

Stablecoins, Liquidity, and Financial Stability in Crypto Markets

Constantinos Challoumis ^{1,2,3,4,*} , Nikolaos Eriotis ², Dimitrios Vasiliou ² and Konstantinos Mavrommatis ⁴

¹ Department of Accounting and Finance, Faculty of Economics and Management, Philips University, P.O. Box 28008, 2090 Nicosia, Cyprus

² Department of Business Administration, School of Economics and Political Sciences, National and Kapodistrian University of Athens, Sofokleous Str., 10559 Athens, Greece

³ Department of Marketing and Communication, Athens University of Economics and Business, 76 Patission Str., 10434 Athens, Greece

⁴ Department of Informatics and Computer Engineering, University of West Attica, Agiou Spyridonos Str., 12243 Athens, Greece

* Correspondence: challoumis_constantinos@philipsuni.ac.cy

Abstract

The distinction between whether a shock to the market of any asset is a valuation event or a financial stability event lies in the mechanism through which such a shock is translated into demand for liquidity. The aim of this integrative review is to apply the same concept to crypto-asset markets, where such a translation is largely via stablecoins. This synthesis draws upon seven lines of research, market efficiency, portfolio behavior, stablecoin architecture, DeFi leverage, macro-financial linkages, illicit finance, and regulation, identified through searches of Scopus and Web of Science, citation searching and official sources for the years 2015 to 2026, as well as a date-stamped database of market and regulatory statistics from the 2021 cycle peak to mid-2026. The databases were last searched on 2 October 2026; of the 136 sources included, 32 were among the 9009 unique records retrieved. The review follows PRISMA 2020 where applicable, was not registered, and received no external funding. Three observations can be made from the findings. First, market efficiency in the crypto markets is time varying but not nonexistent, and tail dependency has reduced even while realized volatility has fallen. Second, a comparison of the 2022 collapse of TerraUSD and 2023 de-pegging of USD Coin highlights what differentiates an uncontained run from a contained run: an external reserve, the liquidity of the reserve and not the face value, and a credible resolution mechanism. Third, the reserve-asset channel is asymmetrical—outflows affect short-term Treasury yields two to three times more than equivalent inflows—hence, it cannot be modeled as a linear relationship. A Crypto Liquidity Stress Index is developed based on volatility, deviation from par, redemption pressure, liquidation intensity, and connectedness, all in a four-state escalation framework whose weights and thresholds remain to be estimated.



Academic Editor: Jawad Syed Shahzad

Received: 16 August 2026

Revised: 7 September 2026

Accepted: 15 October 2026

Published: 20 October 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

Keywords: cryptocurrency; stablecoin; decentralized finance; DeFi; liquidity; financial stability; market efficiency; contagion; illicit finance; systemic risk

JEL Classification: E42; G12; G15; G18; G23; O33

1. Introduction

Financial systems are more dependent on the manner in which price movements of assets are translated to demands for cash than on how far the price of the individual asset falls. Runs on banks, forced liquidation of collateral, and redemption of funds from

solvent financial intermediaries are the processes through which price declines turn out to be systemic events, and each process relies on liquidity and not on valuation [1,2]. In the last fifteen years, there has been the development of markets that operate outside the boundaries under which such processes have been studied before. Markets for digital assets have developed from an experimental technology for peer-to-peer payments into trading platforms, custody, collateralized lending, derivatives, market-making, and settlement arrangements. They have scaled up to such a level that they can pose significant macro-financial risks to the world's financial systems [3–5]. The matter of whether these markets are relevant to the larger economy is hence no longer the issue of the price of an individual token but that of liquidity, and this is what this review focuses on.

Three definitions are necessary prior to formulation of the key research question. The first one is the crypto-asset, a transferrable electronic record of value secured cryptographically and stored in a distributed ledger, which was originally described in the design of Bitcoin [6] and which was subsequently analyzed extensively in terms of its economic, governance and institutional properties [7–9]. The second definition is the stablecoin, a crypto-asset in which the issuer guarantees the possibility to be converted into a nominal unit of account, typically the United States dollar, and which combines, thus, the transference properties of a token with the redemption obligation of a deposit-style liability [10–12]. The third definition is decentralized finance, a set of financial instruments—exchange, lending, collateral management, and derivative services—delivered through smart contract instead of balance sheet intermediation [13–16]. The three layers of definition are not mutually exclusive descriptions of the same phenomena. Each layer delivers a distinct economic function and hence fails in different ways; as will become clear from the review below, there are connections between the three layers, and between them and the traditional financial system, which can be traced through a single dimension: the need for liquidity.

Understanding the relationships between the three layers requires answering first of all a fundamental question of the field, namely, whether the crypto-asset is a currency or an asset. The issue is not semantic but substantive, for money is usually defined by three functions—medium of exchange, unit of account, and store of value—and an instrument failing to fulfil the first two functions is analyzed with the tools of asset pricing, rather than of monetary economics. Early appraisals came to a consensus that Bitcoin fulfils none of the three functions, since its volatility of price prevented it from functioning as a unit of account, and transaction throughput limited its functionality as a medium of exchange [8]. The empirical observations of the same tendency can be found at the transactional level and at the survey level as well: the motives behind holdings are dominantly those of investments and speculation, not payments, and the velocity of the asset is far below that expected from a transactional instrument [17,18]. An opposing position suggests that the instrument should not be classified as a currency but as a synthetic commodity that shares the features of the latter, such as inelasticity of supply with the absence of non-monetary usage of fiat money [19], while another stream of arguments is focused on the conditions of institutions and legitimacy under which a private currency could circulate [20,21]. Empirical research has taken positions along the entire spectrum: the asset demonstrates hedging features similar to gold's in some specification [22] but loses them under replication and generalization in other specifications [23].

The issue is important for three reasons, which recur throughout this review. First, it determines the regulatory regime applied to the instrument, since payment systems, securities, and commodities attract different regimes, and this very classification problem was the core of dedicated crypto-asset regimes of the review period [24,25]. Second, the relevant risk model is determined by classification, for an instrument that is an asset is assessed through distributions of returns and covariances, whereas a money-like instrument

is assessed via the conditions of redemption, par convertibility, and confidence. Third, and foremost for what follows, the emergence of the stablecoin raises rather than solves the issue. A reserve-backed token is designed to serve as a unit of account and means of payment, the functions of which the non-reserve asset fails to perform, and it does so by issuing redeemable liabilities on a portfolio of traditional assets [26–29]. The position taken herein is that the classification of the ecosystem as a whole into currency or asset is unproductive, while the layer-by-layer classification is productive: the non-backstopped crypto-assets act as assets, stablecoins as private money, and their interaction generates financial stability risk.

The language of analysis of the asset side of the classification starts with the theory of informational efficiency. The claim that price series approximate a random walk and that subsequent price changes are therefore serially independent was established for the equity markets by Fama [30] and formulated not long after as the efficient markets hypothesis, well-known for its partitions into weak, semi-strong, and strong forms [31]. Two important caveats are necessary in this context. First, the informational efficiency cannot be complete, since otherwise, the information acquisition would be costless and hence unprofitable, and no agent would acquire it [32]. Second, the adaptation of the markets hypothesis implies that the efficiency is not a constant characteristic of the market but a state dependent on the number of participants, profitability of arbitrage, and institutional context [33]. To these two points, the microstructure literature adds the finding that efficiency is jointly determined with the trading process itself, through liquidity, spreads, and the costs of arbitrage [34,35]. The arbitrage is performed by capital-constrained agents and could fail precisely in cases of large mispricing [36].

Application of the above apparatus to the crypto-assets resulted in literature characterized by the instability of the outcome. Weak-form efficiency of Bitcoin was rejected early on [37]; the finding was challenged by a transformed return series [38] and reconciled by dynamic tests that showed that efficiency increases over time rather than being present or absent [39,40]. The subsequent literature placed the finding in the context of the adaptive markets hypothesis, observing alternation of efficient and inefficient regimes rather than convergence [41,42]. It is at this point that the efficiency literature splits from the stability literature and where the problem of this review arises: the market can increase its efficiency in pricing and become simultaneously fragile from the liquidity point of view, because of the same institutional integration closing arbitrage gaps and generating margin calls, collateral revaluations, and common funding exposures.

