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EXCHANGE RATES AND STOCK MARKET DYNAMICS: ISLAMIC VERSUS CONVENTIONAL FINANCIAL SYSTEMS

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ABSTRACT

This study investigates the changes and persistence in dynamic connectedness between stock market performance and exchange rate fluctuations, comparing conventional and Islamic financial systems. With an eye on a global financial landscape characterized by the integration of capital markets and the adoption of floating exchange rate regimes, it examines the effects of exchange rate variations on the dynamics of the stock market in nine different countries - the United Kingdom, Australia, Japan, Singapore, Canada, China, India, Korea, and South Africa. The study employs daily data spanning from November 2015 to July 2023 and uses a comprehensive analysis of three-step methodology, including nonparametric causality-in-quantiles tests, asymmetric slope Conditional Autoregressive Value-at-Risk (CAViaR), and Time-Varying Parameter Vector Autoregressive (TVP-VAR) Connectedness measure. Our results underline the asymmetric impact of exchange rate fluctuations on stock markets and highlights the distinctive characteristics of Islamic financial markets. Comparing Islamic and conventional stock markets in the context of exchange rate fluctuations, this study not only serves to fill a gap in the existing literature but also emphasizes the significance of currency exchange rate swings for global investors, policymakers, and practitioners trying to understand the intricacies of global financial markets.

Keywords: Exchange rates, Stock markets, Islamic finance, Nonparametric causality, Tail risk connectedness, Financial integration.
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I. INTRODUCTION

Following the adoption of floating exchange rate regimes by many countries, scholars have devoted significant effort to examining the association between stock markets and currency rates. Significant scholarly attention has also been sparked by the global financial system's greater integration, which has facilitated capital flows across countries (Huang et al., 2021; Hussain et al., 2024; Phylaktis & Ravazzolo, 2005; Tsai, 2012). Understanding the relationship between these two markets is critical for domestic policymaking and portfolio reallocation (Reboredo et al., 2016), given the potential for shocks in one market to rapidly spread to the other, affecting the domestic economy through various contagious channels (Chkili & Nguyen, 2014; Sensoy & Sobaci, 2014).

The goods market or flow-oriented model (Aggarwal, 1981; Dornbusch & Fischer, 1980) and the portfolio balance or stock-oriented model (Branson, 1983; Branson & Henderson, 1985; Frankel, 1983) are two theories that have been proposed to explain the relationship between exchange rates and stock markets. According to the first theory put forth by Dornbusch and Fischer in 1980, changes in exchange rates affect trade competitiveness, which in turn affects real output and stock prices. On the other hand, the stock-oriented approach by Branson (1983), asserts that adjustments to capital accounts have an effect on stock market fluctuations, which in turn affects the exchange rate market.

Despite decades of research, there is still no consensus on the relationship between conventional stock prices and exchange rates (Granger et al., 2000; Phylaktis & Ravazzolo, 2005; Smyth & Nandha, 2003). Studies can be categorized into three groups based on their findings: one-way causal relationship from stock prices to exchange rates (Doong et al., 2005; Granger et al., 2000; Hatemi-J & Roca, 2005), one-way causal relationship from exchange rates to stock prices (Doong et al., 2005; Pan et al., 2007), and bidirectional relationship between them (Bahmani-Oskooee & Sohrabian, 1992). Others find no such relationship (Granger et al., 2000; Nieh & Lee, 2001; Smyth & Nandha, 2003). These extensive efforts, however, have been mostly restricted to limited comparisons of conventional stock markets when investigating the relationship between exchange rates and stock markets. The emergence of Islamic finance as an alternative model has gained significant attention due to its unique characteristics, such as the prohibition of usury and its focus on risk-sharing (Narayan & Phan, 2017; Mustapha et al., 2017; Rashid et al., 2014).

Islamic stock markets have shown remarkable resilience during financial crises, attributed to their adherence to Shariah principles and lower credit risk profiles. Research has consistently demonstrated the ability of Islamic equities to withstand global financial crises, making them an attractive option for investors seeking safe havens in times of uncertainty. Despite this, there remains a lack of comprehensive studies on Islamic markets, with the exception of the notable work by Erdoğan et al. (2020).

In addition to the mentioned lack of comprehensive studies on Islamic markets, another much debated question is the disparities between Islamic and conventional financial systems which call for special attention. In this vein, a few studies (Ghroubi, 2023; Hassan et al., 2022) highlight a persistent gap that can be observed in investment behaviour, fundamental principles, and uncertainty management.

According to Azmat et al. (2020), investing in traditional finance can result in higher market volatility and a greater appetite for risk as it emphasizes the goal of maximising profits through investments that generate interest and speculative trading (see also Khan, 2020). Islamic finance, by contrast, operates on ethical principles that prioritise risk-sharing and strict adherence to Shariah guidelines and, it is strictly prohibited to engage in any form of interest, speculation, or ambiguity (Polyzos et al., 2023). In addition, Islamic investors participate in profit-and-loss sharing arrangements, such as Mudarabah and Musharakah, to ensure a fair allocation of risks and rewards among stakeholders. These agreements play a vital role in reducing uncertainty for investors as this Islamic financing involves tangible assets and legitimate economic activities, with a focus on promoting stability and ensuring a fair distribution of risks in the economy (Elnahas et al., 2017).

The expansion of the Islamic financial system has sparked interest in studying the relationship between Islamic stock indices and exchange rates. In this vein, with a presence in over 60 countries, the Islamic financial markets have experienced significant growth (an annual growth rate of approximately 10.3% with the global market capitalization reaching US$3.50 trillion in 2020) (Sherif, 2020). Additionally, the Islamic funds market has seen remarkable growth, with assets under management nearing $200 billion by 2022[1], as reported by the Bahrain-based General Council for Islamic Banks and Financial Institutions (CIBAFI). Moreover, these markets are attractive to investors due to their resilience during financial crises (Akhtar & Jahromi, 2017) and the perception of Islamic indexes as "safe havens." Understanding the flow of information between conventional and Islamic indexes can aid investors in forming successful trading strategies and leveraging diversification advantages. The stock exchange is heavily impacted by exchange rates, which has led to a number of research investigating the relationship between economic fundamentals and Islamic stock exchanges (Majid, 2016; Sakti & Harun, 2015). Addressing the knowledge gap regarding how Islamic and non-Islamic stock markets respond to changes in exchange rates is the main aim of this study.

Our study distinguishes itself from previous studies in three main aspects. First, unlike previous literature that primarily analyzes the impact of exchange rate fluctuations on conventional stock market returns, our study places greater emphasis on understanding the impact on both types of markets. Second, we employ nonparametric causality-in-quantiles test, which combines the k-th order causality test and the causality-in-quantiles test, to analyze exchange rate-induced stock market price movements, addressing a gap in understanding the foreign exchange market's impact on stocks. This test can verify causality in mean and variance for higher-order dependencies and resists misspecification errors. Third, we examine financial market tail risk transmission using an asymmetric slope Conditional Autoregressive Value-at-Risk (CAViaR) and TVP-VAR Connectedness indicator. This analysis aids in developing effective hedging strategies and understanding market behavior during severe events. Finally, this study contributes by pioneering an investigation into the relationship between these variables utilizing daily data spanning the period November 2015 to July 2023.

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1 https://www.reuters.com/markets/funds/global-islamic-funds-market-grows-300-decade-report-2022-01-26/

II. LITERATURE REVIEW

According to Dornbusch & Fischer (1980), real output and stock prices are affected by trade competitiveness, which is impacted by exchange rate swings. Depreciation of the local currency lowers the cost of exporting goods, which may boost exporting companies' sales and foreign demand. On the other hand, exporters suffer from a rise in the value of the local currency, which lowers stock prices and sales (Bashir et al., 2016; Hussain & Bashir, 2013; Pan et al., 2007; Phylaktis & Ravazzolo, 2005; Rai & Garg, 2022). The dynamics are different for importing businesses, where an appreciation (depreciation) of the local currency enhances (diminishes) firm value. Meanwhile, the stock-oriented approach suggests that changes in capital accounts are a means through which stock market movements impact the exchange rate market. According to the portfolio balance approach (Branson, 1983; Frankel, 1983), international investors adjust their asset holdings when anticipating changes in a country's currency value to minimize portfolio losses, thereby affecting the flow of funds into or out of the stock market. Therefore, a flourishing stock market attracts capital flows from foreign investors, influencing a country's currency (Aggarwal, 1981; Tsai, 2012). Foreign investment in a country's equity securities may increase due to the benefits of international diversification and a less risky investment climate. Decreases in stock prices diminish domestic investors' wealth, resulting in decreased money demand, lower interest rates, and increased capital outflow, leading to national currency depreciation (Granger et al., 2000). Additionally, the asset market effect proposed by (Frenkel, 1976) posits no relationship between the two markets, indicating complete segmentation.

A large number of prior studies have used a variety of estimation techniques, including GARCH model (Zhao, 2010), vector error correction models and cointegration (Acikalin et al., 2008), linear and non-linear autoregressive distributed lag model (ARDL) (Mohamed & Elmahgop, 2020; Sheikh et al., 2020), Johansen cointegration and Granger causality test (Brahmasrene & Jiranyakul, 2007), wavelets (He et al., 2023), Copulas (Kumar et al., 2019), and de-trended cross-correlation analysis (DCCA) (Bashir et al., 2016), and TVP-VAR (Huang et al., 2021). However, these techniques are not sufficient to provide a thorough understanding of the foreign exchange-stock market nexus. To be specific, stock prices may react differently to exchange rate shocks depending on market situation (bullish, normal or bearish time). Additionally, it could be time-varying and nonlinear (Al-Shboul & Anwar, 2014; Priestley & Ødegaard, 2007).

