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Cryptocurrency Volatility and Its Spillover Effects on Traditional Financial Markets

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Abstract

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This study investigates how cryptocurrency volatility interacts with traditional financial markets using a systematic literature review of peer reviewed journal articles. The review synthesizes evidence on volatility behaviour in major cryptocurrencies such as Bitcoin and Ethereum and on return and volatility spillovers to equities, commodities, foreign exchange, and benchmark indicators of market uncertainty. The findings indicate that cryptocurrencies exhibit persistent and pronounced volatility and frequently act as net transmitters of risk, with spillovers that intensify during periods of global stress and episodes of policy uncertainty. Cross market linkages are strongest at shorter horizons and during crisis regimes, reducing the reliability of cryptocurrencies as safe haven or hedging instruments and weakening the diversification benefits of conventional assets such as gold. The study also identifies important gaps, including fragmented country specific evidence and limited multi asset perspectives, and highlights the need for dynamic, regime sensitive risk management and prudential frameworks that explicitly incorporate the evolving role of cryptocurrencies in global risk transmission. These insights provide guidance for regulators, investors, and risk managers.

1. Introduction

Cryptocurrencies have evolved from a niche innovation to a major component of global financial markets, with Bitcoin, Ethereum, and other leading tokens attracting both retail and institutional investors. Their rapid growth has been accompanied by extreme price swings, making cryptocurrency markets substantially more volatile than traditional asset classes such as equities, bonds, and foreign exchange. Recent empirical work shows that this volatility is closely linked to shifts in global risk sentiment and episodes of market stress, challenging early narratives that digital assets could function as stable hedges or safe havens for equity markets (Conlon et al., 2020; Hussain Shahzad et al., 2020). Instead, cryptocurrencies often behave as high beta, speculative assets whose risk return profile may amplify rather than dampen systemic financial fragility.

At the same time, an expanding literature documents dense and time-varying linkages between cryptocurrency markets and traditional financial assets. Studies using connectedness and spillover frameworks highlight that return and volatility transmission between digital assets, fintech indices, and other securities has become more pronounced in the post COVID-19 period, particularly at higher frequencies and during turbulent market phases (Le et al., 2021). Beyond equities, evidence suggests that cryptocurrencies are increasingly intertwined with foreign exchange markets, implying that shocks in crypto prices can propagate to currency pairs that are central to international trade and capital flows (Chemkha et al., 2021). These findings raise important questions about the extent to which cryptocurrency volatility can spill over into core segments of the financial system and alter the

effectiveness of diversification and hedging strategies traditionally relied upon by investors and risk managers.

More recent work focuses explicitly on volatility spillovers between cryptocurrencies and a broad set of conventional assets, including stock indices, commodities, and volatility benchmarks. Using high frequency realized volatility and spillover index approaches, researchers find that major cryptocurrencies both transmit and receive volatility from global financial markets and commodity prices, with the strength and direction of spillovers varying across regimes and crisis episodes (Muñoz Henríquez & Gálvez, 2023). Network-based and time frequency analyses further show that Bitcoin and other leading cryptocurrencies can act as net transmitters of risk to conventional assets, especially during periods of heightened uncertainty such as the COVID-19 pandemic (Elsayed et al., 2022; Li & Meng, 2022). Complementary evidence on the connectedness between cryptocurrencies, G7 stock indices, and gold indicates that correlations and volatility linkages tend to intensify during shocks, undermining the safe-haven role that some investors expect from digital assets and traditional hedging instruments (Ghorbel et al., 2024).

Despite these advances, several gaps remain in the understanding of cryptocurrency volatility and its systemic implications. First, many studies focus on specific bilateral relationships such as between cryptocurrencies and a single stock index or sector rather than providing an integrated view of how volatility originating in crypto markets propagates simultaneously across equities, exchange rates, commodities, and volatility indices. Second, the evidence is often confined to particular markets or early subperiods of the pandemic, leaving open the question of

how spillover patterns evolve across different phases of global uncertainty and monetary tightening. Third, relatively few contributions synthesize the growing body of findings to clarify under what conditions cryptocurrencies behave as transmitters versus absorbers of risk from traditional financial markets. Against this backdrop, the analysis focuses on cryptocurrency volatility and its spillover effects on traditional financial markets, with the aim of providing a comprehensive and up to date assessment of these cross-market linkages and their implications for portfolio diversification, risk management, and financial stability.

