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Interconnectedness of Financial Assets across the ASEAN-5 in Crisis Periods

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Abstract

Research Originality: This study advances the financial connectedness literature by integrating a multi-asset (Bitcoin–stocks–sovereign bonds) and time-varying framework within the ASEAN-5 context. Unlike prior studies, this study uncovers a hierarchical and asymmetric spillover structure that evolves across market regimes, providing new evidence on cross-asset transmission channels in emerging markets.

Research Objectives: The study aims to investigate the magnitude, direction, and dynamics of volatility spillovers among Bitcoin, stock, and bond markets, and to assess whether these interconnections change between normal and crisis periods.

Research Method: Using daily data from January 2018 to April 2026, volatility is estimated through a GARCH model. A generalized VAR-based forecast error variance decomposition (G-FEVD), combined with a rolling window approach, is employed to capture both directional and time-varying spillovers.

Empirical Results: The findings show a hierarchical spillover pattern: sovereign bonds act as net transmitters to Bitcoin, while Bitcoin transmits risk to stock markets. Spillover intensity increases significantly during crisis periods, peaking during COVID-19, indicating strong state-dependent connectedness. Cross-asset diversification weakens under market stress.

Implications: These findings imply that financial stability cannot be assessed in isolation, as shocks propagate across asset classes in a structured, time-varying manner. This study underscores the importance of integrated cross-market surveillance frameworks that include digital assets alongside traditional markets.

Keywords:
financial connectedness; volatility spillover; bitcoin; stock markets; sovereign bonds; time-varying analysis

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INTRODUCTION

The growing integration of cryptocurrency with traditional financial markets has fundamentally altered the structure of global financial systems, particularly in emerging regions such as ASEAN. Recent crises, including the COVID-19 pandemic, have intensified market volatility, strengthened cross-asset linkages, and reduced diversification benefits (Baig, Butt, Haroon, & Rizvi, 2021). As financial markets become increasingly interconnected, shocks are no longer confined within individual asset classes but propagate across markets (Bouri, Das, Gupta, & Roubaud, 2018). In this context, financial contagion—defined as the excess and state-dependent transmission of volatility—is captured in this study through a G-FEVD-based spillover framework, enabling the identification of both the direction and evolution of cross-asset shock propagation. The relevance of such dynamics is evident in ASEAN, where episodes such as the 1997 Asian Financial Crisis highlight the region's structural vulnerability to cross-market spillovers.

Periods of market stress intensify volatility spillovers and increase co-movement across asset classes, thereby weakening diversification benefits. However, empirical evidence on Bitcoin remains inconclusive, as it is alternately identified as a diversifier, hedge, or risk transmitter depending on market conditions. This inconsistency suggests that the relationship between Bitcoin and traditional financial assets is inherently dynamic and regime-dependent, highlighting the need for a framework that captures evolving cross-asset linkages.

Despite the growing literature on financial connectedness, existing studies provide an incomplete understanding of cross-market risk transmission. Most prior research relies on bilateral, static frameworks that fail to capture the system-wide, time-varying nature of spillovers across multiple asset classes. As a result, the role of Bitcoin remains ambiguous, particularly during periods of financial stress (Kakinuma, 2021). This limitation is not merely methodological but leads to a systematic misrepresentation of diversification benefits, particularly during crisis periods.

To address these shortcomings, this study introduces a multi-asset, time-varying connectedness framework that simultaneously examines the Bitcoin, stock, and sovereign bond markets in the ASEAN-5. The application of Generalized Forecast Error Variance Decomposition (G-FEVD), which is insensitive to variable ordering, offers greater robustness than the Cholesky-based VAR approach. The use of a rolling window minimizes methodological biases and provides a more realistic representation of spillover dynamics, particularly under extreme crisis conditions. Unlike prior studies that focus on isolated or symmetric relationships, this approach captures directional and hierarchical spillovers within a unified system and explicitly distinguishes between normal and crisis regimes. By doing so, the study provides new evidence that financial connectedness is asymmetric, structured, and regime-dependent, with important implications for financial stability and portfolio management.

