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TIME-VARYING CORRELATIONS AND VOLATILITY SPILLOVERS BETWEEN CRYPTOCURRENCIES AND ISLAMIC EQUITY INDICES: INDONESIA, PAKISTAN AND INDIA

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Abstract
This study investigates the co-movements and volatility spillover dynamics between cryptocurrencies and Islamic equity indices in Indonesia, Pakistan and India addresses the scarcity of comparative evidence for these major developing economies. The study examines volatility spillovers and dynamic correlations across markets based on return series from January 4, 2017, to January 4, 2025, employing BEKK-GARCH and DCC-GARCH models. Empirical results reveal a unidirectional transmission of volatility from cryptocurrencies to Islamic equities, except for Ethereum and Pakistan, where a weak bidirectional spillover is observed. The analysis uncovers a time-horizon dichotomy. Short-term spillovers remain limited. Dynamic correlations intensify significantly over the long run. This suggests a growing integration between cryptocurrency assets and Islamic stock markets indices. Cryptocurrencies act as diversifiers in the short run and their role as hedges weakens over the long term. This deeper integration increases the exposure of Islamic financial systems to cryptocurrency-induced risks and may affect overall financial stability. These results highlight the need for regulators and policymakers to closely monitor volatility transmission channels and enhance oversight mechanisms. A clear understanding of these dynamics is essential to mitigate the risk of systemic disruptions and ensure the resilience of Islamic financial markets amid the growing influence of digital assets.
Keywords: Cryptocurrency, Islamic stock market, Volatility spillover, Dynamic correlations, BEKK-GARCH, DCC-GARCH
Jel Codes: C32, G12, G15

KRİPTO PARA BİRİMLERİ VE İSLAMİ HİSSE SENEDİ ENDEKSLERİ ARASINDAKİ ZAMANLA DEĞİŞEN KORELASYONLAR VE VOLATILITE YAYILIMLARI: ENDONEZYA, PAKİSTAN VE HİNDİSTAN

Öz
Bu çalışma, Endonezya, Pakistan ve Hindistan'daki hisse senedi endeksleri ile kripto para birimleri arasındaki eş hareketler ve oynaklık yayılma dinamiklerini araştırılmaktadır. Çalışmada, 4 Ocak 2017 ile 4 Ocak 2025 arasındaki getiri serilerine BEKK-GARCH ve DCC-GARCH modelleri uygulanarak piyasalar arası oynaklık yayılmaları ve dinamik korelasyonlar incelenmektedir. Ampirik bulgular, Ethereum ve Pakistan hariç, kripto para birimlerinden geleneksel İslami finans piyasalarına tek yönlü bir volatilite aktarımı olduğunu göstermektedir. Ethereum ve Pakistan borsası arasında zayıf bir çift yönlü taşma etkisi gözlemlenmektedir. DCC-GARCH sonuçları, kripto para varlıklarından İslami borsalara olan volatilite yayılımlarının kısa vadede minimum düzeyde olduğunu, ancak uzun vadede önemli ölçüde arttığını ortaya koymaktadır. Bu durum, kripto para varlıklarının İslami finans piyasalarıyla entegrasyonunun güçlendiğini ve bu korelasyonun uzun vadede devam etmesinin muhtemel olduğunu göstermektedir. Kripto para varlıkları ile İslami borsalar arasındaki güçlü entegrasyon, kripto para varlıklarının bu piyasaların finansal sistemi içinde oluşturduğu riskleri artırmaktadır. Bu entegrasyon, finansal sistemin genel istikrarı üzerinde de etkilere sahip olabilir. İslami finans piyasalarının istikrarını korumak için, politika yapıcılar ve piyasa düzenleyicileri, oynaklık iletim mekanizmaları hakkında kapsamlı bir anlayış geliştirmeli ve kripto varlık oynaklığından kaynaklanan olası aksaklıkları önlemek için bunları aktif olarak izlemelidir.
Anahtar Kelimeler: Kripto para, İslami piyasalar, Volatilite yayılımı, Dinamik korelasyonlar, BEKK-GARCH, DCC-GARCH
Jel Kodları: C32, G12, G15

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Introduction

The past decade has witnessed an extraordinary expansion of the cryptocurrency market, with global capitalization fluctuating between hundreds of billions and over two trillion US dollars. Consequently, academic and policy circles are increasingly concerned with how shocks from this largely unregulated domain propagate into conventional finance. The International Monetary Fund has already documented significant spillovers from Bitcoin and Ethereum into equity and commodity returns, particularly during crisis episodes, confirming that crypto assets have matured into systemic risk factors (R. Iyer & Popescu, 2023)

Parallel to this, Islamic finance has expanded to over three trillion US dollars in total assets, operating across more than eighty jurisdictions (Islamic Financial Services Board, 2025). While Shariah principles, which prohibit interest and speculation, have historically offered partial insulation from financial contagion, digitalization is narrowing that cushion. The Islamic Financial Services Board's 2024 Stability Report warns that the rapid rollout of fintech tools and tokenized instruments is eroding the boundary between Islamic and conventional finance, introducing new cyber and market risks (Islamic Financial Services Board, 2024). These developments have transformed the interaction between cryptocurrency turbulence and Islamic financial stability from a theoretical concern into an urgent supervisory priority.

Although a growing body of literature examines volatility spillovers between cryptocurrencies and financial systems, studies specifically targeting Islamic markets focus heavily on the Gulf Cooperation Council (GCC) or global indices (Mansour Nomran et al., 2024; Rehman et al., 2020). Evidence suggests that while Shariah-compliant indices may offer some defensive characteristics, they are not immune to regime-dependent volatility transmission from crypto assets (Bahloul et al., 2021; Bakar & Foziah, 2024; Chkili et al., 2021). However, systematic evidence for South and Southeast Asian Islamic equity indices remains limited. Little is known about how leading cryptocurrencies transmit volatility to Islamic stock indices in Indonesia, Pakistan, and India, which are three major economies where Islamic equity indices are active, crypto adoption is rising, and regulators are increasingly monitoring digital asset risks.

The present study addresses this gap. Using daily returns from January 4, 2017, through January 4, 2025, we examine volatility spillovers from Bitcoin (BTC), Ethereum (ETH), and Ripple (XRP) into the Islamic stock indices of Indonesia, Pakistan, and India. We employ a diagonal BEKK specification to quantify direct volatility transmission and a Dynamic Conditional Correlation GARCH (DCC-GARCH) model to capture time-varying co-movement. By comparing pre-pandemic, pandemic, and post-pandemic subperiods, we isolate how structural breaks in the crypto market alter the strength and direction of spillovers.