The stablecoins are the place where the two lines of research converge. They connect volatile crypto-assets with nominally stable units of account; they allow transferring between venues without correspondent banking; they function as collateral inside DeFi protocols; and they act as on-chain cash-equivalents. The stability of the stablecoins is contingent on their reserve structure, redemption process, market liquidity, governance, and confidence, and hence, the literature on the stablecoin architecture considers them as private money exposed to the same risks as deposits, money market funds, and shadow banking liabilities [10–12,26–28,43]. The size of the stablecoin market makes the taxonomical distinction more than an issue of nomenclature. The aggregate amount of stablecoins has increased from approximately \$27 billion in December 2020 to around \$303 billion in July 2026 [44], and the largest stablecoin issuers are now amongst the biggest holders of short-dated US Treasury securities [45]. A private liability of such an amount backed by the portfolio concentrated in one segment of sovereign debt market is a macro-financial object irrespective of whether it is called money.

The period of review is characterized by three events making the transmission chain observable. TerraUSD, an algorithmic stablecoin, with an aggregate supply of approximately

\$18 billion, lost its peg irrecoverably in May 2022 [46,47]. USD Coin, a reserve-backed token, dropped to \$0.8726 in March 2023 due to the bankruptcy of a bank holding a part of its reserves and recovered par in about seventy-two hours [48,49]. Finally, the failure of the largest centralized venue in November 2022 showed a separate path of propagation of risk based on counterparty risk rather than reserves [50]. In July 2025, the United States introduced the first federal legislation on payment stablecoins [24], after the application of the European Union's dedicated crypto-assets regime [25]. The period, thus, includes a failure of containment, a successful containment, an intermediary failure, and a change in the legal environment, which is an unusual combination of factors for a review concerned with mechanisms.

Against the above background, four gaps in the existing literature motivate the current review. The first is fragmentation: efficiency, portfolio behavior, stablecoin design, DeFi mechanics, connectedness, and regulation are each relatively well-developed but are almost always considered separately, and hence, the chain of transmission of valuation shock into funding shock is never followed from start to finish. The second is episodic specialization: the stablecoin literature consists predominantly of single-event analyses, primarily of the TerraUSD case [46,47] and the March 2023 de-pegging [48], and there are few designs that could help to distinguish between the cases of successful and unsuccessful containment of risk. The third gap is lack of operational composite indicator: a conventional systemic risk measure has provided established conditional and spillover measures [51–53], while recent literature has mapped tail dependence in crypto markets [54], but there is still no compact index incorporating price stress, par deviation, redemption volumes, on-chain leverage, and cross-market connectedness in a way computable by a supervisor. The fourth is methodological: systematic bibliometric and content analysis of the kind now widely used in market microstructure [55], in Islamic finance [56], and more broadly in finance literature [57] is missing in the crypto liquidity literature, and hence, the field lacks a consensus regarding the existence of different strands, their interconnections, and evidence gaps. A fifth gap, covered in Section 10, is near total separation of the illicit finance literature from the financial stability literature, even though both fields operate in the same venues and liquidity.

The goal of the current review is closing the above gaps through reorganization of the evidence around a single mechanism. Four research questions follow. RQ1 asks whether the efficiency and fragility of crypto-assets markets evolved in the same direction during the review period. RQ2 asks which design and institutional characteristics separate a contained stablecoin de-pegging from an uncontained one. RQ3 asks through which channels and which functional form stress in crypto-asset markets is transmitted to conventional funding markets. RQ4 asks whether the available indicators corresponding to each layer can be incorporated into a single diagnostic testable by supervisors and researchers. The contribution is fourfold: structured synthesis of seven strands of literature identified through a documented search and selection procedure; comparative anatomy of two stablecoin stress episodes with different outcomes; the dated evidence base with dispersed providers rather than hidden ones; and the parsimonious diagnostic framework, the Crypto Liquidity Stress Index, together with testable propositions following from it. The contribution is organizational and diagnostic rather than a new causal estimate, and the boundary is explicitly stated.

The rest of the paper is structured as follows. Section 2 reviews the seven strands of literature forming the basis of the synthesis and identifies the specific evidence gaps left by each strand. Section 3 describes the review design, the Scopus and Web of Science search protocol, journal and study selection criteria, the choice of the review period and of the variables, and the limitations of the design. Section 4 reviews crypto-assets as

financial assets, analyzing their efficiency, volatility, and price discovery. Section 5 covers the stablecoins as the liquidity layer, analyzing their market structure, reserve design, and monetary substitution. Section 6 presents the comparative anatomy of the two stablecoin stress episodes. Section 7 addresses decentralized finance, leverage, and endogenous contagion. Section 8 analyzes interconnectedness with the traditional financial system, including the reserve asset channel and the experience of national adoption. Section 9 compares the two dedicated regulatory regimes. Section 10 reviews the illicit finance. Section 11 deals with sustainability and operational resilience. Section 12 develops the Crypto Liquidity Stress Index and its escalation scheme. Section 13 discusses the findings, their theoretical and policy implications, the limitations of the current study, and the future research agenda. Section 14 concludes.

2. Literature Review

This section examines the seven literature strands that underpin the synthesis. Unlike the subsequent sections, this section is not organized chronologically and serves a different purpose: it addresses what is known, how the strands interact, and where the gaps are for each, while Sections 4–12 consider these strands against dated evidence about the market and supervision. Table 1, at the end of this section, provides a summary of the strands, sample studies, and gaps.

2.1. From Efficient Markets to Adaptive Efficiency in Crypto-Asset Markets

The essential reference point is the efficient markets literature. The empirical regularity that successive price changes in equity markets are approximately independent [30], along with the formalization of this regularity in the weak, semi-strong, and strong forms of the efficient capital markets hypothesis [31], constituted both the null hypothesis and the testing apparatus that crypto-literature would later adopt. Two qualifications guide how this apparatus is applied in the current context. Informational efficiency cannot be complete in equilibrium, because prices that reflect costly information remove the incentive to obtain information [32]; and efficiency should be understood as a dynamic state that depends on competition, arbitrage profitability, and the institutional environment rather than a binary characteristic [33]. Microstructure literature provides the mechanism that drives this dynamism, demonstrating that efficiency is shaped by liquidity, trading costs, and the market structure that governs order execution [34,35] and that arbitrage capital is itself constrained and can pull out when mispricings are greatest [36].

Transposed into the crypto-assets world, this apparatus generated a number of controversial findings. First, the weak-form efficiency of Bitcoin was rejected [37]; this finding was challenged on the basis of transformed return series [38]; finally, dynamic and rolling-window designs reconciled the two positions by demonstrating that efficiency is time-varying and improves over time [39,40]. Further studies make the finding consistent with the adaptive approach, showing alternation of efficient and inefficient periods rather than monotonic convergence [41,42]. Complementary evidence on price discovery and integration of exchanges demonstrates fragmentation of the market, with persistent deviations from cross-exchange price levels supported by capital control measures, restrictions on banking access, and settlement problems [58–61]. This strand provides that efficiency in such markets is time-varying but takes efficiency per se as the goal and does not show how progress in pricing relates to changes in market fragility.

Surrounding this core, the research agenda expands, whose results will determine the interpretation of any efficiency finding. Systematic surveys identified crypto-assets as a distinct asset class for empirical finance [62], while cross-sectional studies identified different return factors and risk premia in crypto assets [63]. Market frictions attracted

particular attention: persistent arbitrage spreads across exchanges [58], manipulation of prices and impact of concentration of trading on prices [64,65], and shares of activity attributable to illegal operations [66]. Another research strand examined the supply side, modeling mining as economic equilibrium rather than purely technological process [67], exploring the dynamics of transaction fees as congestion price [68], monetary consequences of fixed issuance schedule [69], and settlement features of distributed ledgers for asset trading [70]. The third strand studied the phenomenon of token issuance itself, analyzing its adoption and valuation in the presence of network effects [71], financing of ventures through token sales and its determinants [72–74], and the economic theory behind the process of verification and disintermediation [75,76]. There are two observations from this strand that are relevant for this review. First, market frictions are not noise but structural characteristics that influence measurement of efficiency, which is the message of microstructure literature translated into the context of crypto [35]; second, the same infrastructure that supports token issuance and settlement also supports leverage, which is the link established in Section 7.

2.2. Volatility, Tail Dependence, and Portfolio Behavior

The second strand focuses on the properties of the return distribution. There is unanimous evidence of fat tails, volatility clustering, and asymmetry of the conditional heteroskedasticity models applied to crypto-asset returns, along with considerable disagreements regarding the best specification [77,78]. The portfolio strand following these findings addresses whether those properties make the asset a good diversifier, a hedge, or a safe haven. Positive answers abound [79–82]; yet they have been largely challenged by the evidence from the COVID-19 shock where correlations with risky assets increased sharply and the alleged protection proved itself absent in the hour of need [83–86], as well as further research distinguishing between inflation hedge and safe haven strategies [87–89]. Comparative analysis of Bitcoin and gold reaches opposite conclusions depending on specification and sample [22,23,90].