The literature on financial connectedness demonstrates that asset markets are increasingly interlinked, allowing shocks to propagate across financial systems rather

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than remaining confined within individual markets (Bouri et al., 2018; Kamalul Ariffin, Mohan, & Goh, 2018; Nielsen, Lueg, & Liempd, 2020). Empirical studies show that volatility spillovers intensify during periods of market stress, reflecting heightened systemic risk and stronger asset co-movement (Khalfaoui, Mefteh-Wali, Dogan, & Ghosh, 2023; Zhang, Bouri, Gupta, & Ma, 2021). This phenomenon is particularly evident during global crises such as the COVID-19 pandemic, where uncertainty, liquidity constraints, and investor sentiment amplify cross-market transmission channels (Baig et al., 2021; Cepoi, 2020; Yaya, Zhang, Xi, & Furuoka, 2024). In emerging markets, including ASEAN, these dynamics are often more pronounced due to structural vulnerabilities and exposure to external shocks (Kamaludin et al., 2021). Consequently, financial contagion can be understood as the excess and state-dependent transmission of volatility across markets, reinforcing the importance of examining how spillovers evolve across different market conditions (Agénor & Pereira da Silva, 2021; Vuković, Frömmel, Vigne, & Zinovev, 2025).

Despite the rapid growth of cryptocurrency markets, the role of Bitcoin within the broader financial system remains inconclusive. Some studies suggest that Bitcoin exhibits weak correlation with traditional assets, supporting its role as a diversifier or hedge (Naeem, Sehrish, & Costa, 2021). However, other research finds that Bitcoin becomes increasingly connected to financial markets during periods of stress, thereby reducing its effectiveness as a hedging instrument (Goodell & Goutte, 2021b, 2021a). Furthermore, evidence indicates that Bitcoin can act as a transmitter of risk, contributing to volatility spillovers across asset classes, particularly during crisis periods (Khalfaoui, Jabeur, & Dogan, 2022; Zha, Yu, Su, & Yin, 2023). Earlier studies also show that interconnectedness between cryptocurrencies and traditional financial markets strengthens under heightened uncertainty (Antonakakis, Chatziantoniou, & Gabauer, 2019; Bouri et al., 2018). These mixed findings suggest that Bitcoin's role is not stable but regime-dependent, shifting between diversification and contagion functions depending on market conditions.

Although prior studies provide important insights into financial spillovers, several limitations remain. First, most studies adopt a bilateral framework, focusing on pairwise relationships such as Bitcoin–stock or stock–bond interactions, which fail to capture the system-wide transmission of shocks across multiple asset classes simultaneously (Antonakakis et al., 2019; Bouri et al., 2018). Second, existing research predominantly relies on static models, which overlook the time-varying and regime-dependent nature of financial connectedness (Khalfaoui et al., 2023). As a result, these approaches are unable to fully capture how spillover structures evolve during periods of market stress. Third, the absence of a unified framework contributes to the persistent ambiguity regarding Bitcoin's role, as prior findings do not account for directional and hierarchical spillover dynamics within an integrated system. These limitations suggest that existing approaches may yield an incomplete or misleading assessment of diversification benefits, particularly during crisis conditions when cross-market linkages intensify. Accordingly, there is a clear need for a unified framework that captures multi-asset interactions, directional spillovers, and regime-dependent dynamics.