This suggests that stock markets may respond differently to changes in exchange rates. This is in line with an asymmetric (nonlinear) relationship between the considered variables found in previous research (e.g., Chang et al., 2020). Arming with the mentioned facts, we aim to address the gap in the literature by examining the asymmetric impact of exchange rates on Islamic and conventional stock markets in nine selected markets. The research employs a three-step technique to provide robust empirical results that can be beneficial for global businesses, investors, and governments.

III. DATA AND METHODOLOGY

3.1. Data

In this study, the impact of exchange rate fluctuations on both conventional and Islamic stock markets is analyzed. The data used for the analysis are sourced from Datastream and cover the period from November 25, 2015, to July 25, 2023. Daily log-returns of these variables are used in the estimation computed as $\ln\left(\frac{P_t}{P_{t-1}}\right) \times 100$. Conventional and Islamic stock markets are represented by the MSCI index for nine countries: Australia, Canada, China, India, Japan, Korea, Singapore, South Africa, and the United Kingdom. These countries are chosen based on data availability and variations in economic size and the presence of pegged exchange rate. These countries vary in their development level, growth rate, and financial market maturity. The UK, Australia, Japan, Singapore, and Canada are considered developed markets, while China, India, Korea, and South Africa are classified as emerging markets. Variations in capital market liberalization and control are also noted, with some countries having minimal restrictions on foreign investments while others impose stricter regulations, as detailed in Table 1.

Table 1.
Description of Selected Markets

Country	Trade as % of GDP-2021 (Trade balance)	Exchange rate arrangement*	Capital Control*
Japan	36.94053 (-158.67)	Freely floating	None
China	37.30199 (567.33)	Currency Board Arrangement	Strong
Australia	39.87005 (97.2)	Freely Floating- Inflation targeting framework	None
India	45.66768 (-135.97)	Managed Floating	Strong
Africa	56.21798 (8.4)	Freely Floating- Inflation targeting framework	Moderate
UK	58.87499 (-111.29)	Freely Floating- Inflation targeting framework	None
Canada	61.86942 (4.03)	Freely Floating- Inflation targeting framework	None
South Korea	80.49234 (9.51)	Freely Floating- Inflation targeting framework	Moderate
Singapore	333.3396 (169.18)	Managed Floating	None

Source: *https://www.imf.org/external/pubs/ft/wp/2015/wp1580.pdf

3.2. Empirical Methodology

Using a three-step technique, this study examines how exchange rates can transmit high tail risk to Islamic and conventional stock indexes. First, we use the Value at Risk (VaR) direct estimation strategy using the asymmetric slope CAViaR (Conditional Autoregressive Value at Risk) method proposed by Engle & Manganelli (2004). Then, we illustrate extreme downside risk spillover using the notion of Granger causality in risk, first presented by Hong et al. (2009). We achieve this by combining the k-th order nonparametric causality test by Nishiyama et al. (2011) with the causality-in-quantiles test by Jeong et al. (2012), and applying the nonparametric causality-in-quantiles test by Balcilar et al. (2016, 2017). With this method, one can investigate the causal relationship between mean and variance, identifying higher-order dependencies within the time series under investigation. This is important because there is a possibility that higher-order interdependencies will persist during times when causality in the conditional mean does not exist. In the third step, we build a topological network using the framework by Diebold & Yilmaz (2014) and evaluate risk connectivity between the series using a TVP-VAR (Time-Varying Parameter Vector Autoregressive) model as in Antonakakis et al. (2018, 2019, 2020). Instead of concentrating on price return or overall volatility, we examine the dynamic transmission of tail risk, represented by the VaR measure, using an asymmetric slope CAViaR TVP-VAR Connectedness measure created by Chatziantoniou et al. (2022). Tail risk connectedness aids in the understanding of extreme event spillovers. It highlights uncertainty contagion within variable networks, crucial for understanding exposure to losses and contagion effects in financial markets. The three-step methodological approach is described below.

3.2.1. Conditional Autoregressive Value-at-Risk (CAViaR)

We depart from conventional methods by using the direct estimation approach for Value-at-Risk (VaR). This method, particularly the slope CAViaR approach, accommodates asymmetric effects, a feature absent in other methods like the symmetric absolute value method and the indirect GARCH (1,1) approach. Following the seminal work of Engle & Manganelli (2004), the asymmetric slope CAViaR model assumes that the VaR of a certain quantile follows an Autoregressive (AR) process written as:

$$f_{\tau,t}(\beta) = \beta_0 + \beta_1 f_{\tau,t-1}(\beta) + \beta_2 y_{t-1}^{+} + \beta_3 y_{t-1}^{-} \tag{1}$$

In equation (1), $f_{\tau,t}$ represents the VaR at the τ level in period t. The constant β_0, along with β_1 and $f_{\tau,t-1}(\beta)$, are the weights assigned to the VaRs and the lagged VaRs, respectively. The effects of positive and negative returns on the VaR are denoted as β_2 and β_3, respectively

For a time series of daily returns $R_{it} \in \{ER, Islamic, Conv\}$, the downside VaR ($VaR_{it}^{down}$) can be written as

$$\tau^{\mathrm{down}} = \Pr\{R_{it} < VaR_{it}^{\mathrm{down}} | \zeta_{i,t-1}\} \tag{2}$$

where $\zeta_{i,t-1} = \{y_{is}, s<t\}$ denotes the information up to time t.

3.2.2. Granger Causality Across Quantiles

In this study, we aim to analyze the spread of significant downside risk in a specific series using a method introduced by Hong et al. (2009). This method focuses on Granger causality in risk, allowing us to examine the relationships between the left tails of two distributions. We argue that this approach is more suitable for understanding extreme downside risk transmission in financial markets compared to the conventional Granger causality in variance approach. Additionally, we consider an extension proposed by Candelon and Tokpavi (2016) that offers a multivariate perspective, enabling us to detect Granger causality across the entire distribution of two-time series.

For a given set of quantiles denoted as $T^{down} = \{\tau_1^{down}, K, \tau_{m+1}^{down}\}$ of $m + 1$ quantiles encompassing the left-tail regions of the distribution support with $0 \leq \tau_1^{down} < L < \tau_m^{down} \leq 0.1$; we divide the $\{R_{it}\}$ into m distinct intervals using the parameters of downside VaRs, such as $f_{\tau,t}(\tau_1^{down}|\zeta_{i,t-1}) < L < f_{\tau,t}(\tau_{m+1}^{down}|\zeta_{i,t-1})$. Afterward, one could proceed to define a vector

$$H_{it}^{down} = (Z_{it,1}^{down}, k,\ Z_{it,m}^{down})' \tag{3}$$

Where $Z_{it,k}^{down} = \boldsymbol{\Gamma}\{f_{it}(\tau_k^{down}) \leq R_{it} \boldsymbol{\Upsilon} f_{it}(\tau_k^{down})\}, k = \boldsymbol{\Gamma}, k, m$. And $\boldsymbol{\Gamma}\{\cdot\}$ signifies the indicator function.

Similarly, in a corresponding manner, considering the set $T^{up} = \{\tau_1^{up}, K, \tau_{m+1}^{up}\}$ and the condition $0.9 \leq \tau_1^{up} < L < \tau_{m+1}^{up} \leq 1$, which encompasses the right-tail regions of the distribution support, the indicator function for assessing upside risk is defined as $Z_{it,k}^{up} = \boldsymbol{\Gamma}\{f_{it}(\tau_k^{up}) \leq R_{it} \boldsymbol{\Upsilon} f_{it}(\tau_{k+1}^{up})\}$. Subsequently, we take a step further to construct a vector that includes all the pertinent variables associated with upside risk as

$$H_{it}^{up} = (Z_{it,1}^{up}, k, Z_{it,m}^{up})' \tag{4}$$

Based on Eq.3 and Eq.4, we proceed to examine the repercussions of risk spillovers through the evaluation of a specific instance of Granger causality. To facilitate this test, we utilize widely recognized τ-levels for Value-at-Risk (VaR). Specifically, T^{down}={0.01,0.05,0.1} for measuring downside risk, while for assessing upside risk, we employ T^{up}={0.9,0.95,0.99}.

To investigate the potential influence of exchange rate downside risks on the corresponding downside risks of series (Islamic and Conv.) known as **down-to-down risk spillover**, the null hypothesis pertaining to Granger causality across quantiles is formulated as follows:

$$H_0: E\left(H_{series,\,t}^{down} \middle| \zeta_{series,t-1}^{down}, \zeta_{ER,t-1}^{down}\right) = E\left(H_{series,\,t}^{down} \middle| \zeta_{series,t-1}^{down}\right) \tag{5}$$

and the alternative is

$$H_1: E\left(H_{series,\,t}^{down} \middle| \zeta_{series,t-1}^{down}, \zeta_{ER,t-1}^{down}\right) \neq E\left(H_{series,\,t}^{down} \middle| \zeta_{series,t-1}^{down}\right) \tag{6}$$

The presence of down-to-down risk spillover is substantiated when H1 is confirmed. Moreover, if there are lagged effects indicating the transmission of downside risk spillovers from the ER to series returns, it implies that a decline in the ER's risk can be utilized to predict the future downturn risk in series returns. In a similar vein, the analysis of **up-to-up risk spillover** is to test the null hypothesis:

$$H_0: E\left(H^{up}_{series,\,t} \middle| \zeta^{up}_{series,\mathrm{t}-1}, \zeta^{up}_{ER,\mathrm{t}-1}\right) = E\left(H^{up}_{series,\,t} \middle| \zeta^{up}_{series,\mathrm{t}-1}\right) \tag{7}$$

Holding of H_0 signifies the influence of upside risks in the ER on the upside risks of stock returns is deemed statistically insignificant.