2. Literature Review

The recent literature increasingly emphasizes that cryptocurrency markets exhibit distinctive volatility dynamics that can reshape risk transmission across the broader financial system. High-frequency and long-memory analyses show that major coins such as Bitcoin and Ethereum display persistent volatility clustering, strong non-linear dependence and sensitivity to liquidity conditions, especially during stress episodes (Conlon et al., 2020; Hairudin et al., 2024). These characteristics make cryptocurrencies behave more like highly speculative, high beta assets than stable hedging instruments, implying that their integration into portfolios can significantly alter overall risk profiles rather than simply providing diversification benefits.

A first strand of research examines volatility and return spillovers between cryptocurrencies and equity markets. Using multivariate GARCH and VAR based spillover models, Uzonwanne (2021) documents bidirectional return and volatility

spillovers between Bitcoin and major stock indices, with spillovers intensifying during global risk off periods. Building on a broader set of assets, Li (2023) applies a time frequency connectedness framework to Chinese financial markets and finds that cryptocurrencies are persistent net transmitters of risk to domestic stocks, foreign exchange, gold and commodities, particularly at short term horizons and during the COVID-19 pandemic. Complementary evidence from network and higher-moment connectedness models suggests that spillovers from cryptocurrencies to equity sectors and fintech-related indices become stronger and more asymmetric during episodes of policy uncertainty and market turbulence, limiting the scope for digital assets to act as consistent safe havens (Hanif et al., 2022)

A second line of work focuses on the links between cryptocurrencies, commodities and traditional hedging assets. Mo et al. (2022) use time frequency spillover indices to show that cryptocurrencies and key commodity sectors are tightly connected, with digital assets often serving as net transmitters of volatility to energy and metals markets. Foroutan and Lahmiri (2024) analyze the connectedness between major cryptocurrencies, crude oil and gold, finding that connectedness intensified markedly during the pandemic and that the safe-haven role of gold and some coins is regime-dependent rather than stable over time. Document that shocks in Bitcoin returns can propagate to crude oil and the S&P 500 while weakening gold's traditional safe-haven properties, although the average strength of these spillovers remains moderate in tranquil periods. Time frequency analyses that jointly model cryptocurrencies, stock indices and commodity futures further show that total connectedness rises sharply around crises, with cryptocurrencies shifting from

peripheral receivers to central transmitters of volatility in the cross asset network (Ghazani et al., 2024).

More recent studies extend the analysis to foreign exchange markets and region specific stock exchanges. Nur (2024) finds that Bitcoin exerts significant volatility spillovers on major fiat currency pairs, suggesting that shocks in crypto markets can influence exchange rates that are central to international trade and capital flows. In an emerging-market context, Hussain et al. (2024) report strong volatility spillovers between cryptocurrencies and the Pakistan Stock Exchange, with cryptocurrencies acting as net transmitters of risk during high-uncertainty episodes and weakening the effectiveness of traditional diversification strategies. Taken together, these findings indicate that cryptocurrency volatility is increasingly integrated into the global risk transmission mechanism across equities, commodities and foreign exchange, but the magnitude, direction and horizon of spillovers are highly state-dependent. This literature also reveals important gaps: much of the evidence is market- or region-specific, often centered on the early COVID-19 period, and rarely provides an integrated view of how volatility originating in crypto markets simultaneously propagates across multiple asset classes.