METHODS

This study investigates the interconnectedness among Bitcoin, stock, and bond markets across five ASEAN countries. Daily data spanning 2 January 2018 to 10 April 2026 are utilized, comprising Bitcoin returns, daily returns of five stock indices—JCI (Indonesia), STI (Singapore), FBMKLCI (Malaysia), PCOMP (the Philippines), and SET (Thailand)—and 10-year sovereign bond yields—INDOGB, SIGB, MGS, PHILIP, and THAIGB. The GARCH model is employed to estimate time-varying daily return volatility, which is subsequently used to examine volatility transmission among the three markets. The interconnectedness driven by volatility transmission across markets is investigated using the generalized vector autoregressive framework developed by Koop, Pesaran, & Potter (1996) and Pesaran & Shin (1998). Following Diebold & Yilmaz (2012, 2014), this study employs generalized forecast error variance decomposition (G-FEVD) derived from the VAR model to measure both total and directional volatility spillovers among three asset classes across five ASEAN countries. The generalized VAR approach is adopted because there is no solid theoretical foundation for the direction of cross-market volatility spillovers. Unlike the standard VAR, this approach produces forecast-error variance decompositions that are insensitive to variable ordering.

The total volatility spillover index measures the contribution of volatility spillovers across asset markets to the total forecast error variance. This index is calculated using the following equation:

$$S^g(H) = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)} .100 = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N} .100 \quad (1)$$

$\tilde{\theta}_{ij}^g(H)$ denotes the H-step-ahead forecast error variance decomposition based on the framework proposed by Koop, Pesaran, & Potter (1996) and Pesaran & Shin (1998), hereafter referred to as KPPS, where H = 1, 2, …

To identify periods when total volatility spillovers reach extreme levels, a rolling window approach is applied over the sample period. The generalized VAR framework is subsequently employed to determine the direction of volatility spillovers, hereafter referred to as directional volatility spillovers. The directional volatility spillovers received by asset market i from all other asset markets j are defined as follows:

$$S^g{}_{i\cdot}(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)} .100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N} .100 \quad (2)$$

Meanwhile, the directional volatility spillovers transmitted from asset market i to all other asset markets j are defined as follows:

$$S^g{}_{\cdot i}(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}^g(H)} .100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^g(H)}{N} .100 \quad (3)$$

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Based on the previously computed directional volatility spillovers, net spillovers from asset market i to all other asset markets j are computed using the following equation:

$$S^g{}_i(H) = S^g{}_{.i}(H) - S^g{}_{i.}(H) \quad (4)$$

The net spillover is calculated as the difference between volatility spillovers transmitted to other asset markets and those received. To estimate the net contribution of volatility shocks from one asset market to another, this study employs the net pairwise spillover, calculated according to the following equation:

$$S^g{}_{ij}(H) = \left(\frac{\tilde{\theta}^g_{ji}(H)}{\sum_{i,k=1}^{N}\tilde{\theta}^g_{ik}(H)} - \frac{\tilde{\theta}^g_{ij}(H)}{\sum_{j,k=1}^{N}\tilde{\theta}^g_{jk}(H)}\right).100$$
$$= \left(\frac{\tilde{\theta}^g_{ji}(H) - \tilde{\theta}^g_{ij}(H)}{N}\right).100 \quad (5)$$

RESULTS AND DISCUSSION

To estimate volatility spillovers among three asset classes—Bitcoin, stocks, and bonds—across ASEAN-5, daily return data for each asset from January 2018 to April 2026 are analyzed. The main findings can be classified into two categories: (1) volatility transmission across Bitcoin, stock, and bond markets, and (2) the time-varying nature of volatility transmission. The findings indicate that volatility spillovers from Bitcoin to stock markets are more pronounced than those to bond markets. Volatility spillovers also exhibit time-varying patterns, with a sharp spike during the COVID-19 pandemic. The GARCH model is employed to estimate daily return volatility for Bitcoin, stock, and bond markets. Table 1 reports the best GARCH model specifications. Volatility estimates obtained from the GARCH model are subsequently analyzed using the generalized forecast error variance decomposition (G-FEVD) approach derived from the VAR model to investigate volatility transmission among the three assets.