Nevertheless, these two categories of risk interdependency are classified as positive spillover effects, a characterization that assumes a default correlation of positive returns between markets. In contrast, concerning negative spillover effects, we conduct tests for down-to-up and up-to-down risk spillovers. Specifically, the down-to-up risk spillover assesses the impact of ER's downside risk on the subsequent upside risk of stock returns, while the up-to-down risk spillover evaluates the effect of ER's upside risk on the ensuing downside risk of stock returns. The null hypotheses corresponding to **down-to-up** and **up-to-down risk spillover** are formulated as follows:

$$H_0: E\left(H^{up}_{series,\,t} \middle| \zeta^{\mathrm{up}}_{series,\mathrm{t}-1}, \zeta^{down}_{ER,\mathrm{t}-1}\right) = E\left(H^{up}_{series,\,t} \middle| \zeta^{up}_{series,\mathrm{t}-1}\right) \tag{8}$$

and

$$H_0: E\left(H^{down}_{series,\,t} \middle| \zeta^{down}_{series,\mathrm{t}-1}, \zeta^{up}_{ER,\mathrm{t}-1}\right) = E\left(H^{updown}_{series,\,t} \middle| \zeta^{down}_{series,\mathrm{t}-1}\right) \tag{9}$$

In the case of the down-to-up risk spillover, if H_0 is upheld, it signifies that the downside risk of ER does not possess predictive capabilities for the upside risk of stock returns. In contrast, rejecting H_0 implies that the downside risk of ER can indeed be employed to anticipate the upside risk of stock returns.

3.2.3. Nonparametric Causality-In-Quantiles

After identifying the dispersion of downside risk across the analyzed series, we shift focus to exploring the sensitivity of distributional predictability from ER to stock returns using a nonparametric causality-in-quantile approach by (Balcilar et al., 2016). The key advantage of this method lies in its ability to discern potential tail-dependence structures, capturing behaviors characteristic of fat-tailed distributions and mitigating the potential for model misconfigurations. Furthermore, we proceed to assess spillovers in volatility and investigate higher-order interdependencies through a causality-in-variance analysis. We then examine directional predictability across markets using the cross-quantilogram (CQ) correlation framework introduced by Han et al. (2016). This framework effectively measures extreme value dependencies and accommodates arbitrary quantiles and lag periods, enabling the detection of direction, strength, and duration of interrelationships among variables.

Following the seminal work of Jeong et al. (2012), it is established that the ER (y_i) does not cause the intended sector (x_i) in the 0<τ<1 quantile with respect to the lag vector of $\{y_{t-1},\ldots,y_{t-p},x_{t-1},\ldots,xt\text{-}p\}$ when

$$Q_\tau \left\{y_t \middle| y_{t-1}, \ldots, y_{t-p},\ x_{t-1}, \ldots, x_{t-p}\right\} = Q_\tau\left\{y_t \middle| y_{t-1}, \ldots, y_{t-p}\right\} \tag{10}$$

The alternative, however, hypothesizes that y_i presumably causes x_i in the τ quantile as for $\{y_{t-1},\ldots,y_{t-p},x_{t-1},\ldots,x_{t-p}\}$ when:

$$Q_\tau \left\{y_t \middle| y_{t-1}, \ldots, y_{t-p},\ x_{t-1}, \ldots, x_{t-p}\right\} \neq Q_\tau\left\{y_t \middle| y_{t-1}, \ldots, y_{t-p}\right\} \tag{11}$$

where $Q_\tau\ \{y_t \mid \cdot\}$ is the τ^{th} conditional quantiles of y_t depending on t.

Define the vectors $Y_{t-1}\equiv(y_{t-1},\ldots,y_{t-p})$, $X_{t-1}\equiv(x_{t-1},\ldots,x_{t-p})$ and $Z_t=(X_tY_t)$. The conditional distribution functions of y_t given Z_{t-1} and Y_{t-1} are respectively denoted as $F_{y_t|\,Z_{t-1}}(y_t, Z_{t-1})$ and $F_{y_t|\,Z_{t-1}}(y_t, Y_{t-1})$ and they are assumed to be absolutely continuous with respect to y_t for almost all Z_{t-1}. Accordingly, the hypotheses of interest based on the definitions in Eqs. (10) and (11) are

$$H_0{:}\, P\left\{F_{y_t|Z_{t-1}}\{Q_\tau(Y_{t-1})|Z_{t-1}\} = \tau\right\} = 1 \tag{12}$$

$$H_1{:}\, P\left\{F_{y_t|Z_{t-1}}\{Q_\tau(Y_{t-1})|Z_{t-1}\} = \tau\right\} < 1 \tag{13}$$

Where $Q_\tau\ (Z_{t-1})\equiv Q_\tau(y_t \mid z_{t-1})=\tau$ with probability one and $Q_\tau\ (Y_{t-1})\equiv Q_\tau(y_t \mid Y_{t-1})$.

Accordingly, the distance function can be itemized as

$$J = E\left[\left\{F_{y_t|z_{t-1}}\{Q_\tau(Y_{t-1}|z_{t-1})\} - \tau\right\}^2 f_z(Z_{t-1})\right] \tag{14}$$

Based on Eq. (14), J=0 if and only if H_0 is true, whereas H_1 is held if and only if J>0. The feasible kernel-based test statistic for J is given as

$$\hat{J}_T = \frac{1}{T(T-1)h^{2P}} \sum_{t=P+1}^{T} \sum_{i=P+1, i\neq t}^{T} K\left(\frac{Z_{t-1} - Z_{i-1}}{h}\right) \hat{\varepsilon}_t \hat{\varepsilon}_i \tag{15}$$

In Eq. (15), T represents the sample size, while P is the lag-order of the estimate regression $J=\{\varepsilon_t\ E(\varepsilon_t \mid Z_t\text{-}1)\ f_z\ (Z_{t-1})\}$. $K(\cdot)$ is the kernel function with bandwidth h. Finally, the estimate of the unknown regression error is $\hat{\varepsilon}_i=1\{y_t \leq Q_\tau\ (Yt\text{-}1)\text{-}\tau\}$.

Eq. (12) and Eq. (13) delineate that the causality within the fat tail of the first momentum (return) differs from that observed at the distribution's center. Moving to the second momentum (variance), Balcilar et al. (2016) adopt the nonparametric Granger-quantile-causality method introduced by Nishiyama et al. (2011), examining both linear and non-linear causality scenarios.

Assume a time series y_t a white noise process (ε_t) and unknowns' stationary function $g(\cdot)$ and $\sigma(\cdot)$ follow the process of the form:

$$y_t = g(Y_{t-1}) + \sigma(X_{t-1})\varepsilon_t \tag{16}$$

Eq. (16) holds significance for two distinct types of Granger-type causality examinations. The first type involves a linear causality scenario x_t to y_t. The second type pertains to a non-linear causality from x_t to y_t^2 given that $\sigma(\cdot)$ represents a generalized non-linear function. Consequently, Equation (16) can be reformulated to define both null and alternative hypotheses for causality in variance as follows:

$$H_0: P\left\{F_{y_t^2|Z_{t-1}}\{Q_\tau(Y_{t-1})|Z_{t-1}\} = \tau\right\} = 1 \tag{17}$$

$$H_1: P\left\{F_{y_t^2|Z_{t-1}}\{Q_\tau(Y_{t-1})|Z_{t-1}\} = \tau\right\} < 1 \tag{18}$$

A feasible test statistic is obtained by replacing y_t by y_t^2 in Eq. (16).

Flexibility exists to sequentially examine causality-in-variance as well as causality-in-mean and variance. However, it's crucial to note that a failure to reject the null hypothesis in Eq. (12) for causality-in-mean does not imply non-causality in the second moment, as indicated by Eq. (17), necessitating individual tests for causality-in-variance, as shown in Eq. (17).

Empirical execution of causality tests through quantiles requires specifying crucial factors: the bandwidth h,, the lag order P and the choice of kernel type for $K(\cdot)$ and $L(\cdot)$ in Equation (15). Lag order is determined using the Schwarz Information Criterion (SIC) within a Vector Autoregression (VAR) model encompassing ER returns and selected sector stocks, while bandwidth is selected through least squares cross-validation. Gaussian kernels are employed for $K(\cdot)$ and $L(\cdot)$ respectively.

3.2.4. Time-Varying Parameter Vector Autoregressive (TVP-VAR) Connectedness

The causality analysis in preceding sections aims to provide comprehensive insights into causal relationships spanning all quantiles of series movements. This framework addresses key research inquiries by examining directional predictability from Exchange Rate (ER) to stock returns and scrutinizing predictability variability across countries under standard and extreme conditions. Here, a time-varying parameter vector autoregressive (TVP-VAR) model introduced by Antonakakis et al. (2020) is applied to alterations in the Conditional Autoregressive Value at Risk (CAViaR) framework to explore the transmission mechanism of exchange rate fluctuations. This analysis involves estimating a TVP-VAR (1) model, as suggested by Bayesian Information Criterion (BIC) selection. The model structure is outlined succinctly as follows:

$$z_t = \mathrm{B}_t z_{t-1} + \varepsilon_t;\ \ \varepsilon_t \sim N(0, S_t) \quad (19)$$

$$vec(\mathrm{B}_t) = vec(\mathrm{B}_{t-1}) + \upsilon_t;\ \upsilon_t \sim N(0, R_t) \quad (20)$$

In Eq. 19 and 20, z_t and z_{t-1} are k×1 dimensional vectors, signifying the tail risk series at time t, t−1, respectively. The corresponding error term is presented by k×1 dimensional vectors ε_t. B_t and S_t is $k \times k$ dimensional matrices demonstrating the time-varying VAR coefficients and the time-varying variance–covariances. $vec(B_t)$ and υ_t are $k^2 \times 1$ dimensional vectors and R_t is a $k^2 \times k^2$ dimensional matrix.