This study contributes to the literature in three key respects. First, it provides unified evidence on volatility spillovers for three under-researched South and Southeast Asian markets, offering a comparative analysis distinct from the GCC-centric literature. Second, it offers a direct comparison of diagonal BEKK and DCC-GARCH results within a consistent multivariate framework, establishing a robust benchmark for volatility transmission. Third, from a policy perspective, it informs financial stability frameworks by demonstrating how crypto-shock transmission evolves during crisis periods, aiding regulators in designing resilient supervisory tools for Islamic capital markets.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data and econometric methodology. Section 4 presents the empirical findings and discussion. Section 5 concludes with policy implications.

1. Literature Review

The empirical literature on cryptocurrency market integration has undergone a significant evolution, transitioning from early views of isolation to contemporary findings of systemic interconnectedness. Initial studies largely portrayed cryptocurrencies as a distinct asset class detached from traditional portfolios. For instance, fractional integration tests and spectral coherence analyses conducted in the pre-2018 period frequently found no cointegration between major cryptocurrencies and conventional stock indices, suggesting that digital assets could serve as effective diversifiers due to their independence from global financial cycles (Corbet et al., 2018; Gil-Alana et al., 2020; Trabelsi, 2018). However, as market depth expanded and institutional participation increased, this isolation diminished. Recent multivariate GARCH and connectedness studies indicate that cryptocurrencies have become progressively integrated with global equity and commodity markets, with volatility transmission intensifying significantly during stress periods such as the COVID-19 pandemic (Ghorbel & Jeribi, 2021; R. Iyer & Popescu, 2023; Rijanto, 2023). This interconnectedness is often bidirectional (Paeng et al., 2024; Şenol et al., 2022; Shahrour et al., 2024) and global in nature, affecting both G7 and E7 markets (Aydoğan et al., 2022; Vuković et al., 2025), suggesting that digital assets have matured into systemic risk factors capable of transmitting shocks to the broader economy (Symitsi & Chalvatzis, 2018).

Systematic reviews and meta-analyses corroborate this structural shift. Comprehensive surveys of the field observe that while early research focused on simple diversification tests using standard linear models, contemporary inquiries increasingly utilize non-linear frameworks (such as cross-quantilograms and wavelet coherence) to capture the time-varying and state-dependent nature of these linkages (Adelopo & Luo, 2025; Kyriazis, 2019). These reviews emphasize that the "safe haven" properties of cryptocurrencies are not static; rather, they are conditional on the market regime and the investment horizon. Consequently, Bitcoin and gold have emerged as central assets in the debate on portfolio protection, with recent bibliometric analyses suggesting that while gold remains a traditional hedge, cryptocurrencies act as conditional diversifiers that may lose their hedging effectiveness during periods of extreme market distress (Anas et al., 2025).

Within the specific domain of Islamic finance, the literature reveals a complex, regime-dependent relationship between Shariah-compliant equities and digital assets. Theoretically, Islamic indices are structured to resist speculative shocks due to asset-backing requirements and the prohibition of interest; however, empirical evidence suggests they provide only partial insulation from global financial contagion (Balcı, 2025; El Mehdi & Mghaieth, 2017). The interaction between cryptocurrencies and Islamic markets typically exhibits non-linear dependence that strengthens during turbulent market states. For example, while some studies identify Islamic stocks and gold as effective safe havens that remain distinct from speculative crypto-volatility during crises like the pandemic, others argue that Bitcoin acts merely as a speculative diversifier rather than a reliable hedge for Islamic portfolios (Bahloul et al., 2021; Chkili et al., 2021). While some studies explore the safe-haven potential of crypto-assets during specific crises (Jana & Sahu, 2024; Jeribi, 2020), portfolio analyses confirm that hedging effectiveness is state-dependent and often inferior to gold or commodities during bear markets (Bandhu Majumder, 2022; Maitra et al., 2022; U. Shahzad et al., 2021; Singh et al., 2024). Advanced modeling using time-varying copulas further demonstrates that the dependence between Bitcoin and major Islamic equity indices is asymmetric, intensifying when markets are in a bearish state (Rehman et al., 2020; Yousaf et al., 2024).

Regionally, the impact of cryptocurrency volatility on Islamic markets remains unevenly explored, with a pronounced focus on the Gulf Cooperation Council (GCC) region. Evidence from GCC exchanges suggests that while Shariah compliance mitigates some downside risk, it does not eliminate the negative impact of cryptocurrency returns on equity performance, particularly in markets with high institutional quality (Mansour Nomran et al., 2024; Sami & Abdallah, 2020). In

contrast, systematic evidence for major South and Southeast Asian Islamic markets (specifically Indonesia, Pakistan, and India) is relatively scarce. In India, findings are mixed; Hung (2021) identifies unidirectional connectedness from Bitcoin to assets, whereas Velappan (2024) suggests broader co-volatility movements, and Nagaraj and Chaterji (2019) highlight the sector's growing relevance. For Indonesia, Wijaya and Ulpah (2022) analyze safe-haven roles during the pandemic, finding limited hedging capabilities. In Pakistan, distinct dynamics are observed, with Ethereum showing specific hedging properties (Nguyen & Pham, 2025) and Bitcoin serving as a hedge during financial distress (Dung et al., 2023), occurring alongside rising adoption and regulatory discourse (Baloch et al., 2023; Saeed & Sial, 2023). Collectively, these studies indicate that emerging Asian markets are increasingly exposed to crypto-volatility, yet a unified comparative analysis remains absent (Bakar & Foziah, 2024).

From a methodological perspective, while recent literature has expanded into frequency-domain and quantile-based approaches, multivariate GARCH frameworks remain the standard benchmark for quantifying volatility transmission channels. Specifically, the diagonal BEKK-GARCH and DCC-GARCH specifications are widely favored for their ability to model time-varying correlations and spillover persistence without violating positive definiteness constraints (Balcı, 2025; Iuga et al., 2024). By applying these established frameworks to the under-represented markets of Indonesia, Pakistan, and India, this study bridges the empirical gap between the GCC-centric literature and the broader discourse on emerging Asian financial stability.

