Decentralized Turbulence and Systemic Risk: Determining Cryptocurrency Market Volatility and Implication for Financial Stability

Sanjana Dhillon

Assistant Professor, CRSU Jind

Abstract

Decentralized cryptocurrency markets take protocol dispersion and service-layer concentration together, establishing channels through which market turbulence may cause systemic instability. In February 2026, the aggregate capitalization of the crypto market around the world stood at 85.7 trillion USD, with Bitcoin representing nearly 57 percent of aggregate value and labelled exchange addresses possessing a little over 3.02 million BTC of concerted liquidity. The analysis presents a synthesis of realized volatility measurements, GARCH family models, tail dependence measures, network centrality diagnostics, and agent-based simulations in order to measure channels of propagation. Findings point to as the key contributors to the intensity of greater tail events protocol composability and stablecoin settlement strategies, derivative leverage, and custodial concentration as the key contributors to the intensity of greater tail events. The paper suggests a regulatory overview of systemic risk reduction through a combination of measures of integrated surveillance, tools of macro-prudentials, and infrastructure resilience. Secondary data collection is used in this study. The results guide the design of macroprudential policies and monitor their activities as well as cross-border coordination mechanisms by financial authorities to maintain market rigor and health around the world.

Keywords: Cryptocurrency Market, Realized Volatility, Bitcoin, Stablecoins, Systemic Risk, Market Turbulence, GARCH, Financial Stability

Introduction

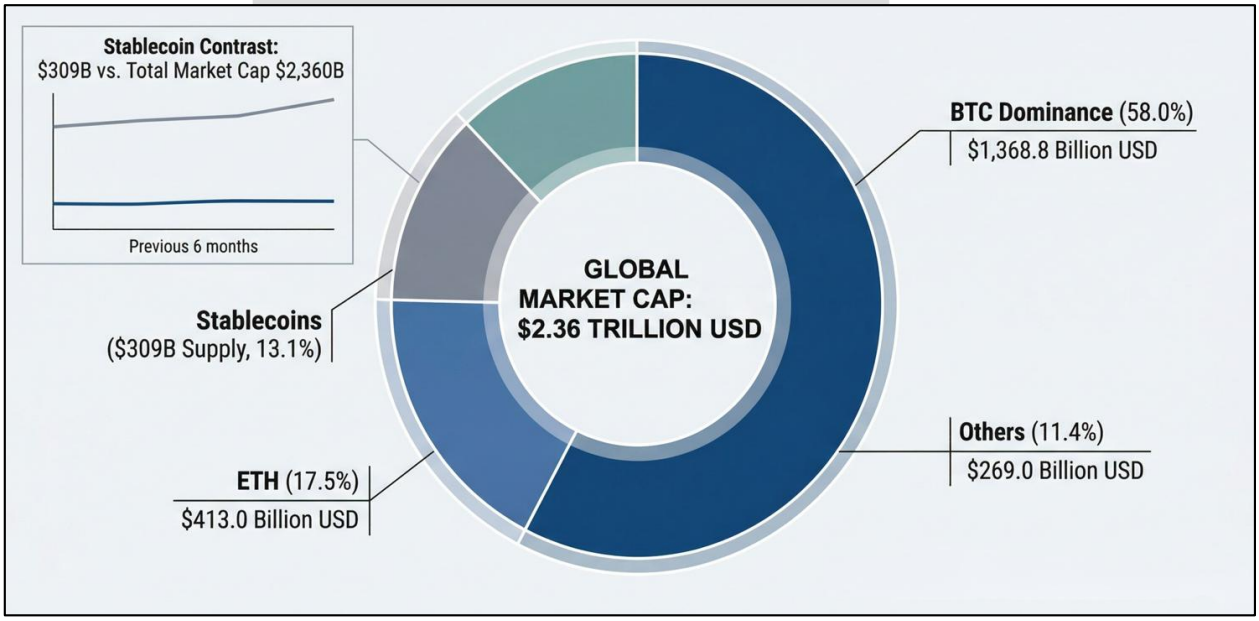

Figure 1: Global Cryptocurrency Market Capitalisation & Asset Dominance

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As of mid-February 2026, the total capital of decentralized digital asset markets had reached an aggregated value of around 2.36 trillion USD with 24-hour trading being close to 90 billion USD and an estimated 58 percent market value on Bitcoin alone (Mckinsey, 2024). Even though the validation is distributed on the public blockchain, economic activity is concentrated around custodial exchanges, rails of stablecoin, which is used as settlement and an infrastructure of funds. Labelled exchange accounts were occupied by approximately 3.02 million BTC, which is approximately 210 billion USD worth of on-exchange Bitcoin at current prices (BBC, 2026).

