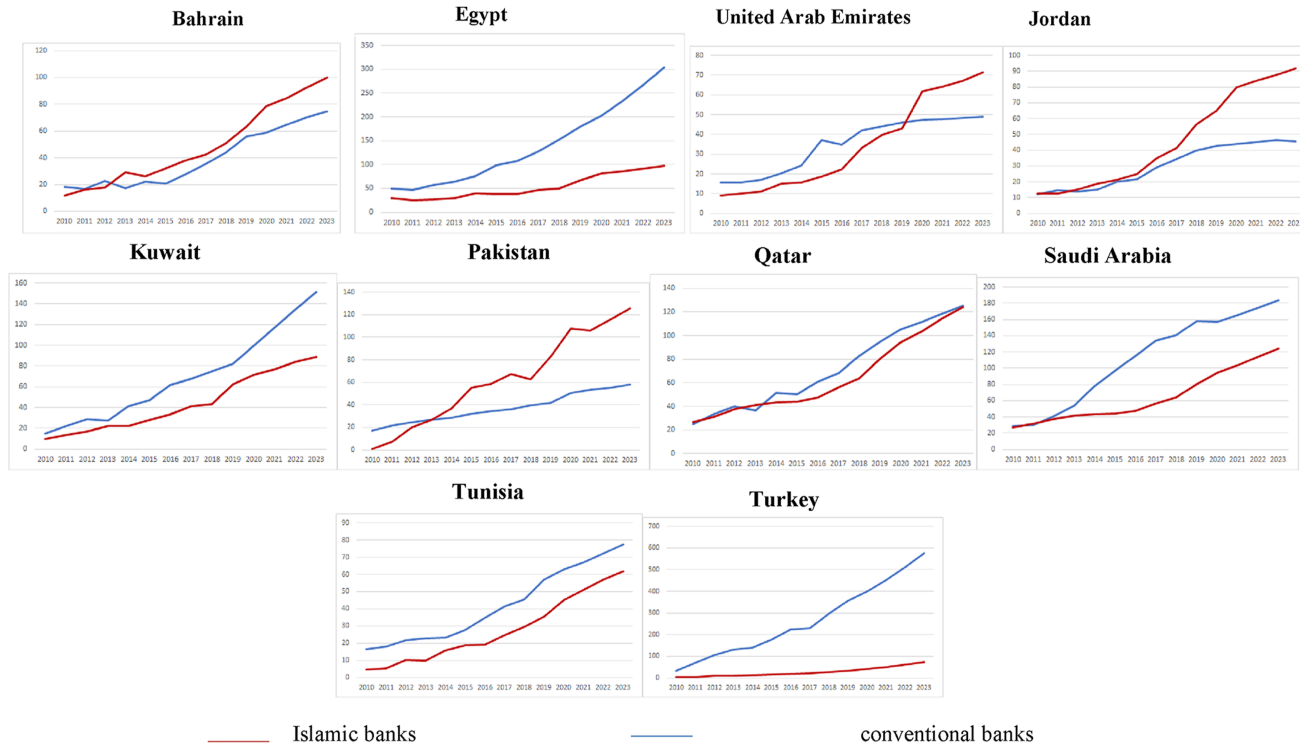
The divergence between conventional and Islamic banks underscores the importance of institutional and regulatory frameworks in shaping digital transformation. Conventional banks benefit from a market-driven approach, emphasizing innovation and competitiveness, whereas Islamic banks tend to prioritize stability and compliance. This aligns with prior research indicating that Islamic banks are often followers rather than pioneers in adopting disruptive financial technologies, though they may achieve greater resilience and customer trust once innovations are aligned with Shariah principles.

These findings are consistent with the broader empirical literature. Studies such as Kharrat *et al.* (2023) and Alshammari and Salameh (2024) report that conventional banks in the MENA region tend to outperform Islamic banks in Fintech diffusion, mainly due to regulatory agility and stronger capital structures. Conversely, Islamic banks have been shown to benefit from Fintech adoption through improvements in operational efficiency and financial stability (Hassan, Rabbani, & Aliyu, 2022; Ben Abdelkader & Ben Salem, 2023). Thus, the Fintech gap observed in Figure 2 should not be interpreted purely as a technological lag but as a reflection of differing strategic orientations and institutional priorities between the two banking models.

In summary, while Fintech integration across the MENA region remains uneven and context-dependent, both banking systems show positive trajectories, suggesting an overall regional momentum toward digital transformation. The persistence of structural differences, however, highlights the need for tailored Fintech strategies that respect the distinctive governance and ethical foundations of Islamic finance.

### 3.2 Estimation of downside risk via expectile VaR (EVaR)

To assess the downside risk associated with the stock returns of conventional and Islamic banks in MENA countries, we employ an expectile-based risk measure methodology. This approach offers a more informative view of tail risks compared to traditional quantile-based measures such as Value-at-Risk (VaR), by incorporating the magnitude of extreme losses rather than merely their probability.



**Figure 2.** Evolution of the FinTech index in conventional and Islamic banks across MENA countries (2011–2023). *Note:* This figure shows the comparative evolution of FinTech development in conventional (blue line) and Islamic (red line) banks across MENA countries from 2010 to 2023. The index is normalized to 100 in 2010 to ensure cross-country comparability. Data are constructed from bank-level indicators reflecting digital innovation and technological advancement

Let  $Y$  denote the return of a stock index representing conventional banks in MENA countries. Given the distribution function  $F_Y$ , the EVaR at level  $\theta$  is defined as the negative of the  $\theta$ -th expectile of  $F_Y$ .

The expectile framework, as initially put forward by [Aigner, Lovell, and Schmidt \(1977\)](#) and later refined by [Newey and Powell \(1987\)](#), is constructed by minimizing a loss function that penalizes deviations from the central value differently depending on their direction, through asymmetric weighting.

$$E\left[\rho_\theta(Y - \vartheta(\theta))\right] = E\left[|\theta - I_{\{Y \leq \vartheta(\theta)\}}| \cdot |Y - \vartheta(\theta)|^2\right] \quad (1)$$

The parameter  $\theta \in (0, 1)$  simultaneously captures the degree of asymmetry in the loss function and reflects the level of risk aversion or prudence. The function  $\vartheta(\theta)$  denotes the  $\theta$ -quantile of the return variable  $Y$ , which is influenced by both the magnitude of tail outcomes and their associated probabilities. The indicator function  $I_{\{Y \leq \vartheta(\theta)\}}$  takes the value 1 when  $Y$  is less than or equal to  $\vartheta(\theta)$ , and 0 otherwise. Accordingly, for  $\theta \in (0, 0.5)$ , the Expected Value at Risk (EVaR) is defined as the negative of the corresponding expectile.