The estimated TVP-VAR model is then transformed into its Time-Varying Process Moving Average (TVP-VMA) form using principles from the Wold representation theorem (Koop et al., 1996; Pesaran & Shin, 1998):

$$z_t = \sum_{i=1}^{p} \mathrm{B}_{it} z_{t-i} + \varepsilon_t = \sum_{j=0}^{\infty} \mathrm{A}_{jt}\, \varepsilon_{t-j} \quad (21)$$

The process of normalizing the (unscaled) GFEVD, signified as $\psi_{ij,t}^{g}(H)$, into its (scaled) form is such that every row attains a cumulative value of unity. Consequently, $\tilde{\psi}_{ij,t}^{g}(H)$ embodies the influence exerted by variable j upon variable i, expressed through the proportion of their respective forecast error variances. This proportion outlines the bidirectional interconnectedness from variable j to variable i. The calculation of this metric involves the following steps:

$$\psi_{ij,t}^{g}(H) = \frac{S_{ii,t}^{-1} \sum_{t=1}^{H-1} \left(\iota_i' \mathrm{A}_t S_t \iota_j\right)^2}{\sum_{t=1}^{H-1} \left(\iota_i \mathrm{A}_t S_t \mathrm{A}_t' \iota_j\right)^2} \text{ and, } \tilde{\psi}_{ij,t}^{g}(H) = \frac{\psi_{ij,t}^{g}(H)}{\sum_{j=1}^{k} \psi_{ij,t}^{g}(H)} \quad (22)$$

Where $\tilde{\psi}_{ij,t}^{g}(H) = 1$, $\sum_{i,j=1}^{k} \tilde{\psi}_{ij,t}^{g}(H) = k$ stands for the forecast horizon, and ι_i corresponds to a selection vector with unity on the i^{th} position and zero otherwise.

To quantify the level of interdependence within the considered series, the Total Connectedness Index (TCI) is calculated as

$$TCI_t^{g}(H) = \frac{\sum_{i,j=1, i\neq j}^{k} \tilde{\psi}_{ij,t}^{g}(H)}{k-1};\ 0 \leq TCI_t^{g}(H) < 1 \quad (23)$$

TCI in Eq. 23 can be then decomposed to the pairwise connectedness index (PCI) measuring the interconnectedness between two variables i and j

$$PCI_{ij,t}^{g} = 2\left(\frac{\tilde{\psi}_{ij,t}^{g}(H) + \tilde{\psi}_{ji,t}^{g}(H)}{\tilde{\psi}_{ii,t}^{g}(H) + \tilde{\psi}_{ij,t}^{g}(H) + \tilde{\psi}_{ji,t}^{g}(H) + \tilde{\psi}_{jj,t}^{g}(H)}\right);\ 0 \leq TCI_t^{g}(H) < 1 \quad (24)$$

Spanning a range of [0, 1], this PCI effectively portrays the extent of reciprocal interconnection existing between variables i and j, a phenomenon that is effectively encapsulated within the confines of the Total Connectedness Index (TCI).

Other important measurement involves the case when variable *i* imparts its shock to every other variable *j* within the system, this condition is denoted as (TO). This term is defined as follows:

$$TO^{g}_{i\rightarrow j,t}(H) = \sum_{i,j=1,i\neq j}^{k} \tilde{\psi}^{g}_{ij,t}(H) \tag{25}$$

Further, the shock variable *i* receives from variables *j* (FROM) is calculated as

$$FROM^{g}_{i\leftarrow j,t}(H) = \sum_{i,j=1,i\neq j}^{k} \tilde{\psi}^{g}_{ij,t}(H) \tag{26}$$

By subtracting the measure of TO others in Eq.25 from that of FROM others in Eq.26, we derive the NET total directional connectedness. This parameter can be construed as an indicator of the influence that variable *i* wields over the analyzed network.

$$NET^{g}_{i,t} = TO^{g}_{i\rightarrow j,t}(H) - FROM^{g}_{i\leftarrow j,t}(H) \tag{27}$$

IV. EMPIRICAL FINDINGS AND DISCUSSION

4.1. Descriptive Statistics

Table 2 summarizes the variables examined in the study. The results demonstrate that every variable has positive average daily returns, and standard deviation estimates point to very little price volatility. Notably, there is a positive skewness observed for all variables except the African exchange rate. Kurtosis values greater than a cutoff of three indicate smoother tails in the return series of the studied variables, except for exchange rate variables, which have low kurtosis values (except the UK pound). The null hypothesis of normality is rejected at the 1% significance level for all series examined by the Jarque-Bera (JB) test. Furthermore, the Ljung–Box statistic shows that serial correlation exists in the majority of nations. With the exception of China and India, the Pearson coefficient shows a negative association between equities and currency returns and a positive relationship between Islamic and conventional markets. The correlation values differed among nations and currencies, with larger values for conventional markets except Singapore, South Korea, and UK.

Table 2.
Descriptive Statistics

	Mean	Variance	Skewness	Ex.Kurtosis	JB	ERS	Q(20)	Q2(20)	Kendall	Islamic	Conv	ER
Africa												
Islamic	2.861	1.755	3.820	22.556	45228.844	-4.852	14143.061	12657.108		1.000	0.377	-0.078
Conv	2.142	0.754	3.811	26.381	60135.327	-7.130	9547.696	8983.970	Kendall	0.377	1.000	-0.090
ER	1.579	0.067	-0.094*	-0.806	54.609	-1.524	18223.662	17980.924		-0.078	-0.090	1.000
Australia												
Islamic	1.976	0.744	4.038	27.200	64873.883	-7.500	8813.396	8526.946		1.000	0.570	-0.048
Conv	1.562	0.770	5.736	48.325	198795.742	-6.531	9985.258	8750.400	Kendall	0.570	1.000	-0.105
ER	1.088	0.099	0.468	-0.761	117.319	-2.831	18008.662	17664.712		-0.048	-0.105	1.000
Canada												
Islamic	1.724	0.526	4.861	36.536	114469.599	-6.410	11741.403	9969.628		1.000	0.639	-0.134
Conv	1.361	0.876	7.213	73.884	453833.546	-7.756	9027.944	6449.158	Kendall	0.639	1.000	-0.121
ER	0.848	0.043	0.659	0.735	182.572	-4.173	14643.436	13806.819		-0.134	-0.121	1.000
China												
Islamic	2.191	0.252	1.740	5.423	3454.740	-10.079	5846.649	5185.669		1.000	0.653	0.067
Conv	2.257	0.561	1.640	4.974	2954.421	-7.838	8288.135	6896.573	Kendall	0.653	1.000	0.082
ER	0.404	0.028	0.770	1.172	311.559	-1.515	18270.463	17376.710		0.067	0.082	1.000
India												
Islamic	1.651	0.481	3.961	29.533	73704.491	-8.821	6065.882	5572.386		1.000	0.596	0.040
Conv	1.560	0.682	4.645	34.226	99151.225	-5.540	11524.656	9517.403	Kendall	0.596	1.000	0.051
ER	0.559	0.013	0.843	1.220	341.247	-3.609	13889.967	13775.388		0.040	0.051	1.000
Japan												
Islamic	1.842	0.465	2.045	7.316	5470.956	-7.462	7326.703	6220.557		1.000	0.853	-0.123
Conv	1.803	0.484	2.289	8.973	7901.709	-6.905	7406.825	6277.592	Kendall	0.853	1.000	-0.132
ER	0.931	0.076	1.263	1.576	690.214	-4.698	13738.897	12878.492		-0.123	-0.132	1.000

Table 2.
Descriptive Statistics (Continued)

	Mean	Variance	Skewness	Ex.Kurtosis	JB	ERS	Q(20)	Q2(20)	Kendall	Islamic	Conv	ER
						Singapore						
Islamic	1.568	0.384	3.734	23.563	50077.048	-6.303	10892.595	10883.262		1.000	0.532	-0.241
Conv	1.439	0.349	3.861	24.062	52338.328	-6.901	9597.357	9695.207	Kendall	0.532	1.000	-0.226
ER	0.559	0.024	0.493	-0.688	118.452	-2.412**	18972.702	18779.858		-0.241	-0.226	1.000
						South Korea						
Islamic	1.933	0.270	3.404	21.569	40138.262	-3.667	12107.813	11099.932		1.000	0.767	-0.098
Conv	1.795	0.325	3.939	27.562	64471.790	-5.387	10397.390	9380.552	Kendall	0.767	1.000	-0.075
ER	0.924	0.057	0.588	0.689	145.855	-3.264	15338.144	14457.614		-0.098	-0.075	1.000
UK												
Islamic	2.070	0.905	3.545	18.053	30329.315	-4.318	15399.414	14181.514		1.000	0.608	-0.075
Conv	1.540	0.695	3.841	24.119	51659.563	-6.429	11671.682	10295.078	Kendall	0.608	1.000	-0.068
ER	1.020	0.128	2.455	11.121	11915.014	-6.323	11011.345	9164.515		-0.075	-0.068	1.000

4.2. GC Across Quantiles between ER and Stock Markets

We apply the GC across-quantiles approach proposed by Peng et al. (2018) to evaluate the link between the daily returns of exchange rates (ER), Islamic, and Conventional stock indexes. The results, detailed in Table 3, are categorized into three scenarios: Downside to Downside (DD) when both variables are in the lowest quantiles of 0.01, 0.05 and 0.10; Upside to Upside (UU) when both variables are in the highest quantiles of 0.90, 0.95, and 0.99; and Center when both variables are in the middle quantiles. Notably, significant causality is observed in both Islamic and conventional markets in the UK across all quantiles. Conversely, China displays significant causality in the downside for Islamic markets and across all quantiles for conventional markets. Similar patterns are observed in other countries, albeit with variations in causality strength and directionality. For instance, Japan's Islamic market exhibits significant causality in the center, while the conventional market shows causality in both tails. Canada's conventional market demonstrates causality primarily in the left tails, with additional causality in the center and upside. Australia's Islamic market displays causality in the left tail, while the conventional market exhibits causality across all quantiles. Meanwhile, India's Islamic market shows no significant causality, while the conventional market exhibits causality across all quantiles. South Korea's Islamic market demonstrates causality in the right tail, in contrast to the conventional market's causality in both tails. Singapore's Islamic market shows causality in the center and right tails, while the conventional market exhibits causality primarily in the downside. In Africa, both Islamic and conventional markets display causality in the left tail, with the Islamic market showing causality in the center.