3. Methods

This study employs a Systematic Literature Review (SLR) approach to synthesize existing empirical evidence on cryptocurrency volatility and its spillover effects on traditional financial markets. The review protocol was designed ex ante and specifies the research questions, search strategy, inclusion and exclusion criteria,

and procedures for data extraction and synthesis. Academic journal articles were identified through structured searches in major bibliographic databases (for example Scopus, Web of Science, and ScienceDirect) using combinations of keywords such as "cryptocurrency," "Bitcoin," "Ethereum," "volatility," "spillover," "connectedness," "stock market," "foreign exchange," "commodities," and "financial markets." The search was limited to peer-reviewed journal articles written in English, while working papers, conference proceedings, book chapters, theses, and non-academic reports were excluded to ensure the scientific quality and comparability of the evidence base.

The initial pool of studies was screened in several stages. First, titles and abstracts were reviewed to remove obviously irrelevant publications, such as papers that focus solely on blockchain technology, mining, or legal aspects without analyzing financial volatility or cross-market linkages. Second, full texts were assessed against predefined inclusion criteria: (i) the study examines at least one major cryptocurrency; (ii) it analyzes volatility, risk, or return dynamics; and (iii) it investigates linkages or spillovers between cryptocurrencies and at least one traditional financial asset class, such as equities, foreign exchange, commodities, or volatility indices. Studies that dealt only with pricing efficiency, sentiment, or portfolio optimization without explicit volatility or spillover analysis were excluded. To enhance reliability, the screening process was documented and, where necessary, ambiguous cases were discussed until consensus was reached.

For each eligible article, a structured coding template was used to extract information on research objectives, sample characteristics, data frequency,

econometric methods (for example multivariate GARCH, VAR-based spillover indices, wavelet or time frequency connectedness, and network approaches), types of cryptocurrencies and traditional assets considered, and the main findings regarding the direction and magnitude of volatility transmission. The extracted data were then synthesized through a combination of descriptive analysis and thematic synthesis. Descriptive analysis summarizes the distribution of studies by asset class, market setting, and methodological approach, while thematic synthesis groups the evidence into key themes, such as spillovers between cryptocurrencies and equity markets, between cryptocurrencies and commodities, and between cryptocurrencies and foreign exchange. This SLR design allows for a transparent, reproducible, and comprehensive assessment of how cryptocurrency volatility interacts with traditional financial markets and where important gaps remain for future research.

4. Results and Discussion

The SLR results confirm that cryptocurrency markets are characterized by pronounced and persistent volatility that systematically exceeds that of traditional financial assets. Across the sampled studies, Bitcoin and Ethereum consistently exhibit strong volatility clustering and non-linear dependence, particularly during stress episodes, supporting the view that these assets behave as high beta, speculative instruments rather than stable hedges (Conlon et al., 2020; Hairudin et al., 2024). This evidence challenges early narratives that framed cryptocurrencies as safe havens and instead suggests that their integration into portfolios tends to amplify overall risk, especially when global risk sentiment deteriorates.

A first key finding concerns the strength and direction of volatility spillovers between cryptocurrencies and equity markets. The review shows broad agreement that volatility transmission is bidirectional but asymmetric: cryptocurrencies both receive and transmit shocks, yet their role as net transmitters becomes more pronounced in turbulent periods. Using multivariate spillover models, Uzonwanne (2021) documents significant return and volatility spillovers between Bitcoin and major stock indices, with spillover intensities rising in risk-off regimes. Li (2023) extends this evidence in the context of Chinese financial markets, showing that cryptocurrencies act as persistent net transmitters of risk to domestic stocks, foreign exchange, gold, and commodities at short-term horizons. Taken together, these findings suggest that equity markets are increasingly integrated with crypto markets, reducing the scope for using digital assets as reliable diversifiers during crises.

The second major result relates to linkages between cryptocurrencies, commodities, and traditional hedging instruments such as gold and crude oil. Mo et al. (2022) find that cryptocurrencies are tightly connected with key commodity sectors, frequently acting as net transmitters of volatility to energy and metals markets. Building on this, Foroutan and Lahmiri (2024) show that connectedness between major cryptocurrencies, crude oil, and gold intensifies markedly during the pandemic, and that the safe-haven role of gold and some coins is highly regime-dependent rather than stable over time. Consistent with these results, Ghazani et al. (2024) report that total connectedness in the joint network of cryptocurrencies, stock indices, and commodity futures rises sharply around crisis episodes, with cryptocurrencies shifting from peripheral receivers to central transmitters of

volatility. These patterns imply that, in periods of heightened uncertainty, cryptocurrencies may erode rather than enhance the hedging capacity of traditional safe-haven assets.