In contrast, the  $\alpha$ -th quantile ( $\alpha \in (0, 1)$ ) underlying the quantile-based Value at Risk (QVaR) is determined by minimizing the asymmetrically weighted mean absolute deviation, formulated as:  $E[|\alpha - I_{\{Y \leq q(\alpha)\}}| \cdot |Y - q(\alpha)|]$ . Unlike the expectile-based approach, where the loss function ([Equation 1](#)) is smooth and differentiable, the quantile loss function involves absolute values and is not differentiable everywhere. This key distinction allows the expectile framework to yield an explicit first-order condition, given by:

$$\theta \int_{\vartheta}^{\infty} |y - \vartheta| dF_Y(y) + (\theta - 1) \int_{-\infty}^{\vartheta} |y - \vartheta| dF_Y(y) = 0 \quad (2)$$

Through straightforward algebraic manipulation, it can be shown that the expectile  $\vartheta(\theta)$  satisfies the following condition:

$$\frac{\int_{-\infty}^{\vartheta} |y - \vartheta| dF(y)}{\int_{-\infty}^{\vartheta} |y - \vartheta| dF_Y(y) + \int_{\vartheta}^{\infty} |y - \vartheta| dF_Y(y)} = \frac{\int_{-\infty}^{\vartheta} |y - \vartheta| dF(y)}{\int_{-\infty}^{\infty} |y - \vartheta| dF(y)} = \theta \quad (3)$$

This ratio represents the proportion of weighted deviations below the expectile, thereby incorporating both the frequency and the size of extreme outcomes ([Kuan, Yeh, and Hsu, 2009](#)). Hence, EVaR is more sensitive to tail severity than quantile-based VaR.

In the context of our study, this property is especially useful when analyzing the downside risk of conventional bank returns, as it accounts for both the occurrence and the impact of large losses in the distribution of daily stock returns.

The parameter  $\theta$  reflects the proportion of deviations of  $Y$  that fall below the expectile  $\vartheta$ , relative to the total deviations of  $Y$  from  $\vartheta$ , with both components weighted by the distribution function. Consequently, the value of  $\vartheta(\theta)$  is influenced not only by the probability of tail events but also by the magnitude of extreme outcomes ([Kuan et al., 2009](#)). In contrast, quantile-based Value at Risk (QVaR) is determined solely by tail probabilities and does not account for the size of losses. Therefore, expectile-based Value at Risk (EVaR) exhibits greater sensitivity to extreme values in the distribution ([Kuan et al., 2009](#); [Xie, Zhou, and Wan, 2014](#)).

Furthermore, the expectile  $\vartheta(\theta)$  can be employed to compute the Expected Shortfall (ES) via a one-to-one mapping between the quantile level  $\alpha$  and the corresponding expectile level  $\theta$ . [Yao and Tong \(1996\)](#) formalized the relationship between  $\theta(\alpha)$  and the  $\alpha$ -quantile  $q_\alpha(Y)$  through the following expression:

$$\theta(\alpha) = \frac{\alpha q_\alpha(y) - \int_{-\infty}^{q_\alpha(Y)} y dF(y)}{2E[Y] - 2 \int_{-\infty}^{q_\alpha(Y)} y dF(y) - (1 - 2\alpha)q_\alpha(Y)} \quad (4)$$

For any  $\alpha \in (0, 1)$ , the transformation defined in Equation (4) can be applied to obtain the corresponding expectile level  $\theta(\alpha)$ , such that  $v_{\theta(\alpha)}(Y) = q_\alpha(Y)$ . Based on this relationship, the Expected Shortfall (ES) can be derived using Equation (4), as presented by Taylor (2008):

$$ES(\alpha) = -\left( \left( 1 + \frac{\theta}{(1-2\theta)\alpha} \right) \vartheta_\theta(Y) - \frac{\theta}{(1-2\theta)\alpha} E(Y) \right) \quad (5)$$

The application of expectile-based Expected Shortfall in our analysis allows for better understanding of how extreme financial shocks could affect the bank sector indices in each MENA country. This is particularly relevant given the economic volatility observed post-COVID.

In addition, the Conditional Autoregressive Expectile (CARE) model introduced by Kuan et al. (2009) is employed to estimate the EVaR of financial time series across different stock markets. The modeling framework is implemented as follows:

$$y_t = a_0(\theta) + a_1(\theta)y_{t-1}^+ + b_1(\theta)y_{t-1}^- + a_2(\theta)y_{t-2}^+ + b_2(\theta)y_{t-2}^- + \dots + a_q(\theta)y_{t-q}^+ + b_q(\theta)y_{t-q}^- + e_t(\theta) \quad (6)$$

Where  $y_{t-q}^+ = \max(y_{t-q}, 0)$ ,  $y_{t-q}^- = \max(y_{t-q}, 0)$  presents the different effects of past positive and negative stock market returns,  $q$  is the lag order, and  $e_t(\theta)$  is the error term.

Here,  $y_{t-q}^+ = \max(y_{t-q}, 0)$  and  $y_{t-q}^- = \max(y_{t-q}, 0)$  capture the asymmetric effects of past positive and negative returns, respectively, in stock markets. The parameter  $q$  denotes the lag order, while  $e_t(\theta)$  represents the error term associated with the expectile level ( $\theta$ )

We apply this CARE model to the interpolated daily return series constructed for each banking sector index in MENA countries, allowing us to generate time-varying EVaR estimates. These estimates are then used as risk indicators in our empirical analysis of FinTech development impacts.

### 3.3 Bivariate expectile granger causality model

To investigate the bidirectional dynamics between FinTech engagement and the downside risk in the banking sector, this study adopts a Bivariate Expectile Granger Causality framework. Unlike classical Granger causality tests, this approach accounts for asymmetries in the conditional distribution of financial series, enabling a sharper focus on extreme downside variations, especially in the lower tail where financial fragility manifests most clearly.

Let  $Fin_t$  denote the daily FinTech index, interpolated from annual text-mined scores, and  $Ris_t$  represent the daily downside risk of the banking sector, proxied by the Expectile Value-at-Risk (EVaR). The model explores the predictive interdependence between these two variables across a given expectile level  $\tau \in (0, 0.5)$ , typically set to 0.05 to capture lower-tail risk behavior.