There are two shortcomings of the above strand relevant to this review. First, it is conducted from the perspective of an individual investor, where the relevant question is the covariance of the position and the portfolio, while financial stability requires understanding of the system where the same position is leveraged, posted as collateral, or financed. Second, it is conducted using mainly unconditional moments that do not reveal tail dependence necessary to judge whether there is a diversification effect in the presence of the liquidity shock common to the portfolio.

2.3. Stablecoins as Private Money

The third stream approaches stablecoins from the economics of money, not of assets. Taxonomies of schemes include three categories: reserve-backed, crypto-collateralized, and algorithmic, and relate each to its own failure mechanism [10]. The policy-focused approach places stablecoins in the context of the historic issue of privately issued par-conversion liabilities and draws parallels with the cases of free banking and money market funds [11,12,27]. Studies of stability mechanisms show when and why arbitrage brings a scheme back to par and when it does not [26], and the money-view literature stresses that par convertibility is a function of dealers that requires balance sheet capacity rather than a consequence of proper backing [28]. Surveys of supervision practices in different jurisdictions show the extent to which actual arrangements fall short of their own criteria [43]. Applied studies that build on this strand address the use of stablecoins in payment systems [29] and the reconstitution of particular de-pegging episodes [47].

The theoretical foundation of this strand lies in the theory of runs on demandable liabilities, where the sequential service constraint makes redemption both an optimal and damaging action for an individual [1]. What this strand needs is an empirical comparative design. As the two most informative episodes of the review period had exactly the opposite outcomes, they allow for the identification of the conditions for containment. Yet, they are usually studied in isolation from each other.

2.4. Decentralized Finance and Endogenous Leverage

The fourth strand considers the protocol layer. Descriptive and taxonomic contributions explain how automatic market-making, overcollateralized lending, and composability work [13–16], whereas critical perspectives highlight the fact that governance and operational control are typically centralized despite the claim of decentralization [91,92]. The functioning of forced deleveraging has been established empirically: liquidations occur when a price reaches a deterministic threshold, performed by competing keepers, and cluster in time in a manner that exacerbates the effect of the price move [93,94]. Regulatory scholarship has developed a functional approach to the industry wherein protocols are evaluated in terms of their financial service rather than their technical architecture [95].

This strand offers the most finely observed leverage data in contemporary finance, because the collateral ratios and liquidations are recorded on blockchains. It has however retained its independence: liquidation clusters are considered in terms of protocol dynamics, without quantifying their impact on the stability of stablecoins or the markets for reserve assets.

2.5. Interconnectedness, Spillovers, and Systemic Risk

The final strand quantifies propagation. In the crypto markets, variance decomposition and connectedness approaches report significant spillover effects and dominance of, though not exclusivity for, Bitcoin [96–99]. This framework builds on the generalized forecast error variance decomposition [100] and its network and time-varying parameter extensions [53,101], and the wider literature of systemic risk analysis offers conditional institutional-level contribution to systemic events [51,52]. Recent research includes the analysis of tail risk transmission through the DeFi tokens, stablecoins, and infrastructure securities [54] and the propagation of a systemic event of an intermediary into other markets [50]. The direct balance sheet channel to the conventional finance has recently been empirically quantified, rather than being theoretically assumed, and stablecoin flows have been identified to affect short-term maturity Treasuries in a state-dependent and asymmetric manner [45].

The issue in this strand is not one of methodology but rather of scope. Connectedness is generally quantified for either the crypto markets or between crypto markets and equity indices. The real channel of macro-financial consequences is the reserve portfolio channel to the short-term maturity government bond market and is asymmetric in sign.

2.6. Illicit Finance and Market Integrity

The sixth strand considers the criminal usage of such markets. Early quantitative research estimated the prevalence of such illicit activity in the case of Bitcoin and established the transaction graph techniques that were later used to estimate such figures [66]. Subsequent research mapped the crypto-enabled cybercrime as a classification [102], estimated the flow of ransomware payments from beginning to end [103], predicted the displacement of financial crime to new instruments [104], and examined the money laundering dialectics through innovations and evasive adaptations [105]. There is also a separate literature stream demonstrating the manipulation of the reported volume itself and indicating that most of the reported volume on such unregulated venues is false [106], thus, contaminating

the very series of indicators that measure the liquidity. The framework is provided by the international standards on virtual assets, along with the periodic assessments of compliance with those standards [107,108], as well as law enforcement threat assessment [109] and commercial forensic aggregations [110,111].

There is virtually no overlap between the criminal finance strand and the financial stability strand, despite them both being about the same venues. Such separation is detrimental to the analysis since the policy action against the illegal finance operates on the very liquidity variables measured in the stability analysis: sanctions designation removes venues, freezing orders immobilize stablecoin balances, and fake volume contaminates the liquidity series.

2.7. Regulation and Financial-Stability Design

The seventh dimension relates to the regulatory approach. At the international level, it includes general guidance on international stablecoin arrangements [4], synthesis of crypto-asset policy in relation to the mandates of monetary and financial stability [112], the prudential approach to banking exposure to crypto-assets [113], recommendations for securities markets [114], and the application of the rules of financial market infrastructures to stablecoin arrangements [115]. At the national and regional levels, it includes two regimes specifically devoted to the review period [24,25]. Work on the design problem is focused on the discrepancy between the jurisdiction that bears the externality and the jurisdiction that holds the supervisory tool and the competition from public digital money as a design [116–122].

What is missing from this strand is a link to measurement. Guidance is given in terms of reserves, redemption rights, and disclosure but not in terms of thresholds in observable time series, and therefore, no method exists of saying when an arrangement has crossed the boundary between supervisory states.

2.8. Synthesis of the Gaps and the Position of This Review

Considered as a whole, these seven strands represent one and the same system from seven different angles without explaining the link mechanism between them. The strand on efficiency reveals that pricing has become more efficient; the strand on portfolios reveals that tail dependence is yet to be resolved; the strand on stablecoins reveals the possibility of par convertibility breakdown; the strand on decentralized finance reveals how a price shift leads to a forced sale; the strand on connectedness reveals the existence of shock propagation; the strand on illicit finance reveals that the underlying data themselves are disputed; and the strand on regulation reveals necessary protections without any triggers. This current review connects all of these strands through liquidity transmission as the link mechanism and through expressing the main findings of each strand as a constituent of one diagnostic tool. The body of literature dealing with issues related to cryptocurrency markets and financial stability covers a number of interconnected research strands, namely market efficiency, volatility, stablecoin features, decentralized finance, systemic risk, illegal financial practices, and regulation. These strands can be systematized via a comparison of some of the relevant contributions, their achievements and open questions presented in Table 1. Comparison indicates gaps in the existing literature, particularly with respect to the relationship between liquidity, stablecoin redemption, decentralized liquidation procedures and systemic risk contagion. These gaps form the theoretical foundation of the current research and stress the importance of a joint examination of liquidity and financial stability in cryptocurrency markets.

Table 1. Literature strands, representative contributions, principal established finding, and identified gap.

Strand	Representative Contributions	Established Finding	Identified Gap
Market efficiency	Fama [30,31]; Grossman and Stiglitz [32]; Lo [33]; Urquhart [37]; Bariviera [39]; Khuntia and Pattanayak [41]	Efficiency in crypto markets is time varying and generally improving rather than absent	Improvements in pricing efficiency are not linked to changes in funding fragility
Volatility and portfolio behavior	Katsiampa [77]; Klein et al. [90]; Bouri et al. [79]; Conlon and McGee [83]; Baur et al. [23]	Diversification benefits are conditional and weaken in joint stress episodes	Investor-level covariance rather than system-level tail dependence
Stablecoin design	Moin et al. [10]; Lyons and Viswanath-Natraj [26]; Gorton and Zhang [27]; Aldasoro et al. [28]; Kosse et al. [43]	Par convertibility depends on reserve liquidity and dealer capacity, not on book backing alone	Single-episode designs; the comparative identification available in the period is unused
Decentralized finance	Schär [14]; Makarov and Schoar [91]; Qin et al. [93]; Aramonte et al. [92]; Alamsyah et al. [16]	Liquidation is deterministic, observable on chain, and temporally clustered	Treated as a protocol phenomenon, unconnected to redemption and reserve markets
Connectedness and systemic risk	Diebold and Yilmaz [53,100]; Adrian and Brunnermeier [51]; Naifar [54]; Ahmed and Aldasoro [45]	Spillovers are substantial within crypto and state dependent towards Treasury markets	Measured within the crypto complex; the asymmetric reserve-asset channel is rarely included
Illicit finance and integrity	Foley et al. [66]; Cong et al. [102,106]; Trozze et al. [104]; FATF [107,108]	Illicit use is measurable and reported volume on unregulated venues is partly fabricated	Disjoint from stability analysis although it acts on the same liquidity variables
Regulation and stability design	FSB [4]; IMF and FSB [112]; BCBS [113]; IOSCO [114]; CPMI-IOSCO [115]; MiCA and the GENIUS Act [24,25]	Convergence on functional regulation of reserves, redemption, and disclosure	Safeguards are not expressed as thresholds on observable series
Review methodology	Snyder [123]; Torraco [124]; Donthu et al. [125]; Khan et al. [57]; Paltrinieri et al. [56]; Said et al. [55]	Structured bibliometric and content-analytic protocols are now standard in finance reviews	Not yet applied to the crypto liquidity and stability literature

Source: Authors' own elaboration.