Left-tailed contagion effects, particularly in the DD quantile, suggest that a reduction in ER risk may anticipate future downturn risk in conventional market returns. It also aligns with the observation that a significant depreciation of a local currency, particularly to an extreme extent, can instigate a flight-to-quality response from foreign investors. This phenomenon involves the movement of capital away from conventional stock markets, leading to a decline in their stock prices. Investors should be cognizant of this occurrence to safeguard their portfolios against potential downside risks. Mitigating downside risk spillovers involves short exchange rate positions, in line with Reboredo et al. (2016). However, these effects are not consistent for Islamic market returns, suggesting ER might not consistently predict downturn risk in Islamic markets. Thus, Islamic markets of Japan, Canada, India, South Korea, Singapore provide some protection against downside exchange rate as extreme downwards movements in exchange rates do not spill over to those Islamic stock markets.

Right-tailed contagion effects, indicating the influence of upside risks in ER on both conventional and Islamic stock returns, are observed in most countries, with exceptions in Canada, Singapore, and Africa. Conversely, distinct evidence of upside risk spillover effects from ER to Islamic stock markets is identified in the UK, Canada, South Korea, and Singapore. This mixed evidence suggests that extreme currency appreciation impacts stock returns differently across countries. An extreme appreciation in the currencies has an impact on the upside risk of the stock returns of all countries, except Canada, Singapore, and Africa. Conversely, in the Islamic stock markets of UK, Candan, South Korea, and Singapore, we have identified distinct evidence of upside risk spillover effects from the corresponding exchange rate. The economic interpretation of this outcome mirrors that of downside risk, albeit considering short positions rather than long positions.

In the center, representing the neutral zone, varying results are observed: Islamic markets in Japan, Canada, Singapore, South Korea, and Africa, while Conventional markets in China, Australia, and India, display causality. The findings highlight significant differences in the impact of ER fluctuations on Islamic and conventional stock markets across countries. Notably, Islamic markets appear less affected by ER fluctuations than conventional markets, especially in India, which seems immune to ER impact. However, our findings do not consistently align with the theory of the goods market, which suggests a stronger causal connection from ER to stock prices in countries with higher trade-to-GDP ratios. For instance, South Korea, with the second-highest trade-to-GDP ratio (refer to Table 1), shows a significant lead of ER over stock prices under downside-downside. Conversely, under upside-upside, India, with the fourth smallest trade ratio, exhibits the highest impact of ER on stock prices.

Table 3.
Granger Causality between Exchange Rate and Various Stock Markets Across Quantile- Positive Spillover

	Center positive	Downside to Downside	Upside to Upside	Center positive	Downside to Downside	Upside to Upside
	ER to Islamic			ER to Conv.		
UK	1.008	10.845 (1)	4.216 (4)	0.468	3.985 (8)	6.073 (6)
China	0.014	5.840 (3)	1.123	4.225	3.269 (9)	7.601 (4)
Japan	4.268 (3)	0.278	1.612	1.050	5.485 (5)	6.291 (5)
Canada	6.957 (2)	1.069	8.294 (1)	1.338	5.907 (3)	1.292 (8)
Australia	0.098	8.920 (2)	1.339	5.613	4.062 (7)	9.872 (3)
India	0.335	1.135	1.675	8.314	6.095 (2)	12.246 (1)
South Korea	0.133	0.124	5.263 (3)	1.001	7.226 (1)	10.821 (2)
Singapore	3.972 (4)	0.762	7.288 (2)	0.391	5.710 (4)	0.747 (9)
Africa	9.625 (1)	2.282 (4)	1.551	0.880	4.725 (6)	1.426 (7)

Table 4 presents causality under two additional scenarios: Upside to Downside (UD) and Downside to Upside (DU), where the exchange rate is in one quantile while the stock market is in the opposite quantile. The cross-quantile correlation reveals that ER's downside risk predicts the upside risk of stock returns in both Islamic and conventional markets, indicating that ER changes can signal potential high returns. However, the relationship between upside and downside volatility is not straightforward. While an increase in ER within the upper quantile coincides with a decrease in conventional returns within the lower quantile, this impact on Islamic returns is evident only in certain cases, including Canada, India, South Korea, and Singapore. These findings align with previous studies showing mixed evidence regarding the immunity of Islamic stocks from financial crises and contagion effects. While some studies suggest Islamic equities may serve as effective hedging instruments during crises (Kenourgios et al., 2016; Rizvi et al., 2015; Salisu & Shaik, 2022), others report risk spillover and contagion effects between Islamic and conventional equity indices (Benzarti & Mighri, 2023; Hassan et al., 2023). While Islamic stock markets may offer diversification benefits and potential for higher returns, investors should conduct thorough research and be aware of associated risks before investing.

Table 4.
Granger Causality between Exchange Rate and Various Stock Markets Across Quantile- Negative Spillover

	ER Upside to Stock Downside	ER Downside to Stock Upside	ER Upside to Stock Downside	ER Downside to Stock Upside
	ER to Islamic		ER to Conventional	
UK	1.107	**3.858**	**8.526**	**12.865**
China	0.989	**3.107**	**9.225**	**14.035**
Japan	1.687	**5.574**	**8.133**	**12.139**
Canada	**6.974**	**5.756**	**4.664**	**5.456**
Australia	1.258	**3.966**	**10.158**	**5.136**
India	**12.597**	**6.389**	**8.857**	**6.350**
South Korea	**5.106**	**7.556**	**5.671**	**10.571**
Singapore	**7.288**	**5.710**	**3.330**	**2.686**
Africa	1.547	**4.721**	**8.732**	**13.933**

4.3. Nonparametric Causality-In-Quantiles Results

We use the robust causality-in-quantile method described by Balcilar et al. (2016), using the GC across-quantiles test results. Market states, as indicated by corresponding quantiles in the dependent variable's distribution, are utilized to predict causality-in-mean (shown in blue) and causality-in-variance (shown in green) in a dynamic setting. As indicated by the 90th (higher), 50th (average), and 10th (lower) quantiles, respectively, the markets are categorized as bullish (favorable), normal (average), or bearish (unfavorable). The quantiles are shown on the x-axis, and the nonparametric causality test statistics are shown on the y-axis. 1.96 and 2.45, the critical values for the significance levels of 5% and 1%, are given. The 10% critical values are shown by dark horizontal yellow lines, whereas the 5% critical values are shown by grey lines. Causality curves show the degree of predictability that exists between ER and stock markets, according to the market conditions that these quantiles indicate. Significant conditional causality is shown by the hump-shaped curvature of the causality curves at the average point, and it diminishes or vanishes at extreme quartiles that are far from the mean or median. Where causation changes, there are quartiles located away from the mean, as seen by the inverted hump-shaped curve. Asymmetric causation is suggested by the left tail's hump to the right and the right tail's hump to the left, capturing both linear and nonlinear causality.

The results presented in Figure 1 unveil distinct disparities not only in the quantile causality analysis for both mean and variance but also reveal substantial variations across diverse countries, highlighting the complexity and variability of the relationships under examination. We discover mixed evidence regarding causality-in-mean from foreign exchange to conventional stock markets (refer to the blue line in Figure 1, right side), with five countries (Singapore, Africa, India, Japan, and the UK) showing directional spillover only in extreme bullish market conditions. Conversely, evidence for causality-in-mean from the exchange rate to the Islamic stock market (refer to the blue line in Figure 1, left side) is less mixed, with fewer significant effects found across countries (Japan and Singapore under extremely bullish conditions and in South Korea with no clear trend).

In contrast, robust evidence is found in favor of causality-in-variance from foreign exchange rates to conventional stock market volatilities in almost all countries, indicating notable spillovers (refer to the green line in Figure 1). The spillovers are evident for seven out of the nine countries from 0.25 quantiles (UK, Australia, India, Canada, UK, Japan, and Singapore). The relationship in the case of Africa and China depends on the quantile. As for the Islamic stock markets, there is strong evidence for all countries except UK under extreme bullish conditions and China. Regardless of the country, the causality is very weak at extreme bearish conditions (below 0.20), except for South Korea and Africa for Islamic markets and Canada and Australia for conventional markets.

Our findings regarding mean causality suggest that, for most countries, exchange rates do not Granger cause Islamic stock returns, except in extreme upper quantiles in Japan and South Korea. This implies that exchange rates are effective predictors of Islamic stock markets in Japan during bullish market states. However, for South Korea, significant causality is observed across different market conditions except during bullish states. To illustrate the hedging potential of Islamic markets against exchange rate fluctuations, it is advisable to hold exchange rates and their corresponding Islamic stock portfolios in the same portfolio under normal and bearish market conditions for other countries, as ER returns do not lead Islamic market returns. In terms of how exchange rates affect returns on conventional stocks, our findings indicate that there is strong predictability between exchange rate returns and conventional stock markets in the extreme upper quantiles, especially in the UK, Japan, Australia, India, and Africa. This emphasizes how crucial it is for portfolio management to constantly monitor currency rates in accordance with market conditions.

Shifting focus to the quantile causality test for the second moment (variance) reveals a significant relationship between ER and market volatility across most quantiles. The presence of a hump-shaped curvature in countries like the UK, Canada, and Australia suggests significant conditional causality during normal market conditions, which diminishes during highly bullish or bearish periods. Additionally, a rightward hump in most cases implies the existence of asymmetric causality, capturing both linear and nonlinear effects. The nexus between the exchange rate and conventional market is upward, suggesting that the relationship strengthens in bullish market conditions while it is the weakest under bearish market conditions. In summary, our findings reveal that the causal effects are heterogeneous across quantiles, in line with Yang et al. (2014) with distinct differences observed between tail quantiles, middle quantiles, and the mean.