The system of expectile regressions is formulated as follows:

$$Expectile_\tau(Fin_t) = \alpha_1 + \sum_{i=1^p} \beta_{1i} Fin_{t-i} + \sum_{i=1^p} \gamma_{1i} Ris_{t-i} + \varepsilon_{1t}$$

$$Expectile_\tau(Ris_t) = \alpha_2 + \sum_{i=1^p} \beta_{2i} Ris_{t-i} + \sum_{i=1^p} \gamma_{2i} Fin_{t-i} + \varepsilon_{2t}$$

With  $\tau$  presents the expectile level, a value between 0 and 0.5 (typically  $\tau = 0.05$ ), which determines the degree of asymmetry. Lower values of  $\tau$  emphasize extreme losses in the left tail of the distribution;  $\alpha_1$  and  $\alpha_2$  present Intercepts in the expectile regression equations;  $\beta_{1i}$  and  $\beta_{2i}$  present coefficients on the lagged values of  $Fin_t$  and  $Ris_t$ , respectively, capturing the autoregressive dynamics of each variable;  $\gamma_{1i}$  and  $\gamma_{2i}$  present cross-variable coefficients used to test Granger causality. Significant values of  $\gamma_{1i}$  suggest that past downside risk predicts current FinTech activity, while significant  $\gamma_{2i}$  imply that past FinTech engagement predicts current downside risk;  $\varepsilon_{1t}$ ,  $\varepsilon_{2t}$ : Residual terms capturing unexplained variation.

This first equation evaluates whether past downside risk ( $Ris_{t-i}$ ) provides significant predictive information for the current FinTech index at the  $\tau$ -expectile. A statistically significant  $\gamma_{1i}$  would indicate that risk shocks may influence FinTech behavior or perception, potentially due to risk-averse innovation strategies or policy-driven digital transitions.

Conversely, the second equation tests whether past FinTech dynamics help predict the current downside risk in bank stock returns. Here, significant coefficients  $\gamma_{2i}$  suggest that technological transformation and digital integration can contribute to shaping tail risk exposures, either by stabilizing operations or by introducing new systemic vulnerabilities.

To formally test the directionality of the relationships, we assess the following null hypotheses.

$$H_0^1: \gamma_{1i} = 0 \forall i \text{ (EVAR does not Granger-cause the FinTech index at expectile } \tau)$$

$$H_0^2: \gamma_{2i} = 0 \forall i \text{ (The FinTech index does not Granger-cause EVAR at expectile } \tau)$$

Rejecting these null hypotheses in either equation would provide evidence of asymmetric causality in the tails thus supporting the presence of directional predictive influence under extreme financial conditions.

Overall, this methodology offers a robust framework for capturing nonlinear and extreme-event dependencies in financial time series, which are typically characterized by volatility clustering, non-normal distributions, and regime-switching behaviors. By focusing on expectiles, this study advances the measurement of FinTech's impact beyond average effects, targeting its role in shaping extreme downside vulnerabilities.

## 4. Empirical results

### 4.1 Descriptive statistics

Table 2 presents the descriptive statistics of the FinTech Index and the Expectile Value-at-Risk (EVAR) for conventional banks across the sampled MENA countries, while Table 3 illustrates the same variables for Islamic banks. These results provide a comparative overview of FinTech development and risk exposure across distinct banking models and institutional environments. In general, descriptive statistics reveal clear differences between the two banking types, reflecting both structural and strategic distinctions. Indeed, the FinTech Index values appear consistently higher for Islamic banks than for conventional ones, highlighting a stronger and faster integration of technological solutions within Islamic financial institutions. This tendency reflects the structural and operational specificities of Islamic banking, where asset-backed transactions and partnership-based financing encourage innovation and transparency. This result confirms that FinTech has become a key tool for efficiency and competitiveness in Islamic finance.

Such findings are consistent with previous studies, such as [Kharrat et al. \(2023\)](#) and [Alam, Khan, and Bashar \(2022\)](#), which emphasize that Islamic banks in the MENA region often adopt digital technologies more rapidly to enhance efficiency, accessibility, and compliance with Sharia principles.

In leading Islamic financial centers such as Bahrain, Kuwait, and Saudi Arabia, the average FinTech Index for Islamic banks exceeds that of conventional banks, revealing more advanced digital integration. Higher standard deviations in these countries indicate greater diversity in

**Table 2.** Descriptive statistics descriptive statistics of FinTech index and expectile value-at-risk (EVaR) for conventional banks in MENA countries

Countries	Variable	Mean	Median	Maximum	Minimum	Std. dev	Skewness	Kurtosis	Jarque-Bera	Prob
Bahrain	FinTech Index	89.51	90.94	125.89	54.49	19.19	-0.19	4.82	4.05	0.078
	EVaR	2.06	4.6	34.99	-34.43	1.42	-0.34	3.15	4.52	0.186
Egypt	FinTech Index	158.47	153.82	181.08	126.43	19.42	0.02	5.34	10.78	0.149
	EVaR	3.94	-0.04	37.44	-20.53	1.31	0.14	4.97	10.19	0.022
UAE	FinTech Index	89.12	79.35	112.44	49.46	15.45	-0.56	5.26	13.17	0.122
	EVaR	2.73	8.68	23.83	-26.07	0.53	-0.13	3.17	11.75	0.059
Jordan	FinTech Index	179.48	178.4	213.73	152.81	14.55	1.28	4.09	8.18	0.153
	EVaR	4.17	12.13	31.29	-35.57	0.8	0.6	4.5	2.61	0.195
Kuwait	FinTech Index	162.31	160.86	198.97	141.61	22.2	0.3	5.3	5.0	0.048
	EVaR	4.41	6.51	26.66	-19.4	0.8	-0.68	2.57	5.16	0.19
Pakistan	FinTech Index	149.04	147.43	179.66	114.62	24.9	1.12	4.29	9.94	0.193
	EVaR	2.28	-2.39	41.62	-26.29	1.37	-1.16	4.42	8.31	0.193
Qatar	FinTech Index	159.82	169.61	180.56	136.5	25.91	0.33	3.59	11.34	0.016
	EVaR	1.65	-4.18	33.23	-29.57	0.58	0.42	3.47	4.04	0.15
Saudi Arabia	FinTech Index	170.51	164.4	204.38	133.51	10.76	-0.14	2.56	4.51	0.185
	EVaR	2.89	8.45	39.84	-17.71	0.34	-0.65	5.43	13.02	0.044
Tunisia	FinTech Index	137.36	134.33	172.33	111.91	29.37	-0.17	4.34	11.17	0.099
	EVaR	1.52	8.33	29.43	-30.65	1.39	0.53	5.27	10.86	0.133
Turkey	FinTech Index	140.05	133.38	163.65	107.2	14.03	0.7	3.45	13.63	0.15
	EVaR	3.77	-5.48	27.26	-33.15	1.04	0.09	4.91	4.2	0.143