3. Review Design, Search Protocol, and Evidence Base

3.1. Choice of Review Method and Its Justification

There were three designs that could have been applied in this situation. A systematic review following PRISMA principles ensures the highest possible replicability and is suitable when the evidence consists of a body of comparable studies estimating a given parameter [126]. A bibliometric review charts the structure of a field through co-citations, co-words, and bibliographic coupling and is applicable when the object of analysis is the field itself [125,127]; the methodology has been particularly rigorously developed for market microstructure [55], for sukuk research [56], and reflexively, for finance bibliometrics [57]. An integrative review synthesizes conceptually diverse evidence into a new framework and is suitable in cases when the contribution is organizational rather than estimative [123,124].

Integrative design is used in this case because of the peculiarity of the object under study. The evidence regarding crypto liquidity transmission is not the set of comparable estimates of one parameter. It includes econometric research of return predictability; engineering studies of on-chain liquidation, issuer attestations, supervisory reports, regulatory instruments, and commercial market estimates; and no meta-analysis is able to aggregate this diversity of evidence. What can be carried out, and what is performed in this paper, is

to apply to an integrative review the methodological rigor of systematic and bibliometric designs: a declared database, a declared search string, declared inclusion and exclusion criteria, a declared review period, and a declared variable set. Thus, this design is based both on [123,124] in terms of its logic and on [35,55–57] in terms of its procedures. Following the example set in these papers, the search is described sufficiently clearly to allow another researcher to reproduce it (Tables 2 and S3), although the selection of the corpus within each strand rests on the authors' judgement (Section 3.8).

However, the methodological background is not just about procedures. The finding in the field of market microstructure that time-varying efficiency depends on trading architecture rather than being an intrinsic property of an asset [35] serves as the theoretical basis for Section 4; the protocol of content analysis used to describe the field [55] serves as the basis of strand-and-gap structure of Table 1. Finally, the reflexive finding in finance bibliometrics that the selection rules are very often omitted [57] is the reason why they are included in this research.

The review is reported in accordance with the PRISMA 2020 statement [126], as far as its items apply to an integrative design. The items that presuppose a pooled quantitative synthesis or a record-by-record screening of the database results (effect measures, meta-analysis, heterogeneity, reporting-bias and certainty assessments, and the screening counts) are reported as not applicable, with the reason given; all other items are reported in full. The completed PRISMA 2020 checklist and the PRISMA 2020 for Abstracts checklist are provided as Supplementary Materials (Tables S1 and S2), together with the full search strategies as run in each database (Table S3), the list of included sources with their route of identification (Table S4), and the list of records retrieved by the database searches (Data S1); the flow of sources is shown in Figure 1. The review was not registered in a prospective register, and no separate protocol document was prepared: the protocol elements (databases, search strings, filters, inclusion and exclusion criteria, review period, and variable set) are those reported in Tables 2–4.

3.2. Databases, Search Strings, and Selection

Both Scopus and Web of Science were employed as primary bibliographic sources. They were both queried, since their coverage complements each other, rather than being nested: comparative analyses have revealed significant differences in the sets of journals covered by these sources, with Scopus indexing more titles, while Web of Science covers longer periods of time in terms of longitudinal coverage of core finance journals [128,129]. Employing either of them separately would bias the corpus; thus, the union of the two was performed followed by deduplication of the results using a digital object identifier. Google Scholar was not employed as the source of record, as its coverage is not curated and reproducible, although it was used to validate the availability of the items.

The search was performed across the title, abstract, and keyword fields for the period 2015–2026 using four thematic strings that were run separately in each database and then combined with OR; the strings and filters are listed in Table 2 and the full syntax as run in each database, with the yield of each string, in Table S3. The databases were last searched on 2 October 2026. The combined searches returned 8154 records from Scopus and 3923 from the Web of Science; after the removal of 3068 duplicates (3064 records retrieved by both databases and 4 records indexed twice in the same database), 9009 unique records remained (Figure 1). Since the review is integrative rather than exhaustive, these records were not screened one by one for inclusion. The working corpus was selected by the authors within each strand, retaining only the foundational papers, the most-cited empirical studies, and the most recent work extending or contradicting them, against the criteria in Table 3; the database search documents the literature from which the corpus is drawn and allows its

coverage to be checked. Thirty-two of the included sources are among the 9009 records. The others were identified through citation searching and the authors' knowledge of the literature (75) or through the supplementary hand search described below (29), because they were published before the search window (Section 3.4), appear in outlets or subject categories outside the database filters, or do not use the search terms in their titles, abstracts, or keywords.

However, bibliographic sources alone were insufficient for this topic, as a material part of the literature base is not indexed. For this reason, four additional sources were manually searched: the working papers and reports published by the Bank for International Settlements, the International Monetary Fund, the Financial Stability Board, and the European Central Bank; the primary legal instruments of the two regimes under study; issuer reserve attestations and examination reports; and the market data dashboards listed in Section 3.7. These items were screened according to the inclusion criteria but were not included in the database output and date-stamped at the moment of use. In order to ensure that the process of reviewing literature is transparent, replicable, and consistent in its methodology, this literature review was carried out through a systematic search and screening process. The systematic search was conducted using Scopus and the Web of Science Core Collection database through the use of defined thematic search strings for cryptocurrency market efficiency, stablecoins, decentralized finance, systemic risk, and regulation. Defined inclusion criteria, document types, subject classification and time frames were used in order to obtain relevant scholarly literature. Table 2 provides an outline of the research methodology, including databases used, search process, thematic filters, inclusion criteria and screening process.

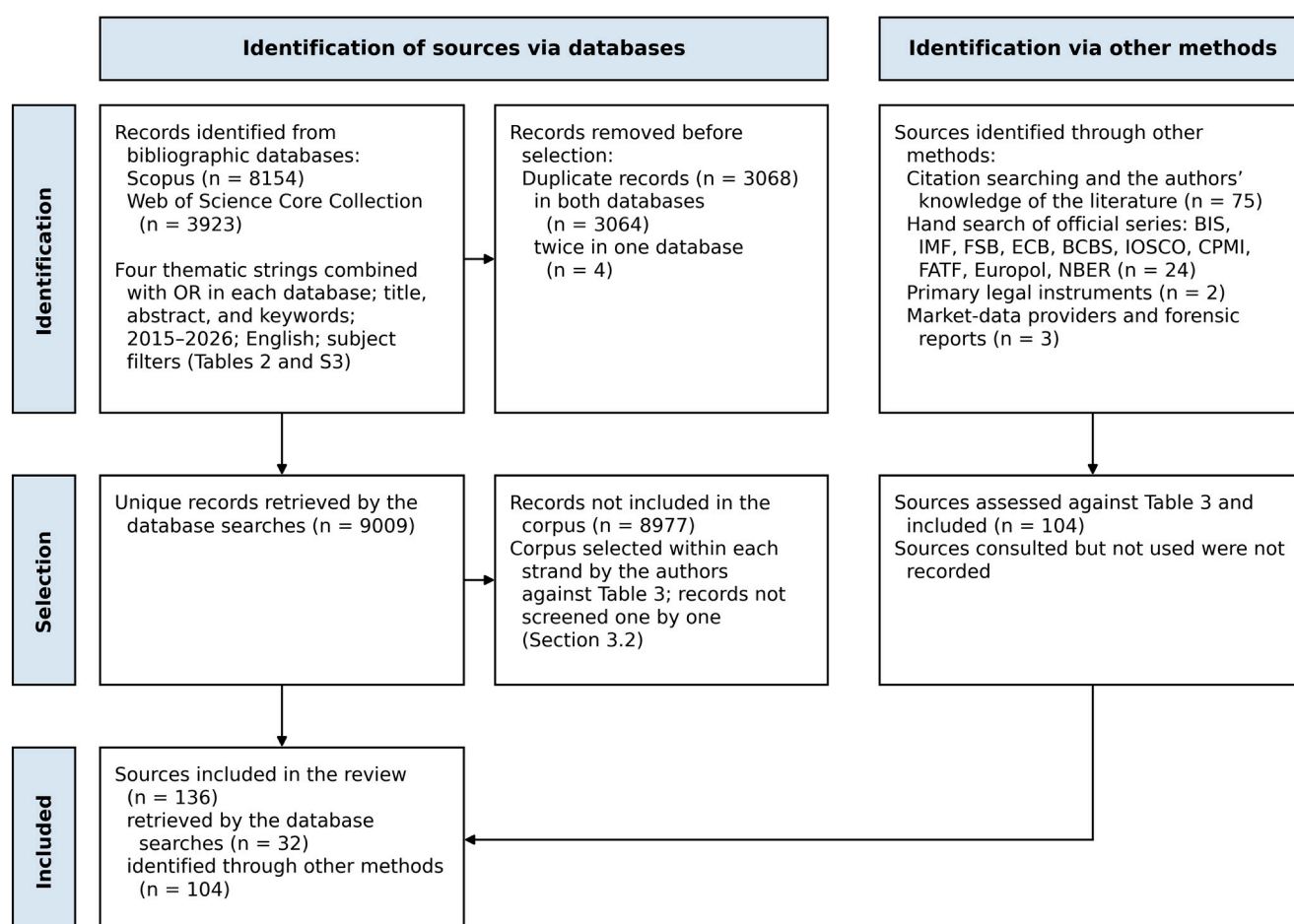
Table 2. Search protocol: databases, thematic strings, filters, and yield.