Figure 1.
Causality-in-Quantile from Exchange Rate to Islamic and Conventional Stock Markets

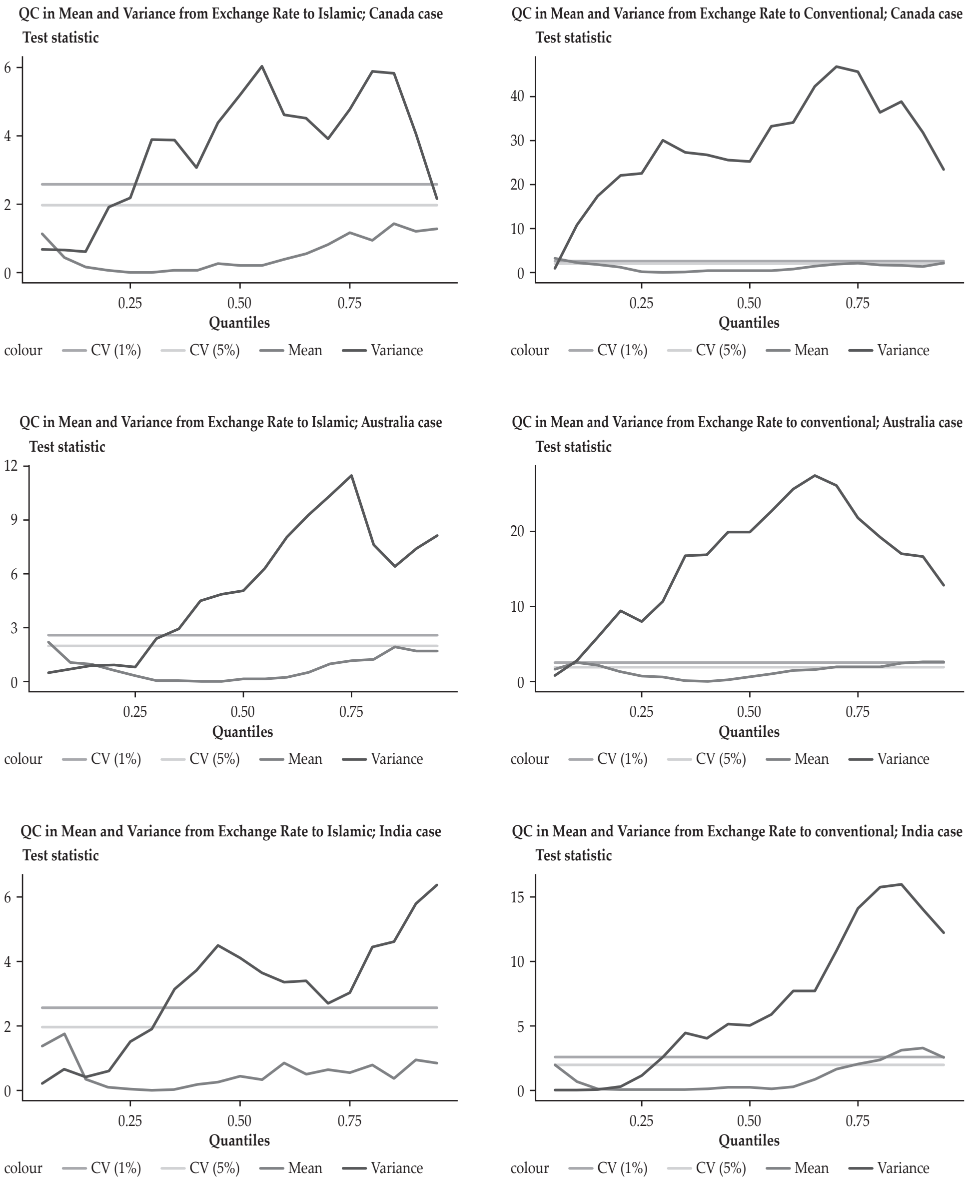

Figure 1.
Causality-in-Quantile from Exchange Rate to Islamic and Conventional Stock Markets (Continued)

Figure 1.
Causality-in-Quantile from Exchange Rate to Islamic and Conventional Stock Markets (Continued)

4.4. CAViaR TVP-VAR Results

This section presents and discusses the connectedness results, with a special emphasis on the impact of exchange rates (ER) on the returns of both conventional and Islamic stocks, with a particular focus on tail risk. Our study sheds light on the connections inside the network at both the pairwise and aggregate levels. Starting with the static outcomes of tail risk transmission among ER and the corresponding conventional and Islamic stock market equities for each country in Table 5, we observe a moderate average total connectedness level across the network, ranging from 34.34% (Africa) to 53.09% (Japan). This indicates a proportion of the volatility forecast error variance resulting from spillover effects, with countries like the UK, India, China, and Australia hovering around 47%-48%, and South Korea and Japan reaching approximately 52%-53%. While this suggests some degree of interdependence among variables, the significant connectedness within the network highlights its importance in understanding the dynamics, especially in assessing tail risk.

Further insights from Table 5 reveal distinct roles among net transmitters and recipients. For instance, Islamic markets primarily receive spillovers, particularly notable in the case of Singapore (-4.66%). In the remaining countries (Canada, Japan, and China), the role of the Islamic market is neutral, ranging from -0.15 (China) to 0.84 (Japan). Conversely, conventional stock returns emerge as the primary net transmitters in countries like Singapore (4.36%), Canada (3.69%), India (2.3%), Japan (2.4%), and the UK (2.35%). The role of exchange rates, on the other hand, shows significantly lower spillovers compared to both stock markets.

Our findings underscore a complex interaction between these two types of stock markets, indicating their high interconnectedness. This implies that, according with Nurdany et al. (2021), Islamic equities are not immune to shocks. There are significant linkages between the Islamic and conventional stock markets, in line with several studies (Ahmed, 2019; Ajmi et al., 2014; Hasan, 2019; Hidayah & Swastika, 2022; Jawadi et al., 2020; Majdoub et al., 2016; Nazlioglu et al., 2015; Rejeb, 2017). Delle Foglie & Panetta (2020) in their bibliometric studies covering papers published from 2009 to 2019 report that there is no consensus regarding the connectedness between these two markets. This implies that Islamic equities respond similarly to volatility shocks as conventional ones, indicating limited diversification benefits. Moreover, there are notable variations in dynamic linkages across nine countries.

However, it is essential to consider that Islamic stocks may not inherently adhere to Islamic principles and may not be immune to shocks from conventional markets, especially in regions with a minority Muslim population[2]. The presence of non-Islamic investors, coupled with the use of replica stocks, challenges the notion that Islamic stocks inherently provide a safeguard against financial crises.

2 Islamic stocks, while labeled as such, are often not original Islamic instruments like Musharakah but rather replicas. As a result, their behavior may closely parallel that of conventional stocks. Moreover, the composition of investors plays a significant role. If investor profiles were solely based on Islamic principles, one might expect different behavior of Islamic stock markets. Islamic principles, which include the prohibition of interest, speculative and uncertain transactions, and excessive leverage, are believed to mitigate mispricing driven by sentiment (Al Hashfi et al., 2021).

This aligns with previous studies and highlights the possibility of Islamic indexes in predominantly Muslim regions to behave differently from those in areas with fewer Muslims (Jaballah et al., 2018). This is also in line with Hassan et al. (2023).

Table 5.
Average Total Connectedness

	Islamic	Conventional	ER	FROM
		Africa (TCI = 34.34)		
Islamic	70.49	27.42	2.1	29.51
conventional	30.25	67.95	1.8	32.05
ER	2.80	4.32	92.88	7.12
TO	33.05	31.73	3.9	68.68
NET	3.53	-0.31	-3.22	
NPT	2	1	0	
		Australia (TCI = 46.71)		
Islamic	58.52	38.17	3.32	41.48
conventional	39.68	57.17	3.14	42.83
ER	5.16	3.96	90.88	9.12
TO	44.84	42.13	6.46	93.43
NET	3.36	-0.7	-2.66	
NPT	2	1	0	
		Canada (TCI = 49.48)		
Islamic	54.09	43.42	2.49	45.91
conventional	41.56	55.89	2.55	44.11
ER	4.55	4.39	91.06	8.94
TO	46.11	47.81	5.05	98.96
NET	0.2	3.69	-3.9	
NPT	1	2	0	
		China (TCI = 47.05)		
Islamic	56.88	40.36	2.77	43.12
conventional	40.12	56.03	3.85	43.97
ER	2.85	4.16	92.99	7.01
TO	42.97	44.52	6.61	94.11
NET	-0.15	0.55	-0.4	
NPT	1	2	0	
		India (TCI = 47.69)		
Islamic	55.3	43.74	0.96	44.7
conventional	43.81	55.18	1.01	44.82
ER	2.48	3.38	94.14	5.86
TO	46.29	47.12	1.96	95.38
NET	1.6	2.3	-3.9	
NPT	2	1	0	

Table 5.
Average Total Connectedness (Continued)

	Islamic	Conventional	ER	FROM
Japan (TCI = 53.09)				
Islamic	49.96	48.51	1.54	50.04
conventional	47.48	50.57	1.95	49.43
ER	3.4	3.32	93.29	6.71
TO	50.88	51.82	3.48	106.19
NET	0.84	2.4	-3.23	
NPT	1	2	0	
Singapore (TCI = 41.43)				
	Islamic	conventional	ER	FROM
Islamic	60.91	34.03	5.06	39.09
conventional	29.96	65.52	4.52	34.48
ER	4.48	4.81	90.71	9.29
TO	34.43	38.84	9.58	82.86
NET	-4.66	4.36	0.3	
NPT	0	2	1	
South Korea (TCI = 52.31)				
Islamic	51.92	46.35	1.73	48.08
conventional	46.3	51.66	2.04	48.34
ER	4.56	3.64	91.8	8.2
TO	50.86	49.99	3.77	104.62
NET	2.78	1.65	-4.43	
NPT	1	2	0	
UK (TCI = 47.61)				
Islamic	56.92	41.78	1.3	43.08
conventional	41.41	56.24	2.34	43.76
ER	4.05	4.33	91.62	8.38
TO	45.46	46.11	3.64	95.22
NET	2.39	2.35	-4.74	
NPT	1	2	0	