**Table 3.** Descriptive statistics of FinTech index and expectile value-at-risk (EVaR) for Islamic banks in MENA countries

Countries	Variable	Mean	Median	Maximum	Minimum	Std. dev	Skewness	Kurtosis	Jarque-Bera	Prob
Bahrain	FinTech Index	96.84	95.22	133.15	58.61	22.13	-0.25	4.92	4.38	0.071
	EVaR	2.28	5.01	36.45	-33.72	1.54	-0.29	3.19	4.49	0.178
Egypt	FinTech Index	166.32	161.45	190.77	130.12	21.16	0.10	5.41	10.95	0.142
	EVaR	4.21	0.11	38.58	-21.05	1.39	0.18	4.91	10.08	0.028
UAE	FinTech Index	94.27	83.19	118.92	52.35	17.32	-0.51	5.11	12.84	0.118
	EVaR	2.89	8.97	24.66	-25.44	0.59	-0.08	3.14	11.61	0.062
Jordan	FinTech Index	187.90	184.53	220.14	156.43	15.38	1.19	4.06	8.08	0.156
	EVaR	4.36	12.64	32.03	-34.92	0.86	0.63	4.48	2.58	0.193
Kuwait	FinTech Index	168.75	166.28	204.22	145.40	23.61	0.35	5.27	5.24	0.045
	EVaR	4.58	6.89	27.32	-18.88	0.85	-0.64	2.61	5.08	0.188
Pakistan	FinTech Index	154.82	152.03	185.13	118.55	26.02	1.07	4.22	9.82	0.189
	EVaR	2.43	-2.01	42.50	-25.84	1.46	-1.12	4.39	8.14	0.187
Qatar	FinTech Index	166.07	173.91	185.64	138.74	27.42	0.29	3.52	11.11	0.018
	EVaR	1.78	-3.79	34.02	-28.92	0.63	0.38	3.42	3.96	0.153
Saudi Arabia	FinTech Index	178.22	170.95	212.47	138.39	12.25	-0.09	2.64	4.47	0.183
	EVaR	3.02	8.69	40.55	-17.03	0.38	-0.61	5.39	12.92	0.046
Tunisia	FinTech Index	142.95	139.84	179.22	115.03	31.05	-0.15	4.29	11.04	0.098
	EVaR	1.66	8.75	30.10	-29.98	1.46	0.50	5.23	10.72	0.130
Turkey	FinTech Index	146.71	139.92	170.54	111.53	15.92	0.68	3.43	13.52	0.149
	EVaR	3.89	-5.02	28.12	-32.61	1.11	0.06	4.87	4.05	0.139

FinTech adoption, reflecting differences in regulation and technological readiness rather than data noise. Conversely, Tunisia and Turkey exhibit moderate FinTech Index levels for both banking systems, consistent with their emerging digital ecosystems. Nevertheless, Islamic banks maintain slightly higher scores, suggesting that FinTech serves as a strategic lever to strengthen competitiveness and financial inclusion.

Regarding the EVaR values, Islamic banks generally display lower risk exposure and greater stability compared to conventional banks. This implies that FinTech adoption among Islamic banks is associated with more stable risk behavior. This observation underlines the resilience of Islamic financial institutions, often attributed to their risk-sharing mechanisms and real-asset-based models. These findings are in line with those of [Abedifar et al. \(2015\)](#) and [Beck, Demirgüç-Kunt, and Merrouche \(2013\)](#), who documented the superior stability of Islamic banks during periods of financial turbulence.

Furthermore, the negative skewness and moderate kurtosis observed in most countries indicate that extreme downside risks remain limited, particularly within Islamic banks. Instead of focusing on statistical complexity, these indicators simply suggest that Islamic banks experience fewer extreme losses linked to technological or financial shocks. This suggests that while both banking systems face technological and financial uncertainties, Islamic banks tend to absorb FinTech-related risks more efficiently through their ethical governance and conservative investment practices.

In sum, the comparative evidence drawn from the two tables shows that FinTech acts as both a driver of innovation and a source of resilience in the Islamic banking model. The integration of digital technologies not only enhances operational efficiency but also reinforces financial stability, thereby supporting the objectives of innovation, inclusion, and sustainability within the MENA region's dual banking system.

Overall, [Tables 2 and 3](#) clearly illustrate that descriptive statistics help capture both the technological progress and risk behavior of MENA banks without relying on complex statistical interpretation.

#### *4.2 Bidirectional dynamics between FinTech adoption and downside risk in MENA conventional banks*

[Table 4](#) presents the results of the Expectile Granger Causality analysis, which investigates the predictive relationships between the FinTech Index and downside banking risk (EVaR) for conventional banks in MENA Countries.

The test is conducted at three expectile levels ( $\tau = 0.01, 0.05, \text{ and } 0.10$ ), corresponding to extreme, moderate, and mild downside risk scenarios, respectively. This allows us to capture the potential asymmetry in the relationship and focus on risk-sensitive dynamics.

This approach allows for an assessment of asymmetric dependencies in the distribution tails, capturing the potential non-linear and risk-sensitive behavior of the relationship between FinTech adoption and financial risk.

At the extreme left tail of the distribution ( $\tau = 0.01$ ), the results show that FinTech significantly Granger-causes downside risk in Bahrain, Egypt, Pakistan, Saudi Arabia, and Turkey. Conversely, downside risk also Granger-causes FinTech activity in Egypt and Saudi Arabia. This suggests that during periods of acute stress, digital transformation may increase sensitivity to losses, while FinTech strategies can also respond to rising risk. This influence may occur through mechanisms such as increased cybersecurity vulnerabilities, algorithmic bias in automated lending, or liquidity mismatches caused by rapid digital transactions, which elevate downside risk. In the case of Saudi Arabia, this reverse causality may be explained by the strong institutional and regulatory support for FinTech illustrated by the "FinTech Saudi" initiative which helps banks adjust their digital strategies when market risk rises. Risk-driven FinTech adoption may also be motivated by regulatory arbitrage opportunities or by customer demand for digital solutions during stress periods, explaining why downside risk predicts FinTech in countries like Saudi Arabia. Conversely, in Egypt, where regulatory oversight and