Table 1. GARCH Model Selection

Variable	Best Model
Sovereign Bonds	
INDOGB	ARMA(1,0) - eGARCH(1,1)
SIGB	ARMA(1,0) - eGARCH(1,1)
MGS	ARMA(0,0) - eGARCH(1,1)
PHILIP	ARMA(1,0) - eGARCH(1,1)
THAIGB	ARMA(1,0) - eGARCH(1,1)
Bitcoin	ARMA(0,0) - sGARCH(1,1)
Stock	
JCI	ARMA(0,0) - gjrGARCH(1,1)
STI	ARMA(0,0) - gjrGARCH(1,1)
FBMKLCI	ARMA(0,0) - gjrGARCH(1,1)
PCOMP	ARMA(0,0) - gjrGARCH(1,1)
SET	ARMA(0,0) - gjrGARCH(1,1)

Table 2 displays volatility spillovers between Bitcoin markets and stock markets across five ASEAN countries. As illustrated in Table 2, bidirectional volatility spillovers from Bitcoin to all stock markets are identified across five ASEAN countries. The results suggest that 7.17% of return volatility in ASEAN stock markets is attributable to shocks originating in Bitcoin markets. Meanwhile, shocks in ASEAN stock markets contribute 4.73% to Bitcoin return volatility. Therefore, the total spillover index between the two markets stands at 5.92%, suggesting that, on average, 5.92% of Bitcoin volatility is transmitted from ASEAN stock markets and vice versa. Table 2 further reveals volatility spillovers across ASEAN stock markets and suggests that Singapore's stock market is the dominant net transmitter of volatility shocks to the other four ASEAN markets. Singapore's role as a net-transmitter is closely linked to its strong economic and financial fundamentals. In 2024, Singapore recorded a GDP of USD 547 billion and the highest GDP per capita in ASEAN at USD 90,674, reflecting a highly developed and globally integrated economy. Its stock market capitalization reached approximately 120% of GDP, indicating a deep, highly active capital market that plays a central role in the economy. In addition, Singapore exhibits a high degree of economic openness, as reflected in substantial foreign direct investment inflows and strong trade performance. These characteristics position Singapore as a key player with high capital mobility and strong global integration. Singapore is more likely to internalize external shocks than other ASEAN markets.

Table 2. Volatility Spillovers between Bitcoin and ASEAN-5 Stock Markets

	Bitcoin	***JCI***	***STI***	***FBMKLCI***	***PCOMP***	***SET***	***from others***
Bitcoin	95.27	0.89	1.24	0.92	0.79	0.9	4.73
JCI	1.71	62.27	10.58	5.95	4.34	15.15	37.73
STI	1.75	7.49	61.48	8.02	8.72	12.54	38.52
FBMKLCI	1.89	5.1	9.75	71.07	5.23	6.96	28.93
PCOMP	0.84	3.82	9.18	5.37	73.74	7.05	26.26
SET	0.97	7.17	11.77	6	4.04	70.05	29.95
to others (spillover)	7.17	24.46	42.51	26.26	23.12	42.6	27.69
to others, including own	102.44	86.74	103.99	97.33	96.86	112.64	

Although shock transmission between Bitcoin and stock markets is relatively modest (5.92%), Table 3 confirms Bitcoin's role as a net-transmitter, with a net spillover value of 2.44%. This finding indicates that the intensity of shock transmission from ASEAN-5 stock markets to Bitcoin is lower than that transmitted in the opposite direction, which may be attributed to Bitcoin's higher liquidity and greater trading volume in global markets. It is consistent with the results of Zha, Yu, Su, and Yin (2023). However, despite functioning as a net transmitter, Bitcoin's relatively low transmission intensity suggests that ASEAN-5 stock markets remain resilient to shocks originating in global crypto markets.