Table 6 presents the average pairwise connections using the PCI, showing the co-movement between various indexes. Notably, the average co-movement ranges from 0 to 100%, the main diagonal elements are all 100%, indicating full correlation within each index, and the off-diagonal elements mirror each other, facilitating the identification of robust co-movements between specific pairs of indexes. For instance, in the UK, Islamic and conventional markets exhibit co-movements of 5.92% and 7.33% with exchange rates, respectively. The significant interconnection observed between Islamic and conventional markets supports previous research (Ajmi et al., 2014; Dania & Malhotra, 2013; Hammoudeh et al., 2014; Nazlioglu et al., 2015), ranging from 58.82% to 97.69%. This indicates that Islamic markets are not isolated from their conventional counterparts, with Asian countries like Japan (97.69%) and South Korea (94.39%) showing the highest correlation. The lowest correlation is for Singapore (67.56%) and Africa (58.82%). These findings suggest that Sharia compliance rules may not sufficiently differentiate global Islamic indexes from conventional ones in terms of dependence structure. Therefore, the Islamic financial system may not offer a protective buffer against financial shocks affecting conventional markets. The extensive interdependence between Islamic and conventional stock markets implies that fluctuations in exchange rates could cascade into Islamic markets, highlighting the interconnectedness within the global financial landscape. While the connection between exchange rates and stock markets is significant, it is smaller compared to the connection between conventional and Islamic stock markets, indicating global integration among financial markets. Investors should be cautious about the diversification benefits of Islamic assets against conventional assets. Pairwise correlations between exchange rates and conventional stock markets range from 5.78% (India) to 11.73% (Singapore), with China conventional markets (10.45%), Canada (9.5%), and Australia (9.44%) showing high correlations. Similarly, correlations between exchange rates and Islamic markets range from 4.63% (India) to 12.06% (Singapore), with Singaporean markets being the most correlated with exchange rates, while Indian markets are the least correlated.

Table 6.
Average Pairwise Connection

	Islamic	**conventional**	**ER**
		Africa	
Islamic	100	58.82	5.92
Conventional	58.82	100	7.33
ER	5.92	7.33	100
		Australia	
Islamic	100	80.37	10.86
Conventional	80.37	100	9.44
ER	10.86	9.44	100
		Canada	
Islamic	100	87.14	9.71
Conventional	87.14	100	9.5
ER	9.71	9.5	100
		China	
Islamic	100	83.37	7.28
Conventional	83.37	100	10.45
ER	7.28	10.45	100
		India	
Islamic	100	88.41	4.63
Conventional	88.41	100	5.78
ER	4.63	5.78	100
		Japan	
Islamic	100	97.69	6.84
Conventional	97.69	100	7.25
ER	6.84	7.25	100

Table 6.
Average Pairwise Connection (Continued)

	Islamic	conventional	ER
		Singapore	
Islamic	100	67.56	12.06
Conventional	67.56	100	11.73
ER	12.06	11.73	100
		South Korea	
Islamic	100	94.39	8.47
Conventional	94.39	100	7.81
ER	8.47	7.81	100
		UK	
Islamic	100	84.7	7.28
Conventional	84.7	100	8.99
ER	7.28	8.99	100

Given the diverse impacts of exchange rate volatility across countries, policymakers face challenges in formulating effective monetary policies. The findings of this study reveal that the effects of exchange rate changes vary depending on the conditions of both the exchange rate and stock markets. These insights can guide policymakers in making informed decisions to avoid unnecessary monetary interventions. Our examination of coefficients across quantiles helps policymakers, investors, and portfolio managers. Policymakers can minimise stock market damage by timing exchange rate interventions. These empirical findings can also help investors and portfolio managers comprehend the link between the two markets and make proactive portfolio modifications depending on market behaviour. Proactive investing protects against spillover effects from exchange rates to stock markets, enhancing portfolio management strategies

V. CONCLUSION

This study conducts a thorough analysis on the correlation between exchange rates and stock market performances in both Islamic and conventional financial systems. The research employed a rigorous three-step methodology, which are nonparametric causality-in-quantiles tests, asymmetric slope Conditional Autoregressive Value-at-Risk (CAViaR), and Time-Varying Parameter Vector Autoregressive (TVP-VAR) Connectedness measure.

Our findings show a pronounced asymmetry in the way that exchange rate swings affect stock markets, underscoring the unique resilience of Islamic financial markets against global financial shocks. This study fills a significant gap in the literature by comparing Islamic and conventional financial systems in the context of exchange rate dynamics, offering important theoretical, managerial (for investors and portfolio managers), and practical implications.

In theory, this study provides valuable insights into the interconnectedness of Islamic and conventional stock markets, particularly in relation to tail risk.

It challenges the notion that Islamic markets are more resilient to financial shocks and highlights the importance of considering market-specific reactions to exchange rate fluctuations. The research emphasizes the need for effective strategic financial planning that takes into account the distinct features of Islamic and conventional financial markets. Portfolio managers and investors should recognize the susceptibility of Islamic markets to global financial shocks and consider the interplay between Islamic and conventional markets when making investment decisions. The study also suggests that the potential benefits of diversifying portfolios with Islamic equities may be limited in mitigating volatility spillovers from conventional markets. Therefore, managers should carefully assess the dynamic relationships between Islamic and conventional indices in different nations. Policymakers can utilize these insights to develop tailored policies that support financial market resilience and stability, taking into account the specific characteristics of both conventional and Islamic financial systems and promoting expansion in global financial markets.

The research conducted on Islamic and conventional stock markets may have limitations in its representation of the global diversity in these markets. The findings may not be applicable to other nations or regions, highlighting the need for future studies to expand the scope of analysis and investigate the worldwide interconnectivity between these markets. Additionally, the analysis is based on data from a limited time frame, which may not accurately reflect long-term changes in the relationship between Islamic and conventional markets. Therefore, longitudinal studies are necessary to evaluate the effects of structural changes in the global financial system and the stability of links between these markets over time. Besides, other factors (e.g., demographic composition of a given area and the level of adherence to Islamic finance principles) that influence the behavior of Islamic indices and their interactions with conventional markets should be considered. Overall, further investigation and consideration of various factors are required for a comprehensive understanding of the dynamics and relationships in Islamic and conventional stock markets.

In short, the empirical results in this paper offer valuable guidance and references for researchers, investors, and policy makers involved in financial risk management, specifically in Islamic and conventional financial markets.

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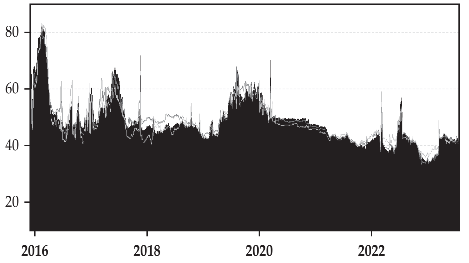
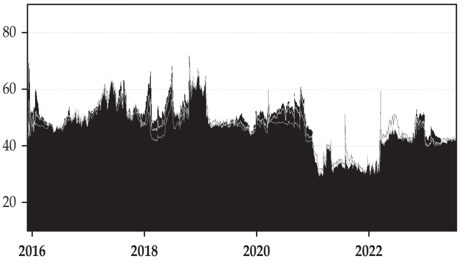
APPENDIX

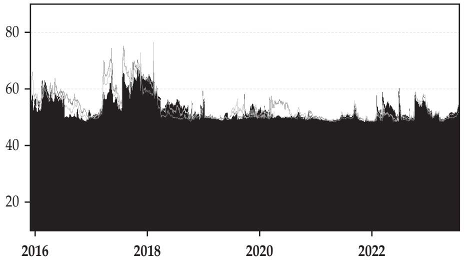
Table A1.
Total Connectedness Index (TCI)