2. Methodology

2.1 BEKK-GARCH Model

While univariate GARCH models effectively capture asset-specific volatility, they fail to account for the joint dynamics and cross-market spillover effects critical to this study. To address this, we employ the multivariate BEKK-GARCH specification (R. F. Engle & Kroner, 1995). The BEKK specification is specifically preferred for this analysis over other multivariate alternatives because it ensures the positive definiteness of the conditional covariance matrix by construction, a critical feature when modeling highly volatile assets like cryptocurrencies (R. F. Engle & Sheppard, 2001). Furthermore, unlike dynamic connectivity approaches that focus solely on total spillovers, the BEKK model allows for the simultaneous estimation of volatility persistence (GARCH effects) and shock transmission (ARCH effects) between specific market pairs, which is central to our research question regarding risk transfer mechanisms.

The baseline BEKK-GARCH (1,1) model is defined as:

$$H_t = C'C + \sum_{k=1}^{K}\sum_{j=1}^{q}(A'_{kj}\,\varepsilon_{t-j}\varepsilon'_{t-j}A_{kj}) + \sum_{k=1}^{K}\sum_{i=1}^{p}(\beta'_{ki}H_{t-i}\beta_{ki}) \quad (1)$$

Where H_t is the conditional covariance matrix and C is a triangular matrix of constants. The parameter matrices A_{kj} and β_{ki} represent the ARCH (shock) and GARCH (volatility persistence) effects, respectively. In our empirical application, we employ the standard BEKK-GARCH (1,1) specification (where p=q=1). The diagonal elements of matrices A and β capture own-market volatility spillovers, while the off-diagonal elements capture cross-market transmission. Specifically, statistically significant off-diagonal parameters indicate the presence of volatility spillover between the cryptocurrency and Islamic equity markets.

2.2 DCC-GARCH Model

To examine time-varying correlations, we employ the Dynamic Conditional Correlation (DCC) GARCH model (R. F. Engle, 2002). This framework is preferred over Constant Conditional Correlation (CCC) models as it captures dynamic shifts in market integration. The estimation proceeds in two steps: first, univariate GARCH models are estimated to obtain the standardized residuals; second, the time-varying correlation matrix is computed.

The conditional covariance matrix H_t is decomposed as:

$$H_t = D_t R_t D_t \quad (2)$$

$$R_t = Conditional\ correlation\ matrix$$

Where D_t is the diagonal matrix of conditional standard deviations from the univariate stage, and R_t is the time-varying conditional correlation matrix. The dynamic structure of the correlation is governed by the proxy matrix Q_t, which evolves according to:

$$Q_t = q_{ii,t} = S(1 - \alpha - \beta) + \alpha\varepsilon_{t-1}\varepsilon'_{t-1} + \beta Q_{t-1} \quad (3)$$

Where S represents the unconditional covariance matrix of the standardized residuals. For the model to remain stationary and mean-reverting, the parameters α and β must satisfy:

$$a + \beta < 1 \quad (4)$$

Finally, the conditional correlation matrix P_t is obtained by normalizing Q_t:

$$R_t = \left[diag(Q_t)^{-\frac{1}{2}}\right] Q_t \left[diag(Q_t)^{-\frac{1}{2}}\right] \quad (5)$$

This specification allows us to observe the evolution of co-movement between cryptocurrencies and Islamic indices over the sample period, capturing potential contagion effects during stress episodes.

2.3 Data

The dataset for this study comprises daily prices of three Islamic equity indices for Indonesia, Pakistan, and India; and three cryptocurrencies with large market capitalizations, Bitcoin (BTC), Ethereum (RTH), and Ripple (XRP). The Islamic equity indices used are ~~the~~ Jakarta Composite Index for Indonesia, Karachi 100 for Pakistan, and Nifty Shariah Index for India. The cryptocurrency data are sourced from CoinMarketCap[3], and the Islamic equity data are sourced from Yahoo Finance[4], covering the period from January 4, 2017, to January 4, 2025. The start date is determined by data availability, and the daily data were collected five days a week, excluding non-trading days for the respective assets. The daily closing price returns for asset *i* at time *t* are defined as $R_{i,t}$:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \times 100 \quad (6)$$

3. Results and Discussion

3.1 Descriptive Statistics

The descriptive statistics for the cryptocurrency assets and the selected Islamic equity indices are presented in Table 1. Among the cryptocurrency assets, Ripple (XRP) exhibits the highest mean return (0.326), while Bitcoin (BTC) shows the lowest (0.249). Regarding the Shariah-compliant equity markets, the Nifty Shariah Index in India reports the highest mean return (0.058), whereas Indonesia's Jakarta Composite records the lowest (0.016). In terms of risk, cryptocurrency assets are significantly more volatile than the equity indices, with XRP exhibiting the highest standard deviation. This aligns with the speculative nature of the crypto market, where regulatory uncertainty and sentiment-driven trading often drive extreme price swings (Rudolf et al., 2021; Trabelsi, 2018; Wilson, 2019).

[3] https://coinmarketcap.com/

[4] https://financeyahoo.com/

The substantial difference between the maximum and minimum values of the return series, along with kurtosis values greater than three, indicates that the series exhibits a leptokurtic distribution. The Jarque-Bera statistics are statistically significant for both cryptocurrency assets and Islamic equity indices, suggesting that none of the return series are normally distributed. To assess stationarity, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirm the rejection of the unit root hypothesis at conventional levels. Furthermore, the significant results from the ARCH Lagrange Multiplier (ARCH-LM) test confirm the presence of conditional heteroskedasticity, indicating potential issues with volatility clustering and autocorrelation. This presence of volatility clustering aligns with the multifractal and inefficient nature of digital asset markets, justifying the application of GARCH-type models (Al-Yahyaee et al., 2020; Zhang et al., 2025).