This article explains the interplay of protocol decentralization and market turbulence in the generation of systemic risk; the article summarizes empirical results on observed volatility, contagion, and tail dependence, and measures and policy tools to enhance financial stability regulation. The analysis independently combines high-frequency used measures, on-chain telemetry, and exposure metrics on an institutional level to understand the channels of transportation and the quantification of tail scenarios to supervisory stress testing (International Monetary Fund, 2025a). Results inform the macroprudential policy, contingency planning of market infrastructure as well as cross-border coordination.

Conceptual Framework: Decentralization, Market Turbulence, and Systemic Risk Linkages

Decentralization means implementation of protocol-level activity, consensus, and transaction validation, at a significant number of independent nodes. This technical aspect is able to mitigate the risk of a single-node failure but fails at removing economic concentration when custody and liquidity supply is concentrated in a small few mediating party (International Monetary Fund, 2025b). Practically, there are three structural layers, which are protocol infrastructure, liquidity and market-making services, and custodial and settlement intermediation. At any point of concentration, the price shocks can be translated into either solvency or liquidity stress of systemically important nodes (Aufiero et al., 2025) . The empirical evidence records that bridges and cross-chain connectors increase the level of contagion through increasing accessible exposure networks between protocols.

The features of market turbulence include a sudden increase in the realized volatility, a sharp decline in the depth of the order-book, and automatic deleveraging by selling margin. Cryptocurrency returns have high volatility clumps and episodic jumps, which become even more intense when leverage and liquidation rules are automated and large compared to the depth (Reuters, 2026). Liquidity vulnerability is caused by low quoted depth on a spectrum of tokens, execution dispersion into dozens of facilities and uneven settlement finality that retards the recovery of normal market clearing. High trading frequency and concentration of retail orders are microstructure characteristics that have a significant impact on short-horizon price impact (Hossain, 2025).

Systemic risk arises when the localized shocks transpire over systemic connections of balancesheets, failure of financing and maturity matches, or dependencies of operation. Stablecoins as settlement and funding rails can generate a similar channel to short-term money markets; believable playback runs or redemption pressures will result in forcefully selling assets that transmit stress to banks, and short-term markets should reserve assets show liquidity-sensitivity (Mckinsey, 2025a). Equally, clearing open interest on venues with a central clearing will create environments in which automated liquidations cause cascade effects at both spot and derivative market environments (International Monetary Fund, 2024). Thus, there is a three-way conceptual connection between protocol dependencies, individually defining the topology, market microstructure, and leverage, defining amplification, and intermediation concentration, defining the possibility of system-wide propagation.

Definitions and Metrics: Volatility, Liquidity, Contagion, Tail Risk, and Financial Stability Indicators

Volatility is parametrically and non-parametrically estimated. Parametric conditional variance models contain GARCH family specification, which bites time variation and leverage, whereas non-parametric realized variance employs intraday returns to approximate integrated variance with less model risk (López-

Pérez et al., 2025). In the case of high-frequency, HAR models using realized measures enhance the quality of multi-horizon prediction, as well as representation of persistent volatility factors (Kumar et al., 2024).

Liquidity has lentigled to tightness, depth, and resilience. Bid-ask spread, cumulative volume of trading at the best quotes and highest levels, and recovery of post-shock price and book depth are the proxies of tightness, depth, and resilience, respectively. On-chain equivalents consist of automated market maker (AMM) pool depth and total value locked (TVL) of particular protocols (Cesaretti, 2025). The exchange flow metrics are in addition to the order-book-based ones, including net inflows to centralized exchanges and on-chain exchange reserves.