Protocol Element	Specification
Databases	Scopus; Web of Science Core Collection (union, deduplicated on DOI and title)
Fields searched	Title, abstract and keywords (Scopus TITLE-ABS-KEY; Web of Science Topic)
String 1: efficiency and microstructure	("bitcoin" OR "cryptocurrenc*" OR "crypto-asset*") AND ("efficien*" OR "random walk" OR "price discovery" OR "microstructure" OR "liquidity")
String 2: stablecoins	("stablecoin*" OR "tether" OR "USDC" OR "peg*") AND ("reserve*" OR "redemption" OR "run" OR "depeg*" OR "stability")
String 3: decentralized finance	("decentralized finance" OR "decentralised finance" OR "DeFi") AND ("leverage" OR "liquidation" OR "collateral" OR "lending" OR "protocol risk")
String 4: systemic risk and regulation	("crypto*" OR "digital asset*") AND ("systemic risk" OR "contagion" OR "spillover" OR "financial stability" OR "regulation" OR "illicit financ*")
Period	2015–2026 (publication year)
Document types	Journal articles, review articles, conference papers in indexed proceedings
Language	English
Subject filters	Scopus subject areas: Economics, Econometrics, and Finance; Business, Management, and Accounting; Computer Science. Web of Science categories: Economics; Business, Finance; Business; Management; Computer Science, Information Systems; Computer Science, Interdisciplinary Applications
Selection	Deduplication on DOI and title; selection of the corpus within each strand by the authors against Table 3 (Section 3.2)
Supplementary hand search	BIS, IMF, FSB, and ECB series; primary legal instruments; issuer attestations; market-data dashboards (not counted in database yield)

Table 2. Cont.

Protocol Element	Specification
Corpus construction	Within each strand: foundational contributions, most-cited empirical studies, most recent extending or contradicting work
Date of last search	2 October 2026 (Table S3)
Yield	Scopus 8154; Web of Science 3923; 3068 duplicates removed; 9009 unique records; 32 included sources retrieved (Figure 1)

The asterisk (*) is the truncation wildcard of both databases and retrieves every ending of the word stem (e.g., “cryptocurrenc*” retrieves “cryptocurrency” and “cryptocurrencies”). Source: Authors’ own elaboration. Protocol design follows the reporting practice of [55–57] and the guidance of [125,126].



Databases last searched on 2 October 2026 (Scopus searches run on 1 and 2 October 2026 with identical yields; Web of Science searches run on 1 October 2026 and combined on 2 October 2026; combined result sets exported on 2 October 2026). A further 20 references are cited for methodology or framing and are not part of the corpus.

Figure 1. Flow of sources, adapted from the PRISMA 2020 flow diagram [126]. (Left) records retrieved by the Scopus and Web of Science searches (Tables 2 and S3) and the included sources among them, selected against the criteria of Table 3 (Section 3.2); (right) included sources identified through citation searching, the authors’ knowledge of the literature, and the hand search of official series, legal instruments, and data providers. Source: Authors’ own elaboration.

3.3. Journal and Study Selection Criteria

Criteria for selection operated at both outlet and study levels and are listed in Table 3 below. At the outlet level, indexed peer-reviewed journals were acceptable without a threshold for ranking as a quartile cutoff would eliminate the specialist computer science publications where the most accurate studies of on-chain liquidation and blockchain

security can be found, which would create a disciplinary bias in a review covering the subjects of finance and engineering. Rather than using a ranking threshold, the criterion was the existence of peer review in addition to indexing in one of the source databases or publication by a standard setting or central bank institution.

At the study level, four conditions had to be fulfilled. The first was addressing at least one of the seven strands described in Section 2; the second, reporting either an empirical finding, a formal model, a documented policy position, or a primary law; the third, stating the data source and time period to make sure that the dating procedure for the purposes of this review could be performed on the basis of the findings; and the fourth—in case of reporting market aggregate data—stating the provider of the figures, since this condition directly addresses the issue described in Section 3.7 and is needed to make sure that different aggregations of data do not contradict each other in the synthesized results. The last requirement is somewhat unusual, since normally a simple aggregation does not carry enough significance to be the object of scholarly review. Predatory journals, retractions, and expressions of concerns regarding any article, as well as promotional literature on cryptocurrency protocols and their tokens issued by respective organizations, and non-peer-reviewed comments were all excluded from the review except commercial forensic aggregates.

In order to increase the rigour of the methodology and maintain consistency in the selection of literature, clear inclusion and exclusion criteria were formulated not only for publication outlets but also for each individual study selected. The purpose of such criteria was to ensure academic validity, topicality, reliability of evidence provided, and data transparency of selected works. It was especially important to consider the quality of publication, its relevance to identified themes of research, evidential base, and presence of reliable data. Table 3 provides an overview of inclusion and exclusion criteria that were used throughout the literature review process in terms of publication outlets, topicality, evidential requirements, data source, publication period, and language requirements.

Table 3. Inclusion and exclusion criteria applied at the outlet and study levels.

Level	Inclusion Criteria	Exclusion Criteria
Outlet	Peer-reviewed journal indexed in Scopus or Web of Science; peer-reviewed conference proceedings in indexed computer-science venues; official publications of BIS, IMF, FSB, ECB, BCBS, IOSCO, and CPPI; primary legal instruments	Outlets on recognized predatory lists; non-reviewed preprints without a subsequent reviewed version; promotional or marketing publications
Topic	Addresses at least one of the seven strands defined in Section 2; concerns crypto-assets, stablecoins, DeFi, their market structure, their connection to conventional finance, or their regulation	Purely cryptographic, consensus-protocol, or engineering contributions with no financial or economic content; blockchain applications outside finance
Evidence	Reports an empirical result, a formal model, a documented supervisory position, or a primary legal provision; states data source and sample period	Assertion without stated evidentiary basis; results that cannot be attributed to a data source or period
Data provenance	Market aggregates identified by provider and observation date	Aggregates reported without provider attribution or date
Period	Published 2015–2026; foundational works of earlier dates admitted where they establish the theoretical apparatus	Superseded working-paper versions where a published version exists
Language and integrity	English; not retracted	Retracted items or items subject to an unresolved expression of concern

Source: Authors' own elaboration.