Table 1: *Preliminary Analysis and Descriptive Statistics*

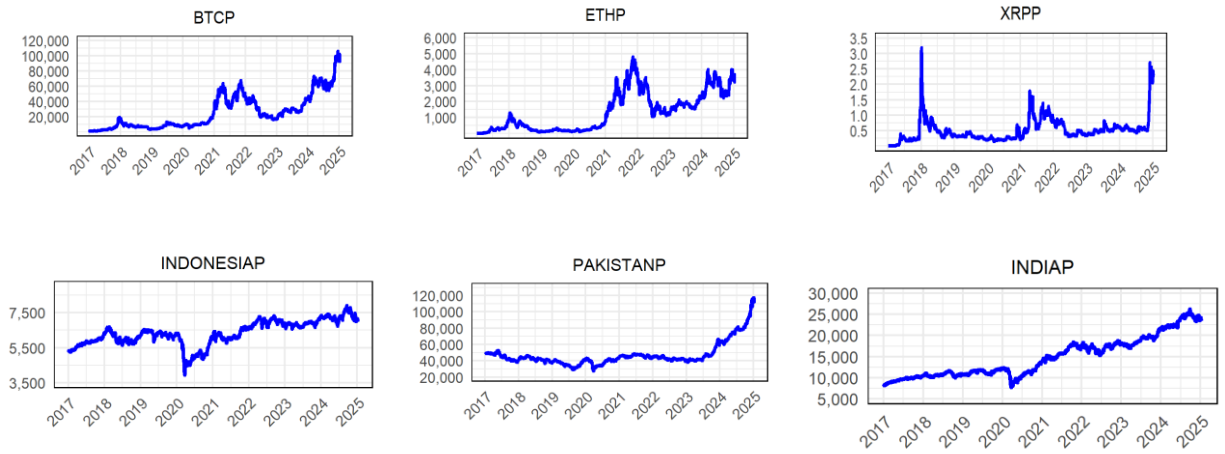
	BTC	**ETH**	**XRP**	**INDONESIA**	**PAKISTAN**	**INDIA**
Mean	0.249	0.321	0.326	0.016	0.046	0.058
Median	0.175	0.082	-0.084	0.046	0.053	0.096
Maximum	22.512	39.354	75.084	9.704	6.927	10.231
Minimum	-46.473	-55.073	-55.050	-6.805	-7.102	-11.428
Std. Dev.	4.718	6.166	7.716	0.980	1.216	1.122
Skewness	-0.655	-0.086	1.839	-0.229	-0.376	-0.736
Kurtosis	11.857	11.075	20.725	13.275	7.236	20.365
JB	6058.497	4930.114	24767.390	7995.044	1398.908	22956.730
Probability	0.000	0.000	0.000	0.000	0.000	0.000
Sum	450.782	581.705	590.520	29.536	84.128	105.089
Sum Sq. Dev.	40363.530	68924.080	107948.500	1741.762	2682.150	2281.015
Observations	1814	1814	1814	1814	1814	1814
ADF	-42.940	-27.263	-25.557	-44.328	-38.726	-47.378
@level	0.000	0.000	0.000	0.000	0.000	0.000
PP	-43.074	-41.868	-39.689	-44.303	-39.194	-47.116
@level	0.000	0.000	0.000	0.000	0.000	0.000

Figures 1 and 2 display the daily closing prices and returns of cryptocurrency assets and Islamic equity indices, with "P" representing price and "R" denoting return in the data series. From the last quarter of 2020 until the end of 2021, market assets experienced significant volatility, reaching high values due to the ongoing impact of the COVID-19 pandemic and the bull market that emerged in 2021. The prices in the cryptocurrency market exhibit a high degree of unpredictability. XRP and ETH appear more volatile than BTC; price jumps (percentage changes) in ETH and especially XRP are sharper than in BTC. Table 1 and Figure 1 demonstrate that the cryptocurrency market exhibits the highest level of volatility among financial asset classes, aligning with and reinforcing the conclusions of previous research (Joseph et al., 2022, 2024).

Figure 1 shows a pronounced decline in all three Islamic equity indices in 2020, largely attributable to the COVID-19 pandemic and the associated global economic recession. This downturn can be traced to the financial shock experienced worldwide, which subsequently affected Islamic markets. While the Indian and Indonesian indices began a gradual recovery around mid-2020, Pakistan's recovery appears delayed. Instead of rebounding swiftly, the Pakistani index remained relatively flat throughout 2020, only to accelerate markedly in 2021 and particularly in 2022, ultimately

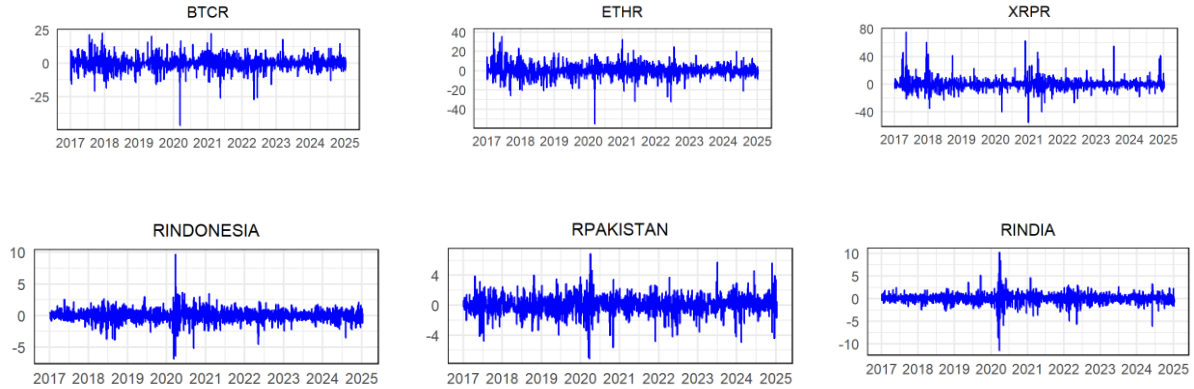
reaching its peak at the beginning of 2025. While the Indonesian index exhibited a robust upward trajectory after 2021, largely backed up by global liquidity conditions, it entered an even steeper ascent from 2022 onward. The index peaked in 2024, followed by a partial decline at the beginning of 2025. In contrast, India sustained its post-2021 recovery, exhibiting marked growth during 2023-2024 and ultimately peaking in the latter half of 2024. These dynamics align with Wijaya and Ulpah (2022) and Jana and Sahu (2024), who likewise reported pronounced volatility in Islamic stock markets during COVID-19.

Figure 1: *Daily closing prices*



Source: Generated by authors.

Figure 2: *Daily closing returns*



Source: Generated by authors.