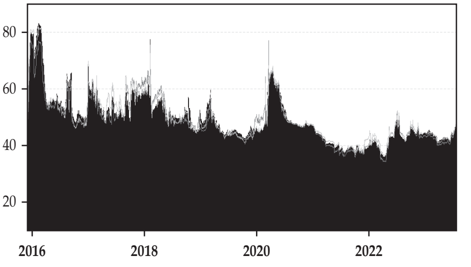
The UK



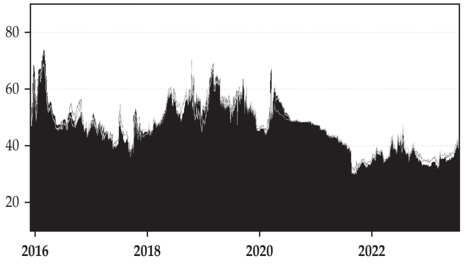
China



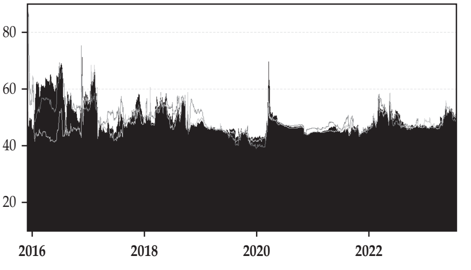
Japan



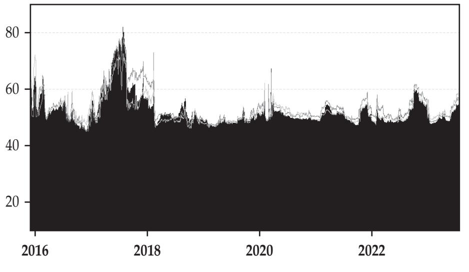
Canada



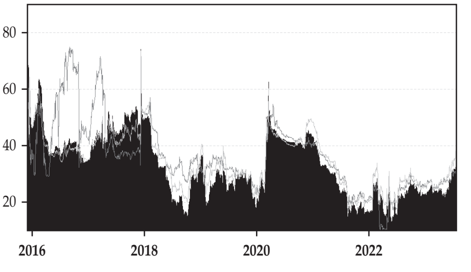
Australia



India

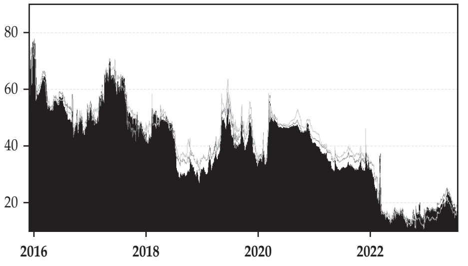


South Korea



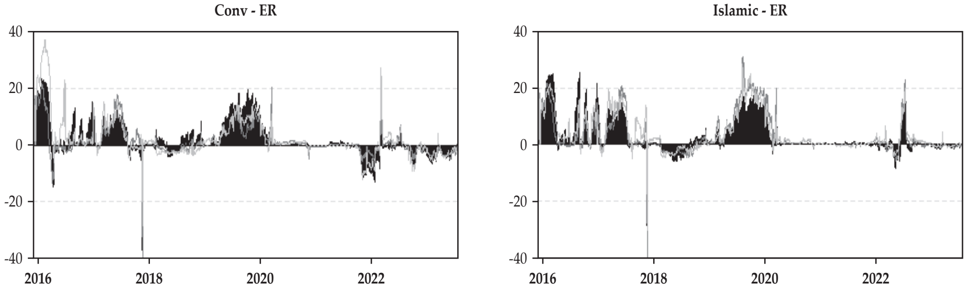
Africa

Table A1.
Total Connectedness Index (TCI) (Continued)

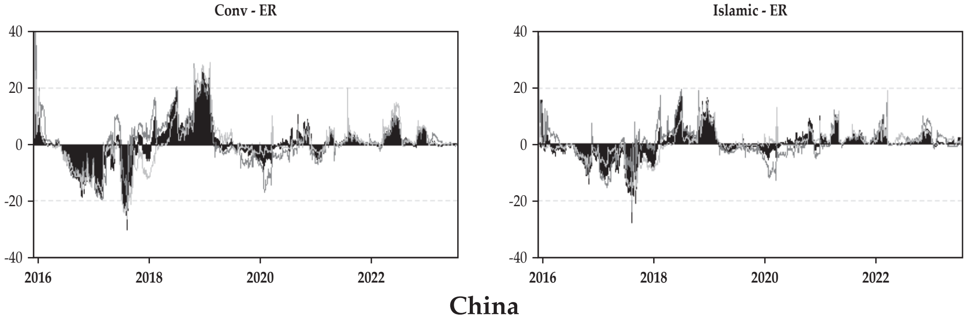


Singapore

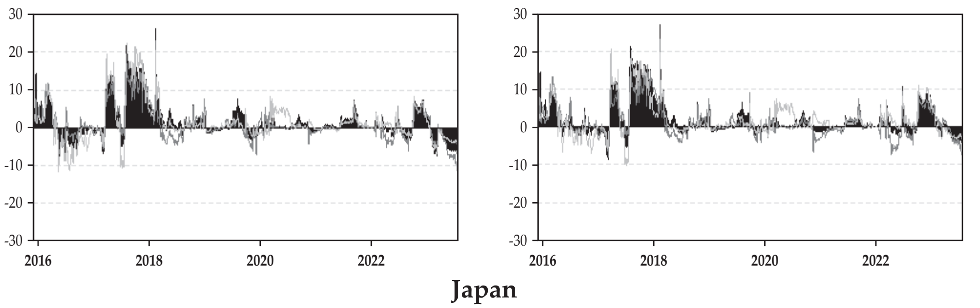
Table A2.
NET Spillover



The UK

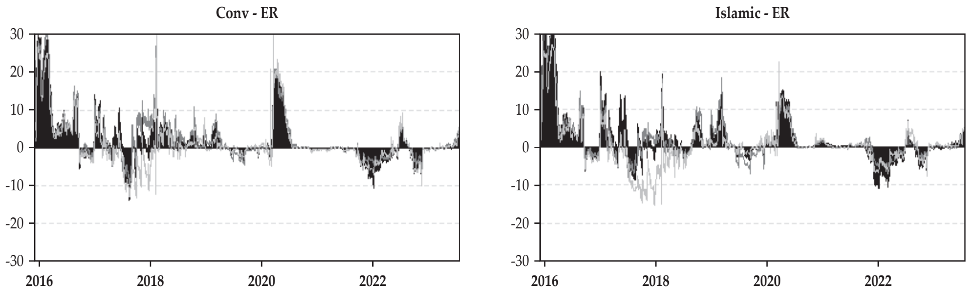


China

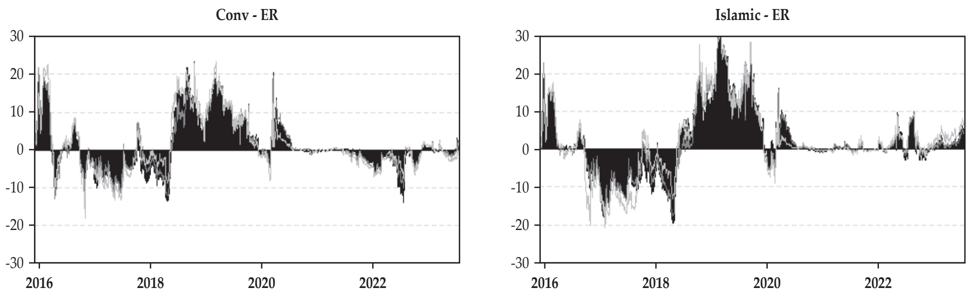


Japan

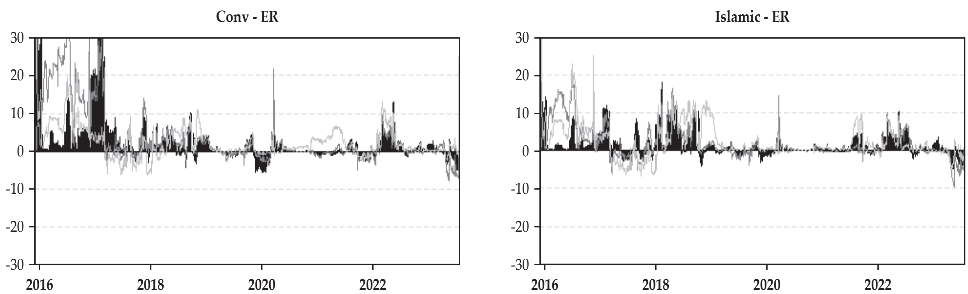
Table A2.
NET Spillover (Continued)



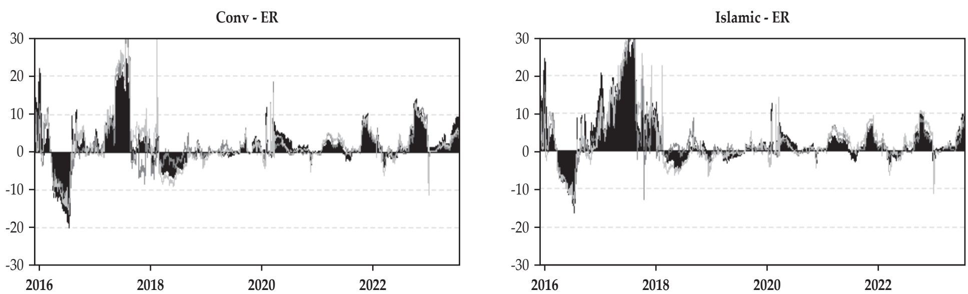
Canada



Australia

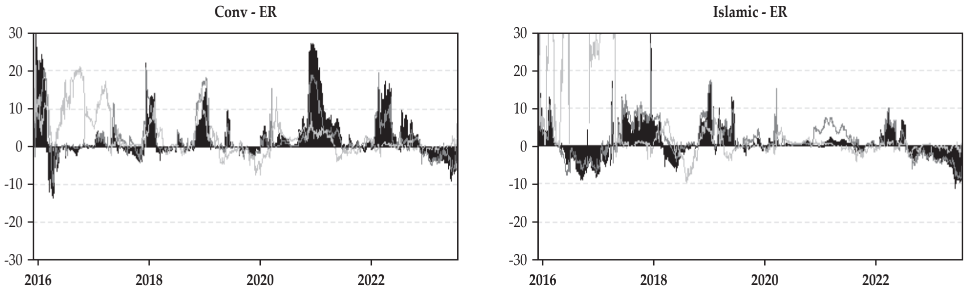


India

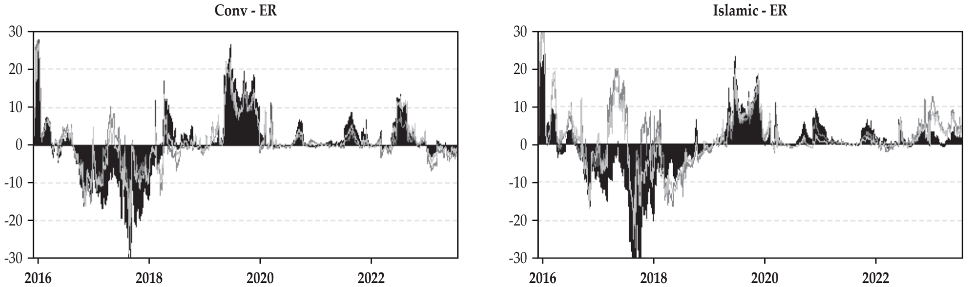


South Korea

Table A2.
NET Spillover (Continued)



Africa



Singapore