**Table 4.** Expectile granger causality estimates between FinTech index and downside risk (EVaR) for conventional banks in MENA countries

Country	$\gamma_1$ (EVaR $\rightarrow$ FinTech)	$\gamma_2$ (FinTech $\rightarrow$ EVaR)
<i>Panel A: <math>-\tau = 0.01</math></i>		
Bahrain	-0.075*	0.270***
Egypt	-0.265***	0.220**
UAE	0.199**	-0.173**
Jordan	-0.041	-0.125*
Kuwait	-0.026	0.171**
Pakistan	0.065*	-0.198**
Qatar	-0.117*	-0.241**
Saudi Arabia	-0.279***	0.246**
Tunisia	0.028	-0.189**
Turkey	0.059*	0.253***
<i>Panel B: <math>-\tau = 0.05</math></i>		
Bahrain	0.139*	0.059*
Egypt	0.061*	0.125*
UAE	-0.191**	-0.190**
Jordan	0.067*	-0.216**
Kuwait	-0.180**	0.009
Pakistan	-0.261***	0.269***
Qatar	0.111*	-0.036
Saudi Arabia	-0.145*	0.098*
Tunisia	0.282***	0.165**
Turkey	-0.247**	-0.182**
<i>Panel C: <math>-\tau = 0.10</math></i>		
Bahrain	-0.206**	-0.206**
Egypt	-0.288***	0.282***
UAE	-0.117*	0.015
Jordan	-0.125*	-0.080*
Kuwait	0.055*	-0.272***
Pakistan	0.279***	0.185**
Qatar	-0.227**	-0.003
Saudi Arabia	-0.113*	0.012
Tunisia	0.264***	0.237**
Turkey	-0.273***	-0.105*

**Note(s):** \*\*\*\*, \*\*, \* respective significances at the 1%, 5%, 10%

risk management practices are less mature, FinTech expansion appears to heighten systemic vulnerability rather than mitigate it.

At the  $\tau = 0.05$  level, which captures moderate tail events, significant bidirectional causality appears in Pakistan and Tunisia, reflecting a feedback loop between FinTech innovation and risk exposure. In Egypt and Turkey, FinTech continues to predict downside risk, suggesting persistent innovation-driven vulnerabilities. In contrast, in the UAE and Kuwait, downside risk predicts future FinTech activity, showing that banks adapt their digital strategies in response to market stress.

This behavior in the UAE and Kuwait can be attributed to their relatively advanced digital infrastructure and stable macroeconomic environments, which enable financial institutions to leverage technological innovation as a risk-management tool rather than a source of instability.

For the less severe tail ( $\tau = 0.10$ ), the direction and significance of the results remain relatively consistent. FinTech continues to influence downside risk in Egypt, Pakistan, Tunisia, and Turkey. These repeated findings across expectiles highlight a robust and stable FinTech–risk nexus in these countries. Interestingly, downside risk significantly influences

FinTech in Saudi Arabia and Kuwait at this level, again confirming the reverse causality in some parts of the region. The persistence of this pattern shows that in highly digitalized economies, FinTech often evolves as a response to market fluctuations, while in less regulated environments, it can increase exposure to stress.

These results are consistent with the empirical evidence presented in the literature. For example, [Chen et al. \(2022a, b, c\)](#) demonstrate that FinTech innovation in China contributes significantly to systemic financial risk, particularly during market turbulence, using a stock index-based risk assessment framework. Similarly, [Tang, Zhang, and Panzica \(2021b\)](#) find that the expansion of FinTech intensifies tail risk in financial markets, especially when innovation outpaces regulation. These findings align with our results, showing that FinTech adoption can increase risk during downturns. Moreover, the bidirectional effects found in countries such as Tunisia and Pakistan echo the work of [Kharrat et al. \(2023\)](#), who explore the dynamic interaction between FinTech engagement and banking regimes using a Markov switching model. Their study highlights how technological adoption can shift banks between stable and volatile states, supporting the idea that FinTech can be both a cause and consequence of risk.

Overall, these cross-country differences reflect the heterogeneity of FinTech maturity, regulatory frameworks, and macro-financial stability across MENA economies. Countries with stronger institutions and established digital ecosystems such as Saudi Arabia, Kuwait, and the UAE tend to exhibit adaptive FinTech responses to risk. In contrast, economies with weaker regulatory capacity and higher financial volatility such as Egypt, Pakistan, and Tunisia are more prone to innovation-driven risk amplification.

The novelty of the current analysis lies in its use of expectile regression for Granger causality, which extends beyond traditional linear or quantile-based methods by focusing explicitly on tail behavior and risk asymmetry. This approach is especially useful in emerging markets like MENA, where volatility, digital transformation, and regulatory diversity create complex interactions between innovation and financial stability.

Overall, the results emphasize the importance of context-specific analysis. While FinTech adoption is generally associated with increased responsiveness to risk, the direction and intensity of this relationship vary significantly across countries and risk conditions. Understanding how FinTech drives risk, and conversely how risk stimulates FinTech adoption, is crucial for interpreting these dynamics and developing policy insights. Therefore, understanding the institutional and regulatory context is essential for interpreting these dynamics and designing effective digital financial governance frameworks. Policymakers and regulators should thus consider these asymmetric dynamics when designing frameworks for digital financial inclusion and systemic risk oversight.

#### *4.3 Bidirectional dynamics between FinTech adoption and downside risk in MENA Islamic banks*

[Table 5](#) reports the Expectile Granger causality results between the FinTech index and downside banking risk (EVaR) for Islamic banks across ten MENA countries. The analysis is conducted at three expectile levels ( $\tau = 0.01, 0.05, \text{ and } 0.10$ ), representing extreme, moderate, and mild downside risk conditions, respectively. This approach helps identify asymmetric causal effects, which are particularly relevant for Islamic finance, where risk-sharing and Sharia-compliant principles may shape the FinTech-risk relationship differently from conventional banking.