Table 2 presents the correlation between the selected cryptocurrency assets and Islamic equity indices. The table reveals a strong and positive correlation among cryptocurrency assets. Similarly, the Islamic equity indices exhibit positive correlations with each other. Conversely, the relationship between crypto asset fluctuations and Islamic market indices remains relatively weak across all series. India (Nifty Shariah Index) shows the highest correlation with cryptocurrency assets, followed by Indonesia (Jakarta Composite Index). These relatively weak correlations suggest that cryptocurrencies remain largely decoupled from Islamic equity markets, offering distinct risk profiles (Corbet et al., 2020; Gil-Alana et al., 2020).

Table 2: *Correlation matrix of stock market indices*

	BTCR	ETHR	XRPR	RINDONESIA	RPAKISTAN	RINDIA
BTCR	1					
ETHR	0.704	1				
XRPR	0.473	0.504	1			
RINDONESIA	0.087	0.090	0.086	1		
RPAKISTAN	0.014	0.038	0.024	0.152	1	
RINDIA	0.101	0.142	0.078	0.467	0.175	1

We investigate the nonlinearity properties of the return series for the final preliminary analysis. Based on these criteria, the BDS test (Broock et al., 1996) is employed, and Table 3 presents the results. The results highlight that BTCR, ETHR, XRPR, RINDONESIA, RPAKISTAN, and RINDIA are statistically significant at the 1% level across dimensions 2 to 6. These results reject the null hypothesis that the residuals are independent and identically distributed (i.i.d.). Consequently, this confirms the presence of non-linear dependence and complex structure in the data, thereby validating the application of the BEKK-GARCH and DCC-GARCH frameworks.

Table 3: *BSD Test Results*

Dimension	BTCR	ETHR	XRPR	INDIAR	RPAKISTAN	RINDENOSIA
M2	0.011***	0.016***	0.033***	0.022***	0.016***	0.023***
M3	0.023***	0.027***	0.063***	0.042***	0.031***	0.043***
M4	0.033***	0.037***	0.082***	0.055***	0.044***	0.054***
M5	0.040***	0.042***	0.091***	0.060***	0.050***	0.060***
M6	0.042***	0.043***	0.093***	0.061***	0.052***	0.061***

Note: ***p < 1%

3.2 Results of BEKK-GARCH

The descriptive and preliminary analysis indicates that our dataset adequately fulfills the fundamental assumptions of both the diagonal BEKK-GARCH and the DCC-GARCH models, thereby enabling robust application of these frameworks. The BEKK-GARCH model is estimated first; and the results are reported in Table 4.

As reported in Table 4, the C_i coefficients represent fixed parameters, indicating whether there are leading relationships regarding daily returns in the markets (Erten et al., 2012). The A_i coefficients show the impact of short-term, lagged shocks on the market (the ARCH effect); $A_{11}$and A_{22} capture own shock effects, while A_{12} captures the cross-shock spillover between markets. The B_i coefficients indicate long-term persistence (GARCH effect); B_{11} and B_{22} capture own volatility persistence. Positive off-diagonal elements of A_i suggest that volatility is more strongly impacted when market shocks occur in the same direction rather than moving in opposing directions (Sajeev & Afjal, 2022).

The analysis results imply that most of the ARCH and GARCH terms are significant at the 5% level, highlighting the considerable impact of the cryptocurrency shocks on the subsequent volatility of the Islamic equity markets. Furthermore, the B_i coefficients are higher than the A_i coefficients and therefore show a more substantial GARCH effect. Markets exhibit prolonged volatility in response to shocks, indicating a slow recovery and long-term volatility persistence. In Table 4, the significant A_{11} coefficients for the BTC pairs with Islamic equity indices indicate that past shocks in BTC have a lasting influence on its current price, with disruptions in BTC's price stability extending into the next trading session. Likewise, for the Islamic equity indices in the case of A_{22}, the coefficients imply that its past price volatility primarily influences current price shocks. Although the A_{11} coefficients are significant, the values of the parameters are not high for

BTC and ETH. For example, the BTC-Indonesia A_{11} estimate (A_{11}=0.2433(0.000)) suggests that 24% of BTC's price disruptions persist into the following day. Comparably, 23% of the breaks in ETH-Indonesia (A_{11}=0.2297 (0.000)) persist until the next day.

The GARCH effects (B_{11}, B_{22}) indicate that own past volatility most heavily influences cryptocurrency assets and Islamic equity markets. In the case of XRP-Pakistan, XRP is affected by its own past volatility by 86% (B_{11}=0.8613(0.000)), and Pakistan is affected by its own past volatility by 91% (B_{22}=0.9186(0.000)).

Cross-market spillovers are summarized by A_{21} and A_{12}. The A_{21} parameter estimates are significant in most cases, and the A_{12} parameter estimates are insignificant in most cases, suggesting a one-way relationship between cryptocurrency assets and Islamic equity indices. The A_{21} parameter estimate shows that crypto asset shocks propagate particularly strongly to the Islamic equity markets, while India and Pakistan are not affected by XRP shocks. These results are consistent with the study by Hung (2021) for India but only partially consistent with Velappan (2024), who finds a two-way relationship between India and cryptocurrencies. Moreover, Wijaya and Ulpah (2022) report similar results for Indonesia during and before COVID-19, and Dung et al. (2023) document comparable patterns for Pakistan.

The fluctuation patterns linking crypto assets and the Islamic equity indices are captured by B_{21} and B_{12} in Table 4. B_{21} is significant and negative in most cases. Significance indicates that the cryptocurrency assets transmit volatility on Islamic equity indices, and the negative sign reflects the direction of the estimated effect. The highest significant B_{21} parameter is in the case of BTC-Pakistan, where BTC transfers 28% of negative volatility to Pakistan. In the case of XRP and Islamic equity indices, B_{21} is insignificant for all three Islamic equity indices, implying that XRP does not spread volatility to these markets. On the other hand, the B_{12} parameter estimate is significant only for ETH-Pakistan (B_{12}=-0.0031(0.040)), indicating that Pakistan Islamic equity indices transmit a 0.3% negative volatility to ETH. Moreover, Nguyen & Pham (2025) find a positive correlation between ETH and the Pakistani stock market and stated that ETH can act as a strong hedging instrument against the Pakistani stock market.

Overall, cryptocurrency assets exhibit high volatility persistence and transmit volatility to the Pakistani and Indonesian Islamic equity markets in particular, but the effect of this contagion is more limited in the Indian Islamic equity market.