Contagion is conceptualized as a growing cross-market dependence following a discernible shock. Dynamic conditional correlation (DCC-GARCH), time-varying spillover indices, transfer entropy, and copula-based tail dependence measures are the empirical estimators of tail dependence (Zeng & Wu, 2025). The tail risk and systemic attribution CoVaR and CATFIN-style indices measure the amount of a systemic downside risk of an asset or venue; the indices are useful in attributing a system. The volatility of key cryptocurrencies is significantly greater, whether unconditionally, than broad equity indices. As an example, historically, one-year realized volatility of Bitcoin has fallen past 100 percent during multiple occasions in bull markets, but has risen intermittently; realized volatility below 50 percent is uncommon (Cryptorank, 2026). The reduction in realized volatility in 2023 was accompanied by the expansion of market capitalization and more impressive liquidity offering elucidating the ability of structural depth to even out the realized dispersal in an instance of high-risk asset (International Monetary Fund, 2023).

Such indicators of financial stability should be used as the supervisory surveillance must be a combination of market indicators (realized volatility, bid-ask spreads, derivatives open interest), on-chain flows (exchange balances, stablecoin mint/redemption volumes, whale transfers), and institutional exposures (custody deposits, prime brokers' lines). These heterogeneous inputs by means of integrated dashboards must be turned into composite early-warning scores that optimize them on the basis of past episodes. Directed by institutions, that is, the combination of on-chain monitoring and supervisory data is encouraged to detect it in a timely manner (Karaduman & Gülhas, 2025).

Crypto Volatility, Contagion Studies, and Comparisons with Traditional Markets

Empirical evidence based on DCC-GARCH and the spillover index concludes that the correlation between crypto and traditional assets are moderate in the calm market, but tail dependence jumps dramatically in systemic stress periods. The percentage of cross-market conditional associations between cryptocurrencies and equities increases considerably during major shocks, enhancing potential drawdown concurrently (NIH, 2022). According to the copula-based analysis and CoVaR results, intra-crypto downside spillovers may be large and concentrated, and some tokens may be good downside transmitters at times of stress (OECD, 2022a).

The evidence of cases shows particular characteristics of crypto contagion. In May 2022, the Terra collapse wiped about a week of a total market value of 50 billion USD between the UST and LUNA in a week, generating fast TVL loss on relevant DeFi protocols and one-way cross-chain spillovers; the protocols that were connected with Terra suffered a 40-percent probability of loss of market share during the incident (OECD, 2022b). In retrospect, denting at the end-run of trust and liquidity by means of centralized counterparty breakdown diffuses like wildfire among large cryptocurrencies by generating rapid re-pricing in native tokens, and generating a seeming increment in the intake of below-tile dependence (Forbes, 2026).

Stablecoins spend density defluent of the systemic considerations as they include settlement and funding rails. By mid-2024, fiat-pegged stablecoin markets regained market capitalizations of the scale of 160 billion USD, meaning quantifiable scale in the context of tradable crypto assets and the possibility of influencing funding dynamics on a short-term basis in the case of a concentration of redemption pressures (International Monetary Fund, 2025b). Research papers of the NY Fed report out flight-to-safety flows between stablecoins through stress and find break-the-peg break-even points that add to redemptions more rapidly, a pattern of operation with existing money-market instruments the analogue of runs.

Crossover markets are heightened by derivatives markets and institutional participation. The synthetic exposures are increased using Exchange-traded and OTC derivatives, and automatic deleveraging dynamics can be generated using non-cleared concentrated open interests. Research of Bitcoin futures has indicated both positive and negative impacts on the dynamics of spot returns with this study showing that derivatives liquidity and microstructure have significant impacts on volatility transmission (Almeida & Gonçalves, 2024). Empirical triangulation thus suggests that although on average spillovers to sizeable disciplined financial markets are ordinarily moderate, in circumstances of crypto markets, tail events with systemic consequences can happen at a relatively small set of exposures, leverage, and mediating concentrations.

Drivers of Cryptocurrency Market Volatility: Protocol Risk, Market Microstructure, Leverage, and Behavioral Factors