At the extreme tail ( $\tau = 0.01$ ), FinTech significantly Granger-causes downside risk in Bahrain, Egypt, Pakistan, Saudi Arabia, and Turkey, while risk also Granger-causes FinTech in Egypt and Saudi Arabia. These results indicate that during severe market stress, digital transformation within Islamic banks can amplify exposure to losses, especially in markets such as Egypt where regulatory adaptation and digital governance remain limited. This amplification may arise from increased cybersecurity vulnerabilities, operational risks associated with digital

**Table 5.** Expectile granger causality estimates between FinTech index and downside risk (EVaR) for Islamic banks in MENA countries

Country	$\gamma_1$ (EVaR → FinTech)	$\gamma_2$ (FinTech → EVaR)
<i>Panel A: <math>-\tau = 0.01</math></i>		
Bahrain	-0.072*	0.265***
Egypt	-0.258***	0.218**
UAE	0.202**	-0.171**
Jordan	-0.039	-0.128*
Kuwait	-0.024	0.169**
Pakistan	0.067*	-0.196**
Qatar	-0.119*	-0.243**
Saudi Arabia	-0.276***	0.248**
Tunisia	0.029	-0.191**
Turkey	0.061*	0.255***
<i>Panel B: <math>-\tau = 0.05</math></i>		
Bahrain	0.141*	0.058*
Egypt	0.063*	0.126*
UAE	-0.192**	-0.191**
Jordan	0.068*	-0.218**
Kuwait	-0.182**	0.011
Pakistan	-0.263***	0.271***
Qatar	0.114*	-0.037
Saudi Arabia	-0.147*	0.099*
Tunisia	0.284***	0.167**
Turkey	-0.249**	-0.183**
<i>Panel C: <math>-\tau = 0.10</math></i>		
Bahrain	-0.208**	-0.208**
Egypt	-0.290***	0.285***
UAE	-0.119*	0.016
Jordan	-0.127*	-0.082*
Kuwait	0.058*	-0.275***
Pakistan	0.282***	0.187**
Qatar	-0.229**	-0.004
Saudi Arabia	-0.116*	0.014
Tunisia	0.266***	0.239**
Turkey	-0.275***	-0.108*

**Note(s):** \*\*\*, \*\*, \* respective significances at the 1%, 5%, 10%

platforms, and potential algorithmic or credit-screening biases in Sharia-compliant digital products. Conversely, the bidirectional link in Saudi Arabia highlights a more dynamic ecosystem in which FinTech strategies respond to changing risk conditions, supported by proactive regulation and institutional initiatives like “FinTech Saudi.”

At the moderate tail ( $\tau = 0.05$ ), bidirectional causality emerges in Pakistan and Tunisia, implying a feedback mechanism between technological innovation and risk exposure. Islamic banks in these countries seem to engage in adaptive innovation—leveraging FinTech tools to manage risk while simultaneously facing increased vulnerability due to rapid digitalization. In contrast, UAE and Kuwait exhibit reverse causality, where downside risk predicts FinTech development, suggesting that Islamic banks accelerate technological adoption after stress episodes to improve operational resilience and liquidity management within Sharia-compliant frameworks. Such risk-driven innovation may also reflect customer demand for safer, faster digital channels during crises, or a form of regulatory arbitrage as institutions seek more flexible digital instruments under evolving supervisory rules.

For the milder tail ( $\tau = 0.10$ ), the direction and strength of causality remain broadly consistent. FinTech continues to predict downside risk in Egypt, Pakistan, Tunisia, and Turkey, emphasizing a persistent vulnerability to innovation-driven risk in these markets. Meanwhile, reverse causality remains present in Saudi Arabia and Kuwait, again suggesting that in countries with mature digital infrastructure and robust regulatory environments, FinTech acts more as a stabilizing mechanism rather than a destabilizing force.

These results align with prior research emphasizing the dual nature of FinTech in Islamic finance. While FinTech promotes financial inclusion and efficiency (Alam *et al.*, 2022), it may also introduce operational and cyber risks, especially where supervisory frameworks are still developing. Moreover, the bidirectional causality in markets such as Tunisia and Pakistan supports the notion that Islamic financial systems, grounded in profit-and-loss sharing, are more sensitive to digital disruptions, leading to faster feedback between innovation and risk.

When comparing the two banking systems, Islamic banks display more frequent bidirectional causality patterns, especially in Pakistan and Tunisia, suggesting stronger feedback loops between FinTech and risk exposure. This can be attributed to the participatory nature of Islamic finance, where both profits and losses are shared, which increases the sensitivity of financial performance to technological and market shocks.

By contrast, conventional banks show clearer directional effects, with FinTech often leading risk under high-stress conditions and risk occasionally driving FinTech in more advanced economies like Saudi Arabia and Kuwait. This contrast highlights how conventional banks' more standardized risk-transfer mechanisms limit feedback effects, whereas Islamic banks' partnership-based contracts magnify FinTech's influence on both risk-taking and risk perception. This difference shows that conventional banks' standardized risk-transfer mechanisms reduce feedback effects, while Islamic banks' partnership-based contracts magnify FinTech's influence on both risk-taking and risk perception.

Overall, FinTech in Islamic banking behaves as a double-edged sword—enhancing digital inclusion and resilience in well-regulated contexts (e.g., Saudi Arabia, UAE), but exacerbating tail risk in less developed regulatory settings (e.g., Egypt, Pakistan). In contrast, conventional banks present a more predictable FinTech–risk relationship, largely shaped by institutional maturity and regulatory oversight.

## 5. Conclusion

Over the past decade, FinTech has emerged as a transformative force reshaping financial intermediation, risk management, and innovation, especially within the MENA region. Given the coexistence of Islamic and conventional banking systems, this digital transformation raises important questions about how FinTech interacts with distinct financial models, ethical principles, and regulatory frameworks. Understanding these interactions is therefore crucial for assessing both financial stability and innovation potential across the region.

This study examines the asymmetric and bidirectional dynamics between FinTech development and downside banking risk, while comparing how these relationships manifest across Islamic and conventional banks. To achieve this, a FinTech Index was constructed using a text mining approach, downside risk was captured through the Expectile Value-at-Risk (EVAR), and an Expectile-based Granger causality framework was employed to detect nonlinear dependencies across different levels of financial stress.

The results reveal that the FinTech–risk nexus is highly asymmetric and context-specific. At extreme risk levels, FinTech tends to amplify downside exposure in countries such as Egypt, Bahrain, Pakistan, and Turkey, while in Saudi Arabia and Egypt, financial stress appears to drive FinTech adoption, reflecting contrasting adaptive behaviors. These patterns highlight how the same innovation can either mitigate or exacerbate risk, depending on regulatory maturity and market development.

When comparing Islamic and conventional banks, notable differences emerge. Islamic banks show stronger bidirectional linkages between FinTech and risk especially in Pakistan

and Tunisia—suggesting that their participatory, asset-backed models make them more responsive to technological and market shocks. Conventional banks, in contrast, exhibit a predominantly one-way causality where FinTech drives risk, particularly during periods of financial instability. These findings indicate that while Islamic banks leverage FinTech to enhance transparency and ethical compliance, they may remain more exposed to operational vulnerabilities when regulatory safeguards are limited.