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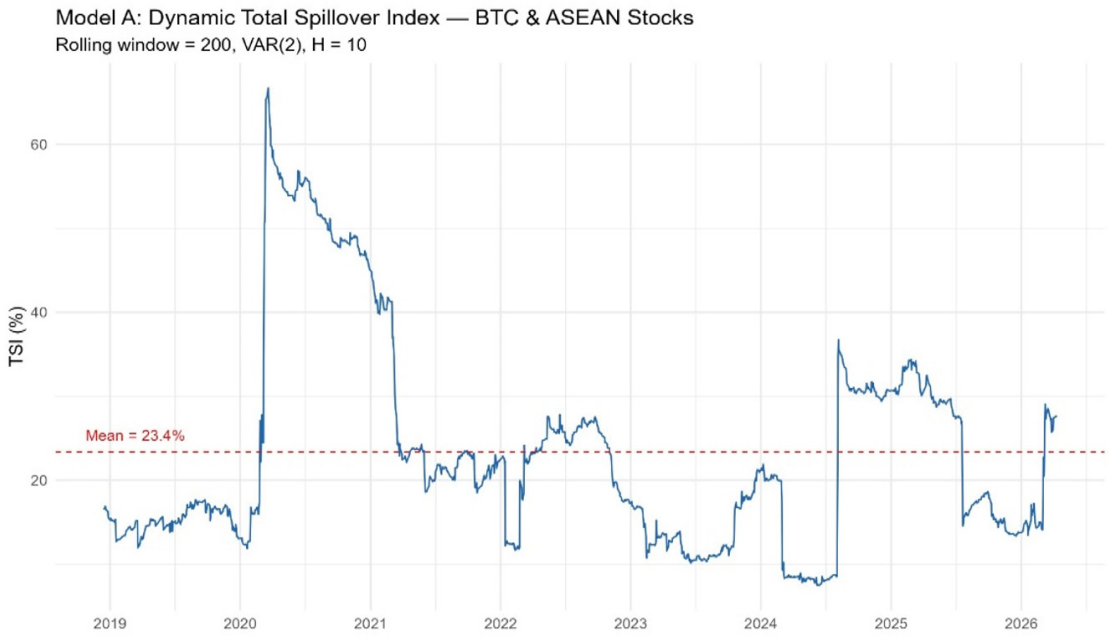
Table 3. Net Spillover

	To	From	Net Spillover
Bitcoin	7.17	4.73	2.44
ASEAN-5 Stock Exchange	4.73	7.17	-2.44

Overall, the total spillover index across Bitcoin and ASEAN-5 stock markets stands at 27.69% (as shown in Table 2, row 7, column 7), encompassing both Bitcoin-to-stock transmission and cross-country stock market spillovers. This number indicates that, on average, 27.69% of volatility in each of the six markets is attributable to volatility shocks transmitted from the remaining markets within the system. Notably, volatility transmission is most pronounced among ASEAN-5 stock markets rather than between stock and Bitcoin markets. It suggests that incorporating Bitcoin into stock-based portfolios offers greater diversification benefits than diversifying across ASEAN-5 stock markets.

The total spillover index reported in Table 3 represents the average volatility spillovers over the sample period. However, this index does not capture the time-varying intensity of volatility spillovers across the observation period. To address this limitation, this study employs a 200-day rolling window to examine the evolution of connectedness between Bitcoin and stock markets across the ASEAN-5. Figure 4 presents the resulting time-varying spillover index.

Figure 4. Dynamic Volatility Spillover Index between Stock and Bitcoin Markets



Results presented in Table 2 suggest an average volatility spillover index of 27.6% over the observation window. Nevertheless, analysis reveals a sharp escalation in shock transmission intensity between 2020 and early 2022, with spillover intensity peaking at approximately 70% during 2020–2021. This escalation coincided with prolonged bearish