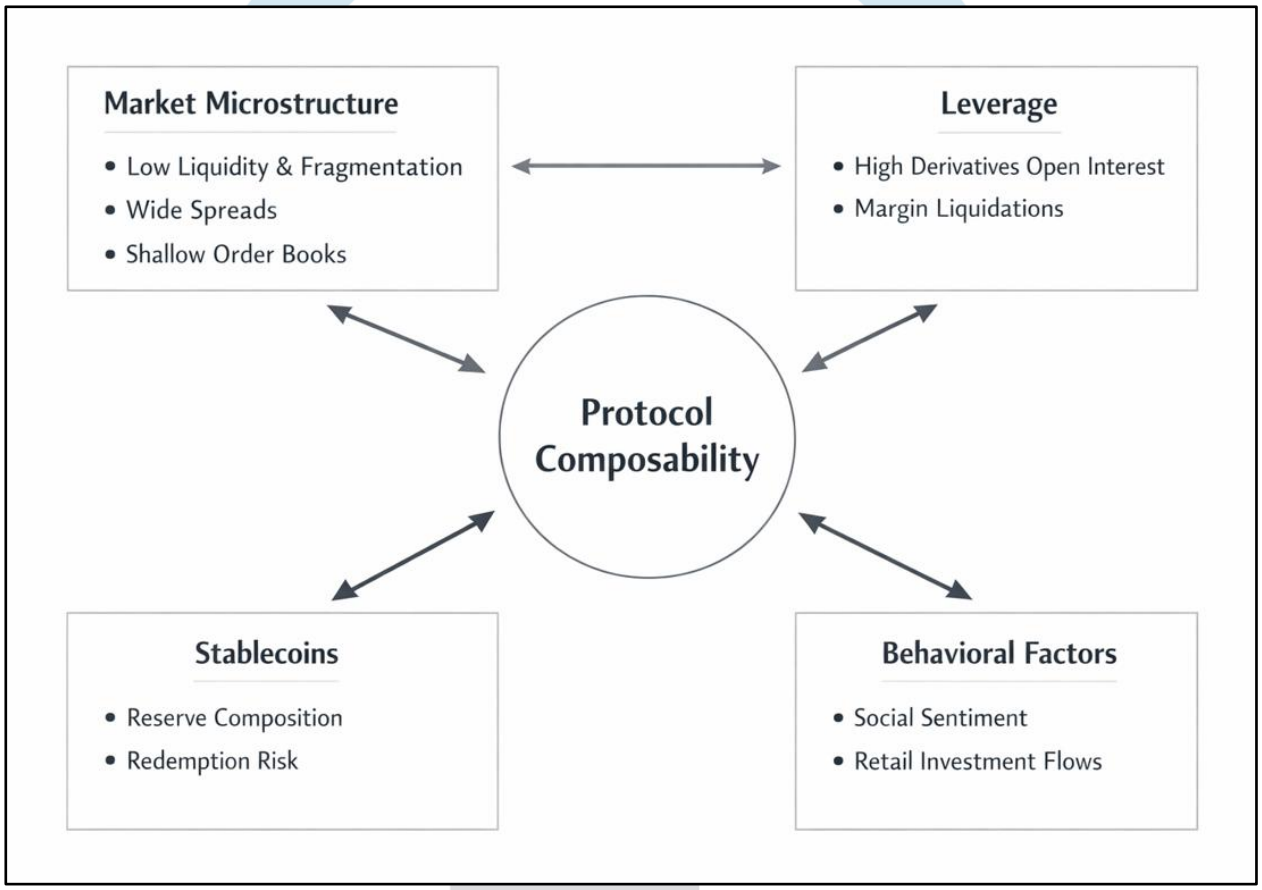

Figure 2: Protocol of the Cryptocurrency Market

(Source: Created by Author)

Protocol risk is structural. Exposures are concentrated through composability and cross-chain bridge dependencies, which means that with recent changes, DeFi total value locked was nearly 105 billion USD and exposed itself in a limited number of pools and has increased the likelihood of single protocol failure propagating across markets (Focusonbusiness, 2025). The stablecoin market is massive: in the plane of early February 2026, the total aggregate stablecoins supply was approximately 307 billion USD, and thus, any believable redemption pressure or reserve impairment effect can result in the immediate sale of reserve assets, which trickles stress into short-term funding markets (OECD, 2022b). The centralized form of the derivatives market is consequential: funded 2025, centralized exchange derivatives consolidations surpassed the value of 85.7 trillion USD, and consequently suggest that the centralized transfer of interest and auto-margining can turn the humble downward or upward movements to systemic demanors across the venues (Mckinsey, 2025b). These structural facts have a systemic effect of consequences of protocol failures during episodes of stress.