Table 4: *Results of BEKK-GARCH*

	BTC			ETH			XRP		
	Indonesia	**Pakistan**	**India**	**Indonesia**	**Pakistan**	**India**	**Indonesia**	**Pakistan**	**India**
C11	1.1984	0.8158	0.9828	0.9153	0.7778	0.8296	2.3536	2.1654	2.1386
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
C12	0.0243	0.2119	-0.0243	0.0377	0.2385	0.0213	0.0118	-0.0580	0.0146
	0.262	(0.000)*	0.519	(0.061)***	(0.000)*	0.531	0.484	(0.096)***	0.509
C22	0.1449	0.3301	0.2066	0.0377	0.2869	0.2059	0.1285	0.2961	0.1914
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
A11	0.2433	0.2130	0.2152	0.2297	0.2274	0.2233	0.5139	0.4483	0.4582
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
A21	0.2687	0.4011	0.1634	0.2692	0.2604	0.2831	0.3436	0.1380	-0.0711
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	0.103	0.359
A12	-0.0104	-0.0022	-0.0039	-0.0032	0.0070	-0.0003	-0.0023	0.0008	0.0027
	(0.003)*	0.594	0.263	0.101	(0.057)***	0.901	0.235	0.773	0.225
A22	0.2476	0.3864	0.3343	0.2641	0.3673	0.3498	0.2301	0.3110	0.3191
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
B11	0.9361	0.9550	0.9536	0.9628	0.9658	0.9655	0.8243	0.8613	0.8580
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
B21	-0.0566	-0.2839	-0.0259	-0.0675	-0.1893	-0.0635	-0.0357	0.0605	0.0540
	(0.043)**	(0.000)*	0.318	(0.007)*	(0.000)*	(0.022)**	0.565	0.369	0.337
B12	0.0020	-0.0006	0.0021	0.0004	-0.0031	-0.0002	0.0013	-0.0005	-0.0014
	0.196	0.817	0.343	0.589	(0.040)**	0.871	0.195	0.737	0.221
B22	0.9542	0.8654	0.9207	0.9481	0.8783	0.9173	0.9626	0.9186	0.9314
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*

*Note: *,**, and *** indicate significance at 1,5, 10% level, respectively*

Several studies, including those by Shahrour et al. (2024), Paeng et al. (2024), Şenol et al. (2022), Bouri et al. (2020), and Symitsi and Chalvatzis (2018), document a bidirectional relationship between financial markets and cryptocurrency assets. In the present analysis, apart from the bidirectional relationship observed between ETH and Pakistan, all remaining pairs demonstrated a unidirectional linkage with Islamic equity indices. Similarly, Joshi et al. (2022), Gherghina et al. (2024), and identify unidirectional connections. Moreover, the detected effects are moderate in magnitude, and the results remain consistent with Joseph et al. (2024), Vuković et al. (2025), and Mensi et al. (2023). Taken together, the evidence aligns with integration and contagion perspectives, under which growing interdependence permits shocks in one segment to propagate to others.

This transmission effect can be explained by multiple underlying factors. First, the heightened economic uncertainty in recent years has eroded investor confidence in traditional financial markets, prompting a shift toward alternative investment instruments as a hedge against rising inflation (Bahloul et al., 2021; T. Iyer, 2022). Second, with the growing prevalence of digital platforms, younger demographics increasingly prefer digital currencies for wealth preservation (Baloch et al., 2023) and global engagement. Third, in jurisdictions such as Pakistan, improving perceptions of crypto assets and rising popularity, coupled with financial inclusion policies, have supported adoption (Saeed & Sial, 2023). Finally, increasing global financial integration may facilitate the rapid transmission of fluctuations from the cryptocurrency market to Islamic financial systems (Zhang et al., 2025).

3.3 Results of DCC-GARCH

We supplement the BEKK-GARCH framework with DCC-GARCH analysis to capture dynamic co-movement and verify volatility transmission channels. The literature commonly employs this dual approach to ensure robustness across different estimation techniques (Apostolakis, 2024; Danila et al., 2024; Iuga et al., 2024; Rastogi et al., 2024). In DCC-GARCH analysis, μ represents the overall mean, while the fixed parameters represent the intercept by Ω. The ARCH effect α is defined as the influence exerted by prior structural shocks. The GARCH effect, denoted by the term β, is characterized as the impact of preceding volatility fluctuations. The short-term volatility spillovers from the cryptocurrency market are captured by the ARCH effect, whereas the long-term volatility spillovers to Islamic equity markets are accounted for by the GARCH effect. Finally, Dcc(θ1) represents the short-run conditional correlation estimates, and Dcc(θ2) represents the long-run conditional correlation estimates.

In the results in Table 5, DCC(θ1) values are significant at the 1% significance level for all markets. The DCC(θ1) results, representing the conditional correlation between cryptocurrency assets and Islamic stock markets, show a volatility pass-through or volatility spillover from all cryptocurrency assets to all Islamic markets in the short term. The short-term volatility spillover from crypto-assets to Islamic exchanges is very low. It is around 1%, indicating that the sudden price change in the markets does not significantly affect the correlation across markets. DCC(θ2) values are significant at the 1% significance level for all markets. DCC(θ2) values are above 91% for all markets and high DCC(θ2) values indicate a volatility carryover between crypto assets and Islamic stock markets in the long run. In other words, it indicates that crypto assets and Islamic stock markets are integrated in the long run; in other words, they tend to move together. These findings support the financial integration hypothesis, suggesting that the convergence of emerging markets with global assets occurs primarily over long horizons. This aligns with Corbet et al. (2018), who found that cryptocurrencies remain relatively isolated from traditional financial assets in the short run, thereby offering diversification advantages for investors with shorter time horizons, but lose this isolation over the long run.

In Table 5, the combined ARCH and GARCH effect estimates ($\alpha + \beta < 1$) remain below one in every instance. The combined value of both effects typically exceeds 0.93, suggesting a strong persistence in volatility. In literature, high volatility persistence is common in times of crisis, as well as in cryptocurrency markets and emerging equity markets (Iglesias & Rivera-Alonso, 2022; Rijanto, 2023).