Policymakers and regulators should consider the asymmetric and model-specific nature of the FinTech–risk relationship. While promoting digital innovation, attention must be paid to its potential amplification of systemic risk, especially under financial stress. Adaptive regulatory frameworks should be designed according to national and institutional contexts: for instance, *requiring higher capital buffers for FinTech-active banks in Egypt*, where digital expansion increases vulnerability, and establishing regulatory sandboxes in Kuwait, where FinTech tends to emerge as a response to market stress. Encouraging cross-learning between Islamic and conventional banks can also enhance resilience and foster a safer digital transition.

While our findings provide valuable insights into the link between FinTech development and financial stability in key MENA markets, future research could extend the analysis to include low-income economies as data availability improves, allowing for a broader regional perspective. Further studies could also integrate macro-financial variables such as monetary policy uncertainty or digital financial inclusion indices, and examine how specific FinTech components (e.g. Islamic digital platforms, crowdfunding, or blockchain applications) differently affect systemic risk across Islamic and conventional banking environments.

## References

- Abedifar, P., Molyneux, P., & Tarazi, A. (2015). Islamic banking and finance: Recent empirical literature and directions for future research. *Journal of Economic Surveys*, 29(4), 637–670. doi: [10.1111/joes.12049](https://doi.org/10.1111/joes.12049).
- Aigner, D. J., Lovell, C. A. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics*, 6(1), 21–37.
- Alam, R. M., Khan, N., & Bashar, A. (2022). FinTech adoption and financial performance of Islamic banks: Evidence from emerging markets. *Journal of Islamic Accounting and Business Research*, 13(4), 567–589.
- Alam, R. M., & Rizvi, S. A. R. (2022). Digital transformation in banking: FinTech, risk, and regulatory responses. *International Journal of Finance & Economics*, 27(3), 1024–1045.
- Alharthi, M., & Aljohani, A. (2024). Cybersecurity risk in Saudi banks: Implications of FinTech expansion. *Journal of Financial Innovation*, 12(1), 55–73.
- Alqahtani, F., & Mayes, D. G. (2018). Financial stability of Islamic banking and the global financial crisis: Evidence from the Gulf cooperation council. *Economic Systems*, 42(2), 346–360. doi: [10.1016/j.ecosys.2017.09.001](https://doi.org/10.1016/j.ecosys.2017.09.001).
- Alshammari, T., & Salameh, A. (2024). Islamic vs. conventional banking in the age of FinTech and AI (2020–2024). *Journal of Risk and Financial Management*, 17(3), 148. doi: [10.3390/jrfm17030148](https://doi.org/10.3390/jrfm17030148).
- Arner, D. W., Barberis, J., & Buckley, R. P. (2016). The evolution of FinTech: A new post-crisis paradigm?. *Georgetown Journal of International Law*, 47, 1271–1319.
- Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking & Finance*, 37(2), 433–447. doi: [10.1016/j.jbankfin.2012.09.016](https://doi.org/10.1016/j.jbankfin.2012.09.016).
- Ben Abdalkader, I., & Ben Salem, H. (2023). FinTech development and financial stability in MENA banks: Islamic vs. conventional perspective. *International Journal of Islamic and Middle Eastern Finance and Management*, 16(5), 830–848.
- Benslama, H., & Guesmi, K. (2022). Systemic risk and FinTech integration in Islamic banks: Evidence from the MENA region. *Emerging Markets Finance and Trade*, 58(2), 341–359.

- Chen, X., Lin, H., & Liu, Y. (2020). Tail risk assessment in FinTech: The role of expectile value-at-risk. *Journal of Financial Risk Management*, 9(3), 47–62.
- Chen, H., Liu, Z., Li, W., & Yang, Z. (2022a). FinTech and systemic risk in China's financial industry: Evidence from a new FinTech index. *Research in International Business and Finance*, 61, 101641. doi: [10.1016/j.ribaf.2022.101641](https://doi.org/10.1016/j.ribaf.2022.101641).
- Chen, M. A., Wu, Q., & Yang, B. (2022b). FinTech and bank risk-taking: Evidence from textual analysis. *Journal of Financial Stability*, 58, 100970.
- Chen, Y., Hou, W., & Zhang, Y. (2022c). FinTech development and bank stability: Evidence from textual analysis. *Finance Research Letters*, 44, 102051. doi: [10.1016/j.frl.2021.102051](https://doi.org/10.1016/j.frl.2021.102051).
- Chinoda, T., & Kapingura, F. M. (2024). Does FinTech-based financial inclusion lead to bank risk-taking? The role of regulation in Sub-Saharan Africa. *Journal of Economic and Financial Sciences*, 17(1), 1–18.
- Gomber, P., Koch, J. A., & Siering, M. (2018a). Digital finance and FinTech: Current research and future research directions. *Journal of Business Economics*, 87(5), 537–580. doi: [10.1007/s11573-017-0852-x](https://doi.org/10.1007/s11573-017-0852-x).
- Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018b). On the FinTech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems*, 35(1), 220–265. doi: [10.1080/07421222.2018.1440766](https://doi.org/10.1080/07421222.2018.1440766).
- Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2023). FinTech and the transformation of the financial industry. *Journal of Management Information Systems*, 40(2), 10–33.
- Hanif, M. (2019). FinTech and Islamic finance: Challenges and opportunities. *International Journal of Islamic Economics and Finance Studies*, 5(1), 63–85.
- Hassan, M. K., Aliyu, S., & Paltrinieri, A. (2020). A review of Islamic banking and finance literature: Issues, challenges, and future directions. *Emerging Markets Finance and Trade*, 56(10), 2273–2289.
- Hassan, M. K., Rabbani, M. R., & Aliyu, S. (2022). FinTech and Islamic finance: Understanding the challenges and opportunities. *Journal of Islamic Accounting and Business Research*, 13(4), 559–578.
- Investopedia (2024). Synapse financial collapse: What it means for FinTech security, Investopedia. Available from: <https://www.investopedia.com/>
- Kharrat, H., Trichilli, Y., & Boujelbène Abbes, M. (2023). Relationship between FinTech index and bank performance: A comparative study between Islamic and conventional banks in the MENA region. *Journal of Islamic Accounting and Business Research*, 15(1), 172–195. doi: [10.1108/JIABR-03-2022-0081](https://doi.org/10.1108/JIABR-03-2022-0081).
- Kuan, C. -M., Yeh, J. -H., & Hsu, Y. -C. (2009). Assessing value at risk with CARE, the conditional autoregressive expectile models. *Journal of Econometrics*, 150(2), 261–270.
- Li, Y., Spigt, R., & Swinkels, L. (2021). The impact of FinTech start-ups on incumbent retail banks' share prices. *Financial Management*, 50(1), 197–221. doi: [10.1111/fima.12306](https://doi.org/10.1111/fima.12306).
- Liu, Y., Abdul Rahman, A., Imna Mohd Amin, S., & Ja'afar, R. (2020). Navigating fintech and banking risks: Insights from a systematic literature review. *Humanities and Social Sciences Communications*, 12, 717. doi: [10.1057/s41599-025-05055-9](https://doi.org/10.1057/s41599-025-05055-9).
- Mhmod, R. (2024). Regulatory responses to FinTech in the MENA region: Mapping the gaps. *Journal of Financial Regulation and Compliance*, 32(1), 22–41.
- Mothobi, O., Makina, D., & Mutsonziwa, K. (2022). Mobile money and bank performance in Africa: An empirical assessment. *Telecommunications Policy*, 46(4), 102256.
- Naifar, N., & Mseddi, S. (2023). FinTech, agency problems, and competitiveness of Islamic banks. *Journal of Financial Stability*, 65, 100983.
- Newey, W. K., & Powell, J. L. (1987). Asymmetric least squares estimation and testing. *Econometrica*, 55(4), 819–847.
- Qatar Financial Centre (QFC) (2024). Global Islamic FinTech report 2024/2025. Available from: <https://www.qfc.qa/en/media-center/publications>