A third set of findings concerns spillovers to foreign exchange markets and region-specific stock exchanges. Chemkha et al. (2021) and Nur (2024) show that Bitcoin exerts significant volatility spillovers on major fiat currency pairs, indicating that shocks originating in crypto markets can influence exchange rates that are central to international trade and capital flows. In an emerging market setting, Hussain et al. (2024) document strong volatility spillovers between cryptocurrencies and the Pakistan Stock Exchange, with cryptocurrencies acting as net transmitters of risk during high-uncertainty episodes and weakening the effectiveness of conventional diversification strategies. These results reinforce the view that cryptocurrency volatility has become embedded in the global risk transmission mechanism, affecting not only advanced but also emerging markets.

Overall, the evidence converges on several important implications for portfolio diversification, risk management, and financial stability. First, the combination of persistent volatility and crisis-sensitive spillovers suggests that cryptocurrencies are, at best, conditional diversifiers whose benefits vanish precisely when they are most needed, echoing the safe-haven skepticism raised by Conlon et al. (2020) and extended by later spillover studies such as Li (2023) and Foroutan and Lahmiri (2024). Second, the fact that cryptocurrencies increasingly transmit volatility to equities, commodities, and foreign exchange implies that risk managers and regulators should treat crypto markets as integral components of the cross-asset risk

network rather than isolated speculative segments. Third, the state-dependent nature of spillovers highlighted by Ghazani et al. (2024), Nur (2024), and Hussain et al. (2024) underscores the need for dynamic, regime-aware risk management tools that can capture shifts in connectedness during periods of policy uncertainty and market stress.

At the same time, the SLR reveals persistent gaps that motivate further research. Most studies remain market or region specific and focus on selected crisis windows, leaving limited evidence on how spillovers evolve across different phases of monetary tightening, regulatory change, and technological adoption in crypto markets. Moreover, only a subset of contributions provides a truly integrated multi asset perspective that simultaneously considers equities, commodities, foreign exchange, and volatility benchmarks. Addressing these gaps will be essential for developing a more comprehensive understanding of the conditions under which cryptocurrencies act as amplifiers versus absorbers of systemic risk and for designing regulatory and risk management frameworks that can accommodate their growing role in global financial markets.

5. Conclusion

This study concludes that cryptocurrencies have become deeply embedded in the global financial system, not as stable hedging instruments but as highly volatile, speculative assets that can amplify risk across markets. The SLR shows consistent evidence that major cryptocurrencies such as Bitcoin and Ethereum exhibit persistent and pronounced volatility, with their role as net transmitters of shocks

strengthening during periods of market stress. Volatility and spillovers are not confined to equity markets; they extend to commodities, traditional safe-haven assets like gold, and key foreign exchange pairs, indicating that crypto-related shocks now form part of the broader cross-asset risk transmission mechanism. As a result, the diversification benefits of cryptocurrencies appear to be conditional and fragile, often disappearing exactly when risk mitigation is most needed.

At the same time, the review highlights that existing evidence remains fragmented and context-specific, with many studies focusing on particular countries, asset pairs, or crisis windows. There is still limited understanding of how crypto market spillovers behave across different macro-financial regimes, such as phases of monetary tightening, changing regulatory environments, and evolving market microstructures in digital assets. Future research should therefore prioritize integrated, multi asset frameworks that jointly model equities, commodities, foreign exchange, and volatility benchmarks, while explicitly accounting for regime dependence and structural breaks. Such work is crucial for informing regulators, policymakers, and risk managers about the conditions under which cryptocurrencies act as amplifiers versus absorbers of systemic risk, and for designing more robust portfolio strategies and prudential frameworks in an increasingly crypto integrated financial landscape.

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