Table 5: *DCC-GARCH*

	BTC	ETH	XRP
Indonesia			
μ	0.0538	0.0555	0.0570
	(0.001)*	(0.001)*	(0.000)*
Ω	0.0416	0.0406	0.0441
	(0.002)*	(0.002)*	(0.003)*
α	0.1061	0.1026	0.1096
	(0.000)*	(0.000)*	(0.000)*
β	0.8507	0.8535	0.8504
	(0.000)*	(0.000)*	(0.000)*
Pakistan			
μ	0.0684	0.0715	0.0730
	(0.002)*	(0.001)*	(0.001)*
Ω	0.1108	0.1092	0.1140
	(0.000)*	(0.000)*	(0.000)*
α	0.1536	0.1482	0.1566
	(0.000)*	(0.000)*	(0.000)*
β	0.7863	0.7904	0.7928
	(0.000)*	(0.000)*	(0.000)*
India			
μ	0.1155	0.1144	0.1139
	(0.000)*	(0.000)*	(0.000)*
Ω	0.0987	0.0383	0.0392
	(0.000)*	(0.000)*	(0.000)*
α	0.0860	0.0835	0.0847
	(0.000)*	(0.000)*	(0.000)*
β	0.8747	0.8775	0.8805
	(0.001)*	(0.000)*	(0.000)*
DCC			
θ_1	0.0098	0.0101	0.0108
	(0.009)*	(0.002)*	(0.007)*
θ_2	0.9196	0.9338	0.9244
	(0.000)*	(0.000)*	(0.000)*

*Note: *,**, and *** indicate significance at 1, 5, and 10% levels, respectively*

The DCC-GARCH results indicate that the integration of cryptocurrency assets with Islamic equity markets has strengthened, and this correlation will continue in the long run. The high integration between cryptocurrency assets and Islamic equity markets increases the risks associated with crypto assets in the financial system of these markets, and cryptocurrency assets have begun to play a vital role in the portfolios of investors in countries with significant Islamic finance sectors, such as India (Nagaraj & Chaterji, 2019). One of the key consequences of this integration for Islamic exchanges is that intensified price fluctuations and market disturbances originating in the crypto asset sector may weaken trust among investors and threaten overall economic stability within Islamic economies.

The conditional correlations between crypto assets and the stock markets of three selected Islamic equity indices are presented in Figures 3-4 and 5. The conditional correlations show that there are volatility spillovers between crypto assets and the stock markets of Islamic countries. Moreover, investment portfolios change in different periods. This suggests that investors make significant changes in their market-traded portfolios over time. There is also a clustering in volatility. Even if contagion between markets is not relatively short-term, it seems to persist in the long run across markets. It would be beneficial for investors to consider the volatility in crypto assets when making long-term investment decisions in Islamic equity markets.

In Figures 3-4-5, conditional correlations are very high for crises such as the first half of 2020 (the COVID-19 pandemic) and the first half of 2022 (the Russia-Ukraine war period). This indicates that BTC, ETH, and XRP failed to serve as effective safe-haven assets for Islamic equity markets during periods of global stress, echoing findings that crypto-equity correlations tend to spike during tail-risk events (Jana & Sahu, 2024; Jeribi, 2020). While they may offer diversification in normal times, their role as a hedge diminishes when systemic risk rises.

Taken together with the BEKK-GARCH results, the evidence indicates that, investors are unlikely to obtain broad diversification benefits by including both cryptocurrency assets and Islamic equity instruments in their portfolios. However, portfolio diversification is possible in the short term.