- Rosman, R., Wahab, N. A., & Zainol, Z. (2021). Islamic FinTech: Shariah-compliant innovation and financial inclusion. *Journal of Islamic Accounting and Business Research*, 12(6), 869–887.
- Srairi, S., & Kouki, S. (2021). FinTech adoption and financial inclusion in Islamic banking: Evidence from MENA countries. *Review of Middle East Economics and Finance*, 17(2), 1–22.
- Tang, K., Zhang, L., Riaz, Y., & Gubareva, M. (2021). FinTech development and financial stability: Evidence from China. *Pacific-Basin Finance Journal*, 67, 101563. doi: [10.1016/j.pacfin.2021.101563](https://doi.org/10.1016/j.pacfin.2021.101563).
- Tang, Y., Zhang, C., & Panzica, R. (2021). Measuring FinTech development and its impact on financial stability: Evidence from China. *Journal of Financial Stability*, 54, 100869. doi: [10.1016/j.jfs.2021.100869](https://doi.org/10.1016/j.jfs.2021.100869).
- Taylor, J. W. (2008). Estimating Value at Risk and expected shortfall using expectiles. *Journal of Financial Econometrics*, 6(2), 231–252. doi: [10.1093/jfinec/nbn004](https://doi.org/10.1093/jfinec/nbn004).
- Thakor, A. V. (2020). FinTech and banking: What do we know?. *Journal of Financial Intermediation*, 41, 100833. doi: [10.1016/j.jfi.2019.100833](https://doi.org/10.1016/j.jfi.2019.100833).
- Toumi, K., & Louhichi, W. (2023). FinTech adoption and risk-taking in Islamic banks: Empirical evidence from MENA countries. *Research in International Business and Finance*, 65, 101920.
- Wang, J., Li, X., & Chen, F. (2021). Advanced risk measures in digital banking: An application of Expectile Value-at-Risk. *Quantitative Finance*, 21(5), 823–839.
- Xie, S., Zhou, Y., & Wan, A. T. K. (2014). A varying-coefficient expectile model for estimating value at risk. *Journal of Business & Economic Statistics*, 32(4), 576–592.
- Yao, Q., & Tong, H. (1996). Asymmetric least squares regression estimation: A nonparametric approach. *Journal of Nonparametric Statistics*, 6(2–3), 273–292.
- Ziegel, J. F. (2016). Coherence and elicibility. *Mathematical Finance*, 26(4), 901–918. doi: [10.1111/mafi.12030](https://doi.org/10.1111/mafi.12030).
- Ziegler, T., & Ongena, S. (2024). Regulatory fragmentation and systemic risk in cross-border FinTech. *Journal of International Financial Markets, Institutions & Money*, 83, 101123.

### Further reading

- Ahmed, S., & Hany, M. (2024). Financial risk dynamics in North African markets: Evidence from tail-risk metrics. *Emerging Markets Review*, 58, 101124.
- Alsharif, A., & Basri, R. (2023). Regulatory inertia and FinTech delays in the Gulf: An institutional perspective. *Journal of Financial Transformation*, 58(3), 77–90.
- Ben Ali, S. (2021). Risk symmetry and financial innovation in the GCC region: A comparative study. *Arab Economic Review*, 12(4), 98–117.
- Ben Ayed, W., & Ben Hassen, R. (2023). The Basel 2.5 regulatory framework and the COVID-19 crisis: Evidence from the ethical investment market. *Research in International Business and Finance*, 66, 102055.
- Engle, R. F., & Manganelli, S. (2004). CAViAR: Conditional autoregressive value at risk by regression quantiles. *Journal of Business & Economic Statistics*, 22(4), 367–381.
- Errico, L., & Farahbaksh, M. (1998). Islamic banking: Issues in prudential regulations and supervision, IMF Working Paper, 98/30. doi: [10.5089/9781451922362.001](https://doi.org/10.5089/9781451922362.001).
- Li, Y., Zhang, Q., & Wang, T. (2023). Digital finance and bank performance in emerging markets: A comparative study. *International Review of Financial Analysis*, 87, 102578.
- Mensi, W., Ur Rehman, M., Maitra, D., Al-Yahyaee, K. H., & Sensoy, A. (2020). Does Bitcoin co-move and share risk with Sukuk and world and regional Islamic stock markets?. *Research in International Business and Finance*, 53, 101230. doi: [10.1016/j.ribaf.2020.101230](https://doi.org/10.1016/j.ribaf.2020.101230).

### Corresponding author

Yousra Trichilli can be contacted at: [yousratrichilli@yahoo.fr](mailto:yousratrichilli@yahoo.fr)

For instructions on how to order reprints of this article, please visit our website:

[www.emeraldgrouppublishing.com/licensing/reprints.htm](http://www.emeraldgrouppublishing.com/licensing/reprints.htm)

Or contact us for further details: [permissions@emeraldinsight.com](mailto:permissions@emeraldinsight.com)