Selection, data collection, and appraisal were conducted as follows. The corpus was selected by the first author (C.C.) against the criteria of Table 3 and agreed on by all authors; the quantities extracted from the sources and their observation dates were cross-checked by D.V. The database records were deduplicated and matched against the included sources with scripts written for this purpose, using digital object identifiers and normalized titles; no automation tool was used to decide inclusion, and no study investigators were contacted. For each included source, the following data items were recorded: the strand or strands of Section 2 that they inform; the type of evidence (empirical estimate, formal model, documented supervisory position, or legal provision); the data source and sample period; for market aggregates, the provider and the observation date; and the finding relevant to the transition that the source discriminates in Table 4. These items are reported in full: the strand, type, and route of identification of every source in Table S4 and every quantity used, with its provider and observation date, in the tables of Sections 3.7 and 4–13. Where a working paper and a published version of the same study were both available, the published version was used. No formal risk-of-bias or certainty-of-evidence instrument was applied, because the corpus combines econometric studies, engineering measurements, supervisory reports, legal instruments, and provider data, to which no single instrument is applicable; the quality safeguards are instead the outlet-level, evidence-level, and provenance criteria of Table 3, applied to every source, and the deliberate retention within each strand of the most recent work contradicting the most-cited findings. The synthesis is narrative and integrative: findings are grouped by strand (Table 1) and by the transition in the liquidity chain that they inform (Table 4), tabulated with their provider and observation date, and disagreements between providers are reported as ranges rather than resolved by selection (Section 3.7). No effect measure was pooled, and no meta-analysis, heterogeneity, reporting-bias, or sensitivity analysis was undertaken, because the evidence does not consist of comparable estimates of a common parameter (Section 3.1).

3.4. Justification of the Review Period

The descriptive data window spans the period between the peak of the cycle in November 2021 and July 2026, while the literature window starts in 2015. The two windows are distinct because they are answering different questions, and both are selected rather than inherited.

The literature window is selected based on three criteria: 2015 is the year when the first economic assessments of the asset class were published in general interest economics and finance literature [7,8]; it is the year preceding the first empirical tests of weak form efficiency [37], which are used as the starting point for the section reviewed in Section 4; and it is the year preceding the emergence of the instruments in question, which means that the entire development of the literature about stablecoins and DeFi from its inception is captured in the corpus, rather than midway through. Foundational papers of prior years are included in the corpus if they provide the theoretical framework rather than empirical evidence about the asset class—thus [1,30–32,36] are included in the corpus despite the above-defined window.

The data window is driven by the mechanism under consideration, not data availability. It starts at the November 2021 capitalization peak because it is the first and currently only instance of the full transmission channel working (valuation losses, leverage unwind, redemptions, and liquidation of reserves), and because a window that starts at the peak prevents the selection bias created by starting the sample during a drawdown. It ends in mid-2026 because it is the latest period in which all data series considered could be verified against dated primary sources. Between these two dates, the window includes by

construction the four events that give the review its variation: the failure of an algorithmic stablecoin in May 2022; the collapse of a major intermediary in November 2022; a reserve-induced de-pegging, successfully contained in March 2023; and the implementation of two targeted regulatory regimes in 2024 and 2025.

3.5. *The Variable Set and the Justification for Treating It Jointly*

A review that takes into account volatility, par deviation, redemption amounts, on-chain leverage, connectedness, reserve composition, regulation regime, and illicit finance risk in one study is likely to face criticism about having too many variables. Indeed, this objection has a point in general, because an excessive number of variables without a clear structuring leads to mere description and not an explanation. However, the response in the present case is that all the variables together form a joint requirement, and each one is insufficient alone, because each variable measures one step in the causal chain, and any subset of this chain does not define the mechanism.

Namely, volatility alone cannot distinguish between a valuation effect and a liquidity effect, because the same price move triggers none of the two when positions are unlevered and both of them when they are levered. Par deviation alone cannot distinguish between an arbitrage barrier and a run, because a token that is entirely covered in terms of reserve coverage trades under par value whenever redemption is temporarily unavailable [28,36], hence, the need for the redemption amount variable. Redemption pressure alone cannot distinguish whether the mechanism is confidence or collateral, which demands on-chain leverage and liquidation variables [93]. Liquidation pressure alone cannot distinguish whether the mechanism is on-chain, because a connectedness variable is needed to check for that [53,100]. Moreover, connectedness alone cannot determine whether the disturbance reaches funding markets, which depends on reserve composition and on the depth of the market in which reserves could be sold [45]. In short, each variable in the set is the discriminating factor for one particular transition in the escalation structure specified in Section 12, while excluding any one collapses two distinct states. This relationship is stated explicitly in Table 4.

Two variables in the set are conditioning rather than transmitting. Regulatory regime is included as a state variable, because the same observable configuration implies a different probability of escalation depending on whether there are legal provisions for redemption rights and reserve composition [24,25]. Illicit-finance risk is included for the reason mentioned in Section 2.6, namely, that enforcement directly affects liquidity, while reported volumes in unregulated exchanges are not true [106], and so, an indicator of liquidity calculated irrespective of the quality of exchange would measure an artifact. Neither is a component of the composite index; both are conditioning variables in the transition equation.

The selection of variables is guided by their theoretical relevance and their distinct roles in explaining the transmission of liquidity shocks across cryptocurrency markets and the broader financial system. Each variable captures a specific dimension of market vulnerability, including volatility, deviations from parity, redemption pressures, liquidation intensity, financial connectedness, and reserve composition, while regulatory regimes and illicit finance exposure are incorporated as conditioning factors. Table 4 presents the justification for the selected variables by identifying the transmission mechanism each variable helps distinguish and the analytical consequences of its omission. This framework ensures that the proposed analysis captures the interconnected mechanisms of liquidity fragility, contagion, and systemic risk while minimizing conceptual overlap and strengthening the interpretation of the empirical findings.

Table 4. Justification of the variable set: the transition each variable discriminates and the consequence of omitting it.

Variable	Transition It Discriminates	Consequence of Omission	Section
Realized volatility	Quiescence to valuation stress	No measure of the initiating shock; the chain has no entry point	Section 4
Deviation from par	Valuation stress to impairment of the liquidity buffer	Loss of the only direct signal that the settlement asset is no longer performing at par	Sections 5 and 6
Redemption pressure	Arbitrage constraint to run	Par deviation is uninterpretable; a temporary dealer constraint is indistinguishable from an exit	Sections 5 and 6
Liquidation intensity	Price movement to forced transaction	The endogenous amplification mechanism is unobserved, and contagion appears exogenous	Section 7
Connectedness	Localized disturbance to common factor	No basis for distinguishing an idiosyncratic protocol failure from systemic propagation	Sections 8 and 12
Reserve composition and coverage	Protocol-level contagion to spillover into funding markets	The external channel cannot be quantified; fire-sale capacity is unknown	Sections 5 and 8
Regulatory regime (conditioning)	Modifies the probability of every transition	Cross-jurisdictional differences in outcome are attributed to the market rather than to the regime	Section 9
Illicit-finance exposure (conditioning)	Modifies venue integrity and the reliability of the liquidity series	Fabricated volume and enforcement-driven liquidity withdrawal are treated as market phenomena	Section 10

Source: Authors' own elaboration.

3.6. Functional Taxonomy and Analytical Scope

The functional perspective means we take the financial function as the analytical unit rather than token label. There are four types of crypto-assets recognized. The first type is unbacked crypto-assets such as Bitcoin that obtain their value primarily due to scarcity, adoption, and market expectations. The second type includes reserve-backed stablecoins that provide for a stable redemption value and generate balance sheet and liquidity management issues. Tokenized claims and initial coin offerings are the third type that links digital markets with entrepreneurial finance and security-like claims. Finally, DeFi protocols represent exchange, lending, collateral, and derivative financial functions through smart contract technology. Such a functional classification enables one to compare crypto-finance with market institutions using the traditional terminology without making a presumption that similar technologies imply similar risks and reflects an approach taken in the recent supervisory analysis of decentralized intermediation [95]. Table 5 provides the taxonomy based on this functional classification alongside the associated instability mechanism and observable indicator.

Table 5. Taxonomy of crypto-financial layers by primary function, instability mechanism, and observable indicator.

Layer	Primary Function	Key Instability Mechanism	Observable Indicator
Unbacked crypto-assets	Speculation, transfer, store-of-value demand	Volatility, speculative episodes, market fragmentation	Realized volatility, bid-ask spreads, cross-exchange price gaps

Table 5. Cont.

Layer	Primary Function	Key Instability Mechanism	Observable Indicator
Stablecoins	Settlement, liquidity, collateral, on-chain unit of account	Deviation from par, redemption runs, reserve liquidation	Price deviation from par, net redemptions, reserve composition
DeFi protocols	Exchange, lending, leverage, derivatives	Smart-contract failure, liquidation cascades, oracle manipulation	Total value locked, utilization, liquidation volume, collateral ratios
Centralized intermediaries	Custody, brokerage, market making	Counterparty exposure, maturity mismatch, key compromise	Withdrawals, proof-of-reserve metrics, funding spreads
Traditional-finance linkages	Banking, securities, payment, and reserve assets	Fire sales, funding spillovers, confidence effects	Treasury bill holdings, bank exposures, payment substitution

Source: Author’s own elaboration.