market conditions triggered by the COVID-19 pandemic. This finding is consistent with results of prior studies documenting the significant impact of the COVID-19 pandemic on volatility spillovers in stock markets (Bora & Basistha, 2021; Chaudhary, Bakhshi, & Gupta, 2020; Kusumahadi & Permana, 2021; Okorie & Lin, 2021). Similarly, Saadah (2013) and Bae & Zhang (2015) confirm that the intensity of risk transmission across financial markets intensifies significantly during crisis periods. It further indicates that the interconnectedness between Bitcoin and ASEAN-5 stock markets strengthens markedly during crisis periods, thereby heightening systemic risk. Bitcoin's role as a net transmitter to ASEAN-5 stock markets underscores the need for cross-market monitoring and the strengthening of integrated regulatory frameworks governing crypto assets, with financial authorities strongly advised against treating crypto markets in isolation.

This study further investigates volatility transmission between Bitcoin and sovereign bond markets across ASEAN-5. Table 4 reports the results obtained from G-FEVD based on a VAR model. Table 4 presents volatility transmission between Bitcoin and ASEAN-5 bond markets. The results indicate that 4.35% of return volatility in ASEAN-5 bond markets is attributable to shocks originating from Bitcoin markets, while shocks in ASEAN-5 bond markets contribute 5.27% to return volatility in Bitcoin markets. The total spillover index between Bitcoin and bond markets across ASEAN-5 stands at 4.81%, suggesting that, on average, 4.81% of Bitcoin's return volatility is attributable to volatility transmitted from ASEAN-5 bond markets, with the reverse direction exhibiting a similar pattern.

Table 4. Volatility Spillovers between Bitcoin and ASEAN-5 Sovereign Bond Markets

	INDOGB	***SIGB***	***MGS***	***PHILIP***	***THAIGB***	***Bitcoin***	***from others***
INDOGB	88.56	3.86	1.18	0.11	5.15	1.14	11.44
SIGB	3.48	76.12	7.67	0.04	11.95	0.75	23.18
MGS	2.38	4.33	88.49	0.17	4.37	0.26	11.51
PHILIP	0.39	2.51	1.79	91.43	2.38	1.5	8.57
THAIGB	5.24	11.87	3.87	0.58	77.74	0.7	22.26
Bitcoin	1.15	1.49	0.33	0.08	2.21	94.73	5.27
to others (spillover)	12.63	24.07	14.84	0.98	26.06	4.35	13.82
to others including own	101.19	100.19	103.33	92.4	103.8	99.09	

Table 4 further reveals volatility transmission among ASEAN-5 bond markets, with Singapore's bond market emerging as the second-most dominant net transmitter of shocks, following Thailand. The total spillover index across Bitcoin and the five ASEAN-5 bond markets stands at 13.82%, indicating that, on average, 13.82% of return volatility in each of the six markets is attributable to shocks originating from the remaining markets within the system. Notably, volatility transmission among ASEAN-5 bond markets is more pronounced than that between bond and Bitcoin markets, indicating that integrating Bitcoin into bond portfolios offers greater diversification benefits than diversifying across ASEAN-5 bond markets.

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A comparison of Tables 2 and 4 indicates that volatility transmission between Bitcoin and stock markets across the ASEAN-5 is greater than that between Bitcoin and bond markets. It suggests that Bitcoin-stock interconnectedness is more pronounced than Bitcoin-bond interconnectedness within the region. Similar to the Bitcoin-stock interconnectedness analysis, a rolling-window approach is used to examine the time-varying nature of volatility spillovers between Bitcoin and bond markets.