Figure 3: *Conditional Correlations between BTC and Islamic Equity Indices*

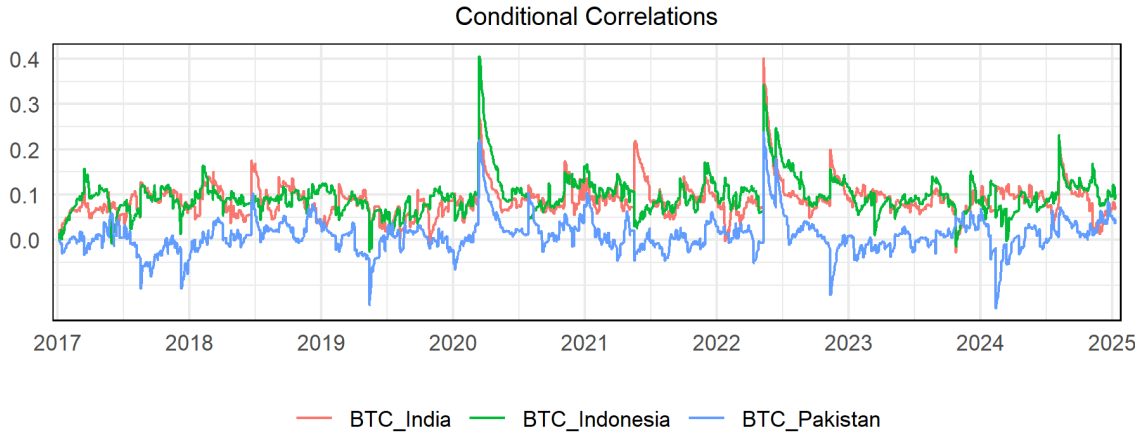


Figure 4: *Conditional Correlations between ETH and Islamic Equity Indices*

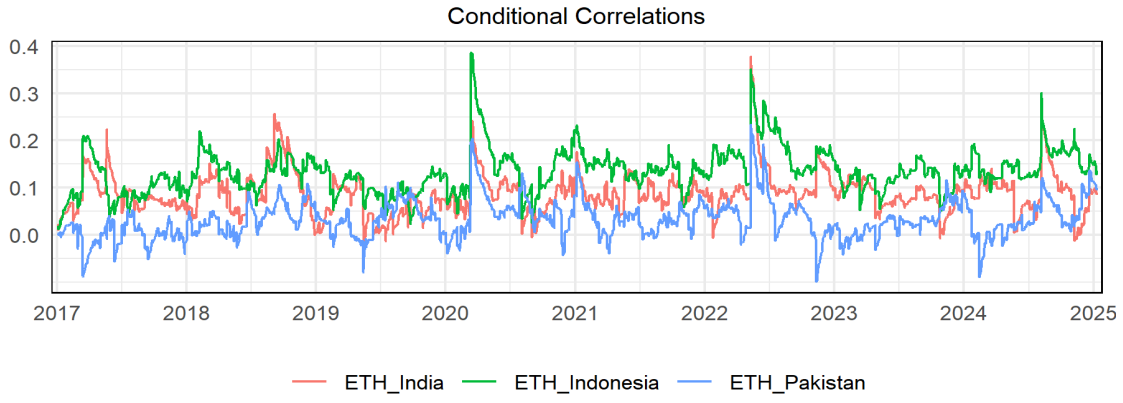
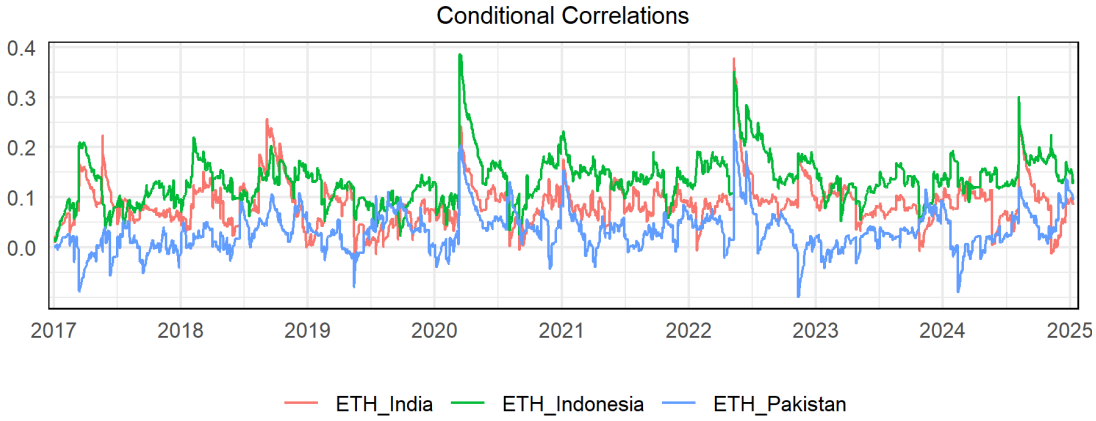


Figure 5: *Conditional Correlations between XRP and Islamic Equity Indices*



4. Conclusion

This study investigates the dynamic relationship between cryptocurrency assets and the Islamic equity markets in Indonesia, Pakistan, and India, and examines the impact of this relationship on Islamic equity markets. To identify potential transmission of price fluctuations from crypto assets to Islamic equity markets, BEKK-GARCH and DCC-GARCH models are utilized. The sample spans January 4, 2017, to January 4, 2025, with daily observations aligned to a common business-day calendar.

The BEKK-GARCH results indicate predominantly unidirectional spillovers from cryptocurrency assets to Islamic equity indices, with the exception of the Ethereum-Pakistan pair. For Ethereum-Pakistan, a bidirectional link is detected: Pakistan transmits an estimated 0.3% volatility effect to Ethereum, while Ethereum transmits approximately 19% to Pakistan. Spillovers are strongest toward Pakistan and Indonesia; effects on the Nifty Shariah Index in India are comparatively smaller. Moreover, positive shocks exhibit greater transmissibility than negative shocks. The DCC-GARCH results show statistically significant, time-varying correlations between crypto assets and Islamic equity indices. Nevertheless, these findings do not provide strong evidence of a sizable transmission impact from crypto assets to Islamic equity markets over short horizons. The equity indices in India, Pakistan, and Indonesia exhibit a modest yet growing spillover from crypto assets. In other words, the results indicate that volatility spillovers are weak in the short run but become economically meaningful over longer horizons. Ethereum and Ripple display weaker correlations, whereas Bitcoin shows a stronger and more persistent connection with Islamic equity markets, as evidenced by the conditional correlation analysis.

The results suggest that financial investors can use cryptocurrency assets to diversify risks in Islamic equity markets primarily over short investment horizons, taking into account the low correlations and weak short-run spillovers between cryptocurrency assets and Islamic equities. The weak correlation between cryptocurrency assets and other financial assets offers investors the opportunity to diversify portfolios and obtain hedging benefits (Maitra et al., 2022; S. J. H. Shahzad et al., 2021). However, as correlations become persistent over longer horizons, it is thought that relying on cryptocurrencies for long-term diversification against Islamic equity markets is less effective. Prior studies likewise confirm the state- and horizon-dependent nature of cryptocurrency hedging and diversification capabilities (Bandhu Majumder, 2022; Singh et al., 2024).

Policy implications are best framed as an integrated supervisory program rather than a set of discrete checklists. Model-based indicators derived from BEKK and DCC should be embedded directly into supervisory dashboards, with explicit thresholds on off-diagonal BEKK parameters and rolling median correlations used to signal rising crypto–Islamic equity interdependence as it

develops rather than ex post. The same indicators should feed macroprudential stress testing in which crypto-shock scenarios are calibrated to historical drawdowns and correlation spikes consistent with the DCC estimates are simulated; liquidity drains and margin-call channels should be modeled explicitly so that procyclical amplification is not understated. At the disclosure layer, listed firms and funds with crypto exposure should report valuation methodologies, custody arrangements, rehypothecation practices, and effective leverage, allowing the transmission channels across Islamic equity indices to be mapped in a tractable manner. When indicators breach correlation or concentration thresholds, countercyclical liquidity buffers, portfolio concentration limits, and margin add-ons should tighten automatically so that intervention is rules-based rather than discretionary. Product and custody oversight should require segregation of client assets, intraday risk limits, and transparent circuit breakers for crypto-linked ETPs/ETFs, exchanges, and custodians, thereby reducing the probability that operational failures become market events. Because trading and custody infrastructures are cross-border, information-sharing arrangements should be formalized and incident taxonomies should be harmonized, including major outages, protocol forks, and stablecoin de-pegs, so that responses are synchronized across jurisdictions serving Islamic investors.

Further research is best directed toward deepening and stress-testing these conclusions rather than expanding claims. Frequency-domain techniques, such as wavelet-based DCC, would separate short- and long-horizon co-movements more cleanly and clarify when diversification is genuinely available. Robustness should be evaluated across alternative Islamic equity indices and liquidity filters to ensure that results are not artifacts of index construction. Event-study overlays around salient episodes, including exchange failures, protocol upgrades, ETF approvals, and stablecoin dislocations, would identify the state dependence of spillovers that aggregate models only suggest. Finally, nonlinear correlation models (cDCC/aDCC) and asymmetric BEKK variants can test whether bad news propagates more strongly than good news and whether the persistence of co-movement changes after stress; if so, supervisory thresholds and portfolio guidelines should be made regime-sensitive rather than static.

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