Using a functional unit of analysis implies a methodological disadvantage that should be made explicit. Functions are not observable themselves but inferred from contractual promises, balance sheet structures, and behavior. A token could be promoted as a payment instrument even if the holder holds it mainly as a speculative investment, and a protocol could claim it is decentralized in spite of the fact that control is exercised by only a handful of governance holders. The functional classification thus requires attaching some quantifiable observable to each of the functional types and making the process of inference explicit. It is exactly the same issue one faces when any behavioral or institutional variable has to be made quantitative for economic analysis [130].

3.7. Descriptive Evidence Base

The descriptive base of the present review is summarized in Table 6. All quantitative data are from the published sources and are provided along with their observation dates since crypto-markets aggregates are revised, defined differently in various providers, and can change materially during a single quarter. Neither proprietary dataset nor new econometric estimates were produced in the study; the following quantitative data are descriptive and used for characterization purposes only. Disagreements between independent trackers are reflected rather than resolved by selection.

Table 6. Evidence base: literature strands and descriptive data sources with coverage and observation dates.

Strand	Principal Evidence Used	Coverage	Observation Date
Efficiency and volatility	Peer-reviewed time-series and microstructure studies; published realized-volatility estimates	2015–2026	Q1 2025; April 2026
Stablecoin market structure	Aggregate and per-token supply, issuer shares (DefiLlama and derived trackers)	December 2020–July 2026	12 July 2026
Reserve composition	Issuer attestations and examination reports; supervisory summaries	Q4 2025–Q1 2026	Q1 2026
Stress episodes	On-chain and exchange reconstructions of the May 2022 and March 2023 events	May 2022; March 2023	As dated

Table 6. *Cont.*

Strand	Principal Evidence Used	Coverage	Observation Date
DeFi scale	Total value locked across chains (DefiLlama)	November 2021–June 2026	18 June 2026
Operational losses	Annual stolen-fund aggregates and attack-vector attribution	2021–2025	2026 update
Reserve-asset transmission	Instrumented local-projection estimates of stablecoin flows on Treasury bill yields	January 2021–March 2026	February 2026 revision
Regulation	Primary legal instruments and international recommendations	2021–2025	As enacted

Source: Compilation of literature and data sources used in this review by the author.

There is one element of Table 6 that warrants special attention as it directly relates to the thesis of this review. Independent providers report aggregate stablecoin capitalization for the first half of 2026 ranging between USD 270 billion and USD 321 billion depending on which tokens are included, whether the supply measure is based on circulation or issuance, and which chains are considered. Such dispersion in the headline number of the sector is, indeed, a supervisory finding. If the outstanding amount of a private money-like asset cannot be determined to be within fifteen percent accuracy by independent providers, then any indicators calculated using such a stock—including any stress composite index—can only be obtained using a declared source with a declared definition, and cross-study comparisons must take the provider into account.

The layered architecture of crypto finance and the transmission mechanism governing the rest of the paper are depicted in Figure 2 below. A shock hits the layer of unbacked crypto-assets, is translated into a forced transaction by the collateral requirements in DeFi, drives the need for stable liquidity, and ultimately spills over to conventional funding markets through the sale of the reserve assets. Each layer adds one observable indicator to the composite index proposed in Section 12. This is a schematic depiction of the theory, not an estimated model. The direction of the arrows indicates the sequence under stress, not necessarily every single shock going through each of the layers.

3.8. Limitations of the Review Design

Four such limitations flow from the design and are discussed below rather than in the conclusions section, as each one affects the way the findings in Sections 4–12 should be interpreted. First, there is selection. An integrative corpus created through the retention of foundational, most cited, and most recent work in each strand is replicable in its process but not in its final content, as the winnowing of the screened sample down to the corpus is based on judgment. Selection through citation weighting also favors older work mechanically, while the measure taken against this effect—explicit retention of most recent contradictions—is partially effective only. Second, there is coverage. Limitation of the corpus to indexed English-language material means exclusion of non-English and national supervisory series publications that are not indexed; and since the use of the tools in question is prevalent in jurisdictions where the research output is often not indexed in either source database, the omission is unlikely to be random. Third, there is measurement. The descriptive base of this paper is made of providers with different definitions, and the dispersion found in Section 3.7 is not solved but reported. Therefore, any quantity discussed in Sections 4–12 should be considered provider-specific and time-specific rather than a market fact. Fourth, the very character of the contribution: the structure put forward

in Section 12 is a diagnostic framework, complete with its own logic and data requirements, but not an estimated model, as no parameter is identified by the data gathered for this study.

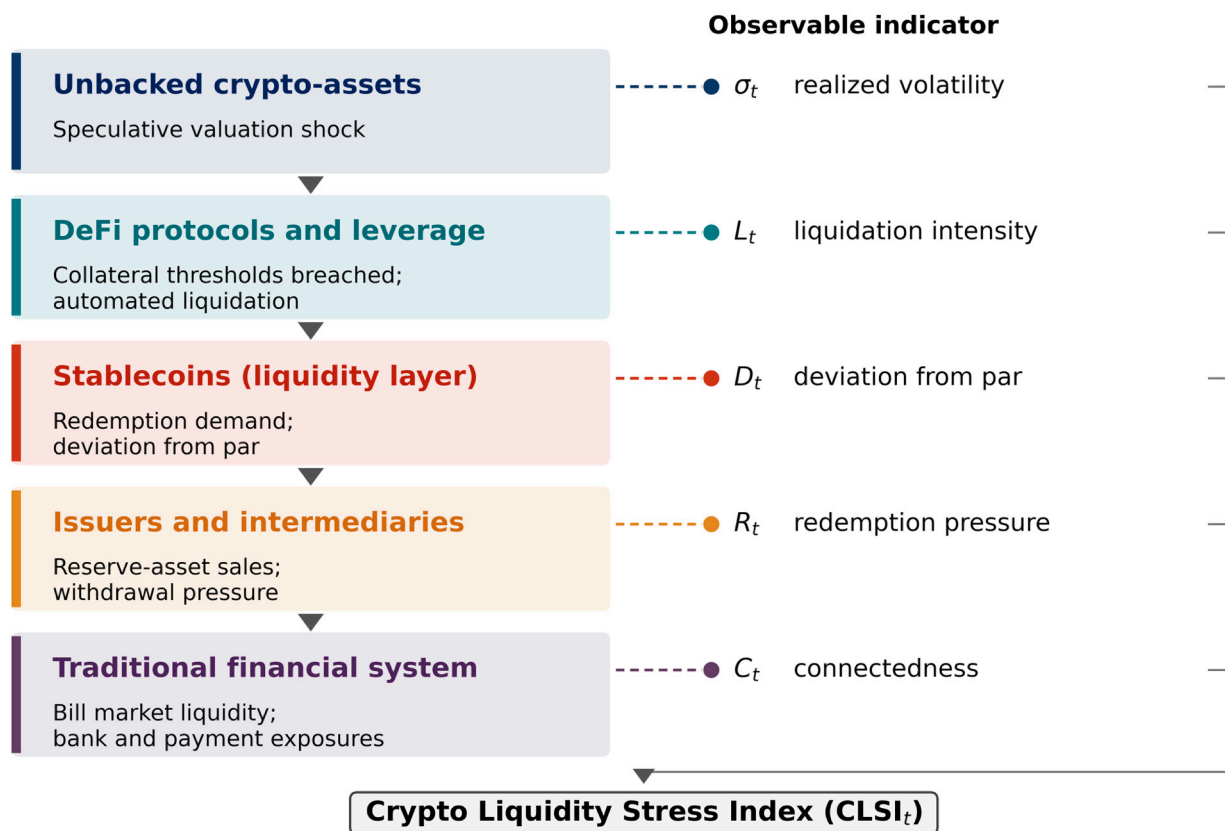


Figure 2. Layered architecture of crypto finance and the liquidity-transmission chain. Each layer contributes one observable indicator to the composite index defined in Section 12. The diagram is a schematic of the argument, not an estimated model. Source: Elaboration of the author.

A further limitation concerns the search. The database search documents the literature from which the corpus is drawn and its coverage, but its 9009 records were not screened one by one; 32 of the 136 included sources are among them, and the remainder were identified through citation searching, the authors' knowledge of the field, and the hand search of official series. Relevant studies outside the corpus therefore exist, and the corpus should be read as a selection designed to represent each strand rather than as an exhaustive census.

Generative artificial intelligence was employed, under the authors' supervision, as a drafting and language assistance tool and to prepare the scripts used to deduplicate the database records and match them against the included sources. All bibliographic references are checked against published works, official reports, and legal instruments; all data points are verified against their original source and are provided with dates in the following tables.