Figure 5. Dynamic Volatility Spillover Index between Bond and Bitcoin Markets

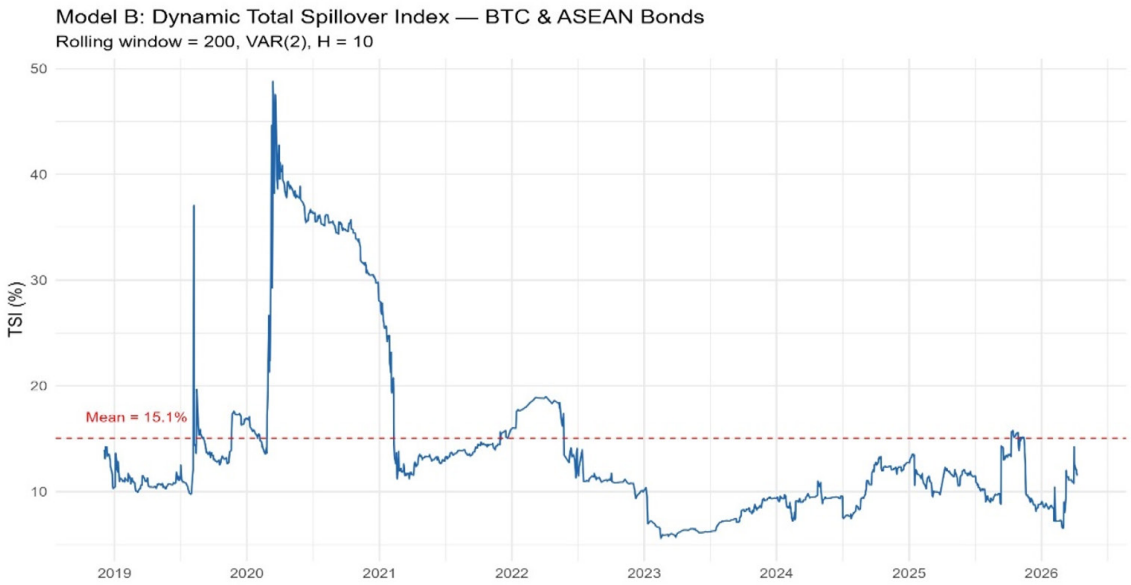

Figure 5 presents the time-varying volatility spillovers between the bond and Bitcoin markets across the ASEAN-5 over the study period. Similar to the Bitcoin-to-stock volatility transmission pattern, volatility transmission between the bond and Bitcoin markets escalated sharply, peaking at nearly 50% during 2020–2021, coinciding with the extended period of bearish market conditions induced by the COVID-19 pandemic. This finding confirms that volatility transmission across the three asset classes tends to escalate sharply during crisis periods, a pattern consistently observed in this study as evidenced in Figures 4 and 5.

This study investigates the interconnectedness (volatility spillovers) among Bitcoin, stock, and bond markets across the ASEAN-5, spanning the pre-crisis, crisis, and post-crisis periods, with a particular emphasis on the post-COVID-19 recovery phase and the normal period. The findings indicate that, within the ASEAN-5, volatility spillovers from Bitcoin to stock markets are more pronounced than those to bond markets. From an investment perspective, this suggests that integrating Bitcoin and bonds into portfolios offers greater diversification benefits than integrating Bitcoin and stocks. However, as illustrated in Figures 4 and 5, a sharp increase in volatility spillover intensity across assets reduces the effectiveness of cross-asset diversification strategies during crisis periods. This finding corroborates previous studies indicating that the COVID-19 pandemic has

affected volatility spillovers in the stock market (Bora & Basistha, 2021; Chaudhary et al., 2020; Kusumahadi & Permana, 2021; Kakinuma, 2021; Okorie & Lin, 2021).

Additionally, Tables 3 and 4 demonstrate the role of each asset in the interconnectedness across ASEAN-5 markets, where bond markets act as net transmitters to Bitcoin markets. In contrast, Bitcoin markets subsequently act as a net transmitter to stock markets. It suggests that shocks in one market can transmit to others and may escalate into broader systemic risk, underscoring the importance of treating crypto markets as an integral component of the conventional system rather than in isolation. Moreover, statistics show that global crypto transactions reached USD 6.34 billion in 2025 and are projected to reach USD 18.26 billion by 2033, reflecting a 14.5% growth since 2026. Financial authorities are strongly encouraged to develop a cross-market, integrated monitoring framework and to incorporate crypto markets into the existing financial stability monitoring dashboard. Harmonizing regulations controlling crypto assets with those governing conventional financial markets has become crucial.