Shocks are enhanced by market microstructure and leverage. Fragmentation of Liquidity in central areas as well as in AMMs has the effect of providing tokens some shallow quoted depth enhancing price impact at frequent flow sizes. The 24-Hour liquidation tallies witnessed have been over 300 million USD forced 24 hours of deleveraging, which illustrates the deleveraging risk of volatilities (CCN, 2026). Auto-liquidation cascades are magnified in concentrated perpetuals and options open interest where the concentration of margin triggers clusters. Retail herding and social amplification also align exits, which increases the prospects of downside co-movement substantially.

Measurement and Modeling Approaches: GARCH and Volatility Models, Realized Measures, Network Analysis, and Agent-Based Models

Conditional heteroskedastic models are considered to be a benchmark in low-frequency volatility. The realized GARCH family, where high-frequency realized variance is nestled into conditioned variance dynamics, delivers a better short-horizon forecast as compared to conventional daily GARCH due to its ability to capture intraday variation and jumps (Hung, 2020). Empirical comparisons are to the extent that the Habitual-state HAR stylistics prove to understand better than numerous variants of GARCH used to estimate the multi-horizon forecasts of Bitcoin and other top tokens and lower the explained margin of forecast errors by quantifiable factors in out-of-sample analyses.

Systemic attribution and tail attribution incur the estimators necessary to include time-dependent extreme dependence (copula and CoVaR). The employing of network econometrics on return and on-chain transaction graphs collects the high-impact nodes that are based on centrality measures and impact-weighted contagion indices, engaging proportion where exposure and liquidity sensitivity intersect (Liao et al., 2024).

Econometrics cannot be considered complete without agent-based models (ABMs), which are used to simulate heterogeneous traders, market-making algorithms, and automated liquidation engines. Recent ABS research recreate volatility clustering, fat tail,s and endogenous liquidity withdrawal, and establish that calibrated ABMs can produce liquidation cascades of comparable size as those of the past where leveraged open interest is larger than normal spot depth (Kakran et al., 2023). An integrated toolkit, achieved measures, tail copulas, network centrality and calibrated ABMs are the sources of a strong inference based on monitoring and stress testing.

Transmission Channels to the Wider Financial System: Exchanges, Custodians, Stablecoins, Derivatives, and Institutional Exposures

Counterparty risk is concentrated on the exchanges and custodians. On-exchange balances in Bitcoin amounted to about 3.02 million BTC as of February 2026, which are an important portion of liquidity and a possible origin of quick withdrawals in the event of a confidence collapse (Forbes, 2026). The concentration of business in custody intensifies operations and credit channels since individual large venue suspension may reduce fiat rails and margining capacity of an institutional customer.

Stablecoins are settlement and funding purposes on a large scale. In early 2026, the global supply of stablecoins was approximately **307** billion USD, spread among the largest biggest issuers of them; concentrated redemptions thus create the risk of transmitting liquidity at the short end in case assets in fields are illiquid (OECD, 2022b).

Derivatives increase market connections. In the centralized crypto derivatives market, approximately 85.7 trillion USD trade volume will be registered in 2025, which means that the concentrated open interest and automated margins will transform the significantly small price changes into large automatic liquidating across the markets (Mckinsey, 2025b). The bank custody and OTC prime desks is an example of an institutional entry-spot ETF that can impose bilateral exposures through which losses are converted to bank capital and credit markets in extreme situations. Supporting macroprudential surveillance should therefore involve continuous surveillance of exchange reserves, flows of stablecoins, and open interests of derivatives.

Analytical Approach and Identification Strategy: Variable Considerations, Triangulation Methods, and Robustness Checks

Strict empirical initiatives need to integrate causal identification of events, attribution, and simulation. High-frequency realized volatility, bid-ask spread and depth, exchange inflows and outflows, derivatives open interest, steadycoin mint/redemption volumes, and counterparty concentration metrics (on-chain large address holdings, bridge flow volumes) are considered to be primary variables (Leushuis & Petkov, 2026). Applying intraday-order-book-snapshots and on-chain-tradings can allow tight event-windows to do causal attribution on events and less aggregate bias.

Detection must take advantage of exogenous protocol or venue shocks, such as smart-contract exploits, exchange outage or bridge downtime, and be exploited as quasi-random shocks whose direct impact on volatility, liquidity, and systemic indicators can be identified using difference-in-differences and event-study designs. Synthetic-control and staggered DiD estimators can be used to infer the effects of regulations in case of staggered adoption across jurisdictions, e.g. when policy changes (such as the EU Markets in Crypto-Assets Regulation) cause staggered adoption (Bosco, & Maranzano, 2025). Supplement econometric inference with the instrumental-variable approaches in which technical outages or oracle failures are instrumented to identify liquidity shocks are involved in cases of endogeneity.

