

# Cryptocurrency Market Connectedness Across Time and Frequency: New Evidence

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## Abstract

This study investigates the dynamic linkages and co-movement patterns among major cryptocurrencies, including Bitcoin (BTC), Ethereum (ETH), Tether (USDT), Binance Coin (BNB), and XRP. Specifically, it examines how risk transmission evolves across time horizons and market conditions, with particular attention to tail dependence and asymmetric spillover effects during bear, normal, and bull market states. To achieve this objective, we employ an integrated framework combining wavelet coherence analysis, wavelet quantile correlation, and the cross-quantilogram approach. This time–frequency and quantile-based methodology enables the decomposition of connectedness into short-, medium-, and long-term components while capturing state-dependent dependence structures across different market regimes. Using daily cryptocurrency return data, we analyze directional spillovers, horizon-specific co-movements, and tail-risk transmission mechanisms. The empirical findings reveal that connectedness among cryptocurrencies is highly time-varying, frequency-dependent, and asymmetric. Co-movement intensifies during periods of market turbulence, particularly at medium- and long-term investment horizons. The results further indicate significant tail dependence, with downside spillovers during bear markets being stronger and more persistent than upside spillovers. Bitcoin and Ethereum emerge as the primary transmitters of systemic risk within the cryptocurrency ecosystem, whereas USDT exhibits comparatively weak dependence and a distinct behavior consistent with its role as a stabilizing liquidity instrument. These findings have important implications for investors, portfolio managers, and policymakers. The results suggest that diversification benefits within cryptocurrency markets diminish during market downturns and over longer investment horizons, highlighting the importance of accounting for tail risk and horizon-specific correlations in portfolio allocation and risk management strategies. Moreover, regulators should recognize the potential for systemic risk amplification arising from interconnected crypto assets, particularly during periods of financial stress, and design appropriate measures to enhance market resilience.

**Keywords:** Cryptocurrency markets; Time–frequency connectedness; Wavelet coherence; Risk spillovers

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