Tables 3 and 4 further suggest that volatility spillovers among the three assets extend across countries within the ASEAN region. Figures 4 and 5 additionally indicate that crises have reinforced market integration. Therefore, financial authorities in the ASEAN region are advised to strengthen collaboration in responding to global financial shocks and to harmonize cross-country regulations governing digital assets.

As illustrated in Figures 4 and 5, volatility spillovers exhibit time-varying patterns. The findings of this study, therefore, extend the existing literature on financial interconnectedness, which has predominantly examined spillover phenomena in a static framework. Specifically, this study highlights the time-varying nature of volatility spillovers and their significant intensification during crisis periods, particularly during the COVID-19 pandemic. The application of Generalized Forecast Error Variance Decomposition (G-FEVD), which is insensitive to variable ordering, offers greater robustness than the Cholesky-based VAR approach. The use of a rolling window minimizes methodological biases and provides a more realistic representation of spillover dynamics, particularly under extreme crisis conditions. Bearish markets, as illustrated in Figures 4 and 5, not only intensify volatility but also alter the structures of cross-asset risk transmission. Heightened volatility spillovers during bearish market conditions may serve as early warning indicators. Financial authorities are therefore encouraged to develop early warning systems based on interconnectedness indices and to incorporate spillover measures as a basis for countercyclical policies and for timely market interventions.

From an investment perspective, Figures 4 and 5 indicate that cross-asset diversification strategies prove ineffective under market distress, corroborating prior findings by Asih, Achsani, Novianti, & Manurung (2024), Kakinuma (2023), and Robiyanto, Huruta, Frensidy, & Yuliana (2023). This study not only confirms that crises amplify interconnectedness across ASEAN financial markets but also demonstrates that Bitcoin is unable to serve as an effective haven or hedging instrument during the COVID-19 crisis in the region.

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An examination of the results yields three main patterns. First, asset interconnectedness exhibits an asymmetric pattern, in which bonds transmit risk to Bitcoin, while Bitcoin transmits risk to the stock market. Second, the intensity of volatility spillovers escalates sharply during crisis periods, exceeding levels observed under normal conditions. Third, increased interconnectedness undermines the effectiveness of cross-asset diversification strategies, particularly during periods of extreme market stress. These patterns suggest that financial market stability is contingent on market conditions.

CONCLUSION

This study provides empirical evidence that financial interconnectedness among Bitcoin, stock, and sovereign bond markets in ASEAN is both time-varying and structurally asymmetric, with a clear hierarchical spillover pattern. Specifically, sovereign bond markets act as net transmitters of shocks to Bitcoin, while Bitcoin subsequently transmits risk to equity markets, indicating a multi-layered transmission mechanism across asset classes. Moreover, spillover intensity increases significantly during crisis periods, confirming that financial connectedness is regime-dependent rather than stable over time. These findings extend the literature by demonstrating that cross-asset linkages are not only dynamic but also directional, challenging conventional assumptions of symmetric spillovers and stable diversification benefits in emerging financial systems.

From a policy perspective, these results highlight the need for integrated cross-market regulatory frameworks that account for the growing interaction between digital assets and traditional financial markets. Regulators in ASEAN should strengthen macroprudential surveillance systems by incorporating cryptocurrency markets into systemic risk monitoring, particularly during periods of financial stress when spillovers intensify. In addition, policymakers should enhance cross-border regulatory coordination, given the regional nature of financial contagion, and develop early warning indicators based on time-varying spillover dynamics. For investors and portfolio managers, the findings imply that diversification strategies must be dynamic and regime-sensitive, as Bitcoin's hedging effectiveness deteriorates during crises. Overall, effective policy responses should move beyond isolated market supervision toward a holistic, cross-asset approach to safeguard financial stability in increasingly interconnected markets.

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