Triangulation is essential. Insulate volatility dynamics prediction through DCC-GARCH and realized-measure, extreme co-movements through tail-copula and CoVaR, network centrality regressions to parameterize noble nodes in a system, and calibrated agent-based through simulations to test an amplification cascade, a liquidation cascade (Zeng & Wu, 2025). The outputs of this model should be incorporated in regulatory stress tests of banks and payment systems; the Basel Committee suggests scenario and stress analysis on crypto exposures and encourages supervisory stress testing in case of bank exposures. Robustness tests have to encompass alternative volatility tests, sub-sample testing across market-regime conditions, placebo events, and Monte Carlo testing of ABMs.

Policy and Regulatory Implications for Financial Stability: Macroprudential Tools, Market Infrastructure, Disclosure and Crisis Management

The regulatory frameworks should be commensurate but comprehensive. The Markets in Crypto-Assets Regulation of the European Union develops the foundation of issuer and service-provider regulation, reserve and transparency obligations of e-money tokens and stablecoins, and also creates market-integrity protection measures throughout the EU (Surges et al., 2022). International standards are underlined by international authorities such as IOSCO and venous bodies and emphasize the pace of similarity both abroad and in the home nation; the current (2023) program of IOSCO singles out operational resilience, disclosure and market behavior many examples of 16 recommendations to tackle provided by national frameworks.

Crypto-specific indicators must be included in supervisory boards as a part of macro prudential surveillance. The Bank of England emphasizes that the amount of total value locked down in DeFi has dropped by approximately 74 percent since the November of 2021 and comprises about 47 billion dollars by the end of 2023, reflecting the risks of rapid contraction and the necessity to track the composability and concentration rates (OECD, 2022a). Supervisors are supposed to ensure that the issuers and service providers who are systemically important are stress-tested. Recommendations issued by the Basel Committee about prudential treatment promote the conduct of the scenario analysis of banks, as well as the provision of the capital and liquidity reserves in case of material exposure to the crypto-related risks (Reiners & Gazi, 2023).

Changes in infrastructure interventions in the market that can be made include better custody regulations, reserves that are not mandated, and governance of cross-chain bridges and oracle services. The liquidity stress testing guidelines that are in line with MiCAR guidelines will place on issuers of important e-money tokens the responsibility to perform regular liquidity stress testing; the guidelines put into effect the preparedness of reserves and redemption (Pereira Coelho & Quelhas Poças, 2024). In the case of tokenisation and tokenised money, FSB suggests legal situational visibility and enforceability, operational resiliency provisions, inter-country supervisory cooperation to maintain calm and prevent risks (Nagesh, 2025). The

best crisis-management frameworks are supposed to feature cross-border collaboration, accelerated information sharing, and predetermined resolution routes of systemically significant crypto intermediaries (Gourgourinis, 2025).

Avenues for Future Research

The areas of priority are the following: building operational early-warning indices which combine high-frequency on-chain telemetry with supervisory exposures; building stress-testing templates of DeFi and tokenised money that help quantify composability and rehypothecation; quantifying, using empirical methods, macro transmission channels through the linking of crypto tail losses with bank lending, corporate credit spreads, and household consumption. Methodologically, the identification of causality by using staggered implementations of regulation needs to be refined further, exploitation protocol upgrade timing as a natural experiment, and ABM calibration through refinement using granular liquidation and transfer-flow data. This will require the research of the legal enforceability and cross-jurisdictional resolving of tokenised claims that will support the policy structures in the scale of tokenisation (Kochergin, 2022).

Conclusion

Decentralized protocols provide novel functionality but direct services with newly re-created systemic fragility, shared with concentrated layers of service. Credible surveillance consists of volatility measurement agenda involving tail attribution, network diagnostics, and calibrated simulations combined. Policymakers need to complement microprudential custodian and stablecoin issuers' rules with macro ones and global and coordinated cross-border crisis measures. The EU MiCA framework and global guidelines of IOSCO, BCBS, and FSB are starting points in managing the emerging nexus between crypto turbulence and financial stability, and further research will be needed alongside real-time monitoring and stress-testing innovations.

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