4. Crypto-Assets as Financial Assets: Efficiency, Price Discovery, and Volatility

4.1. Market Efficiency and Return Formation

Consistent with the literature on the information content of crypto-finance, informational efficiency is not stable. Applied tests using Bitcoin data have revealed inefficient and persistent periods with changing dependence structures [37–40]. In economic terms, this is sensible since crypto markets have undergone rapid changes in terms of trading platforms,

participant mix, use of derivatives, accessibility of institutions, and regulation. As market thickness grows, predictable types of dependence become less likely, but additional reasons for fragmentation and endogenous leverage become more likely.

Combined, it means that crypto-market efficiency has an adaptive character. The increase in institutional involvement does not ensure the elimination of the instability but leads to changes in mechanisms of its transmission. It is possible that the greater degree of integration with conventional finance will lead to the closing of arbitrage opportunities while making margin calls, collateral valuation, funding liquidity, and inter-market hedging even more relevant. The distinction between these two aspects is crucial for the analysis below since the market could become more efficient in pricing but more fragile in terms of liquidity.

4.2. Volatility, Tail Dependence, and the Conditional Diversification Claim

Volatility models confirm this point of view. Bitcoin as well as other cryptocurrencies demonstrates significant conditional heteroskedasticity, fat-tails, and asymmetric reactions that are not reflected in the constant variance models [77,78]. Comparison of Bitcoin and gold proves that the former asset may have some features of diversification but possesses different volatility and correlations [90]. It is important for risk management purposes because the position in cryptocurrency that shows low correlation with conventional assets in normal time could behave differently in the case of coordinated liquidity crisis.

The description provided in Table 7 and Figure 3 offers a crucial nuance to the traditional view of crypto-assets being highly volatile in equal measure. The annualized realized volatility of Bitcoin has been steadily falling in the course of the asset's development from triple-digit figures to 52 percent at the end of Q1 2025 and then to 35 to 40 percent by April 2026. While that is still materially higher than gold or broad equities' volatility, it is no longer an outlier when compared to that of individual large-cap equities. The implication here is that while the first moment of the return distribution tends to convergence, the tail behavior need not do that simultaneously—and that is what really matters for financial stability.

Table 7. Volatility across asset classes. Estimates are taken from published sources and are not directly comparable across the rows unless adjusted for the estimation window; both window and date are stated for each.

Asset	Volatility (%)	Measure and Window	Reference Date
Bitcoin	52.2	Annualized realized volatility	End Q1 2025
Bitcoin	38.5	30-day annualized realized volatility	April 2026
Ethereum	45.2	30-day annualized realized volatility	April 2026
Solana	62.8	30-day annualized realized volatility	April 2026
Cardano	58.4	30-day annualized realized volatility	April 2026
S&P 500	18.2	Implied volatility index level	April 2026
Gold	15.5	Annualized realized volatility	End Q1 2025
Gold	12.5	Annualized realized volatility	April 2026

Source: Own compilation of published volatility estimates. Figures are from various providers and estimation windows and are not directly comparable across the rows unless adjusted for the estimation window.

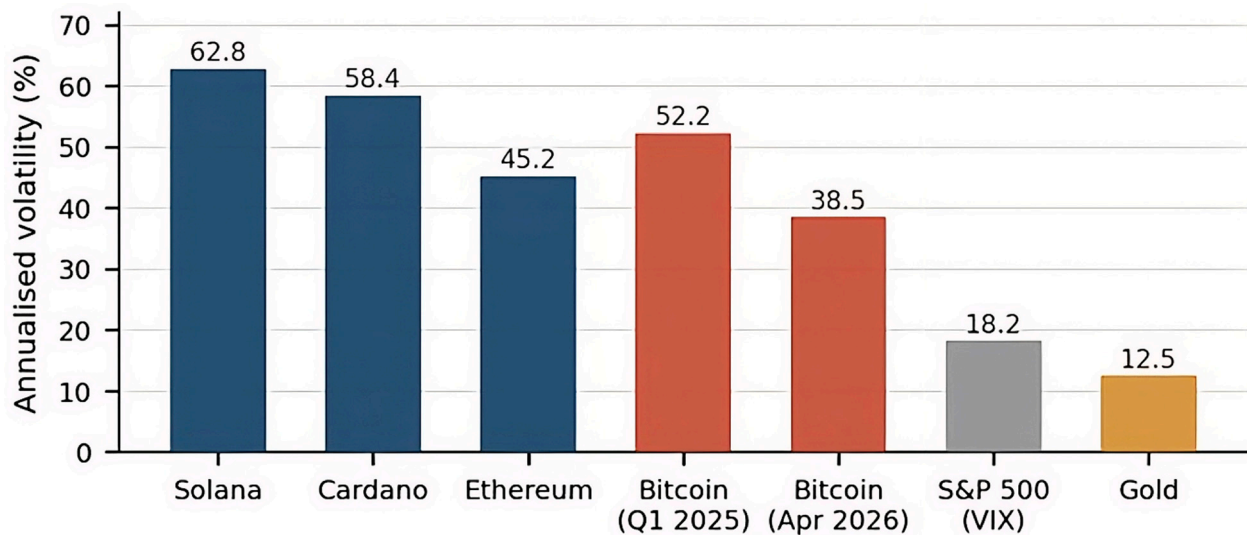


Figure 3. Volatility across asset classes. Bitcoin is plotted for two reference dates in order to show the direction of changes. Source: Author's elaboration based on published estimates of realized volatility collected in Table 7; return data underlying the figures are from exchange price series. Estimation windows vary across the series and are specified in Table 7.

Hence, safe-haven and diversification claims should be conditional rather than universal. While research suggests that Bitcoin could help achieve diversification in some portfolios [79–82], the evidence from crises—especially during the COVID-19 shock—has demonstrated that protection could be lost precisely at the times when it was most needed [83–86]. This conclusion is later corroborated by other studies on inflation and equity markets protection [87–89]. It is critical to understand the difference between unconditional correlations and tail dependence. The fact that the unconditional correlation is low does not mean that the asset will preserve its value in case of a simultaneous liquidity crunch.

4.3. Bubbles, Speculation, and Price Discovery

Speculative dynamics and bubble behavior offer a second basis for distinguishing the prices of crypto-assets from the prices of conventional currencies. There is evidence of speculative dynamics, explosiveness, and regime changes in Bitcoin and Ethereum prices [131–133]. Value-based models connect the process of pricing to the uptake of the currency, its demand for transactional purposes, the technical constraints, and macro-finance variables, but the relative weight of each varies over time [134–136].

Market microstructure matters too. The process of price discovery occurs across several exchanges, and exchange-level frictions may lead to temporary price inconsistencies [59–61,137,138]. There is volume information about return and volatility dynamics, there are spillovers in the volatility and returns among cryptocurrencies [96–99], and the leadership role in the price discovery process is not static. This architecture leaves room for arbitrage activities, but the ability to arbitrage is constrained by settlement delays, capital constraints, credit risk, transfer restrictions, and the cost of moving assets across markets [58]. These frictional constraints will play an important role in the argument made later in the paper: the same constraints that permit price differences to exist will also dictate how quickly an undervalued stablecoin can be brought back to parity through redemption arbitrage.

5. Stablecoins as the Liquidity Layer of Crypto Finance

5.1. Function and Market Structure

Stablecoins are economically distinct from other types of crypto-assets because their value resides in their stability against a benchmark. Their usefulness depends on convertibility, transferability, and integration into trading and DeFi platforms. In practice, they facilitate holding a cash-like instrument within the crypto ecosystem, reducing the necessity to switch between the blockchain networks and bank money. It is the convenience factor that allows stablecoins to become pivotal hubs within liquidity networks despite not directly being the target of speculation [28]. Private instrument with public monetary function implies that the conditions of its circulation are a matter of economic governance and not only of technicalities [139].

The corresponding market structure is depicted in Figure 4 and summarized in Table 8, and two aspects come into view. First, scale. Aggregate supply increased by roughly an order of magnitude from the end of 2020 to mid-2026, and stablecoins represent a significant proportion of crypto-market capitalization. Second, and more crucial from the standpoint of stability analysis, concentration. As of July 2026, two issuers provided approximately 85 percent of the outstanding supply and the top five almost 90 percent. Such a level of concentration implies that the failure of one issuer is not a diversifiable event within the industry: it is a change in the liquidity regime of the whole market. Moreover, the distinction between idiosyncratic and systemic risks, a cornerstone of prudential regulation, is hard to draw in this case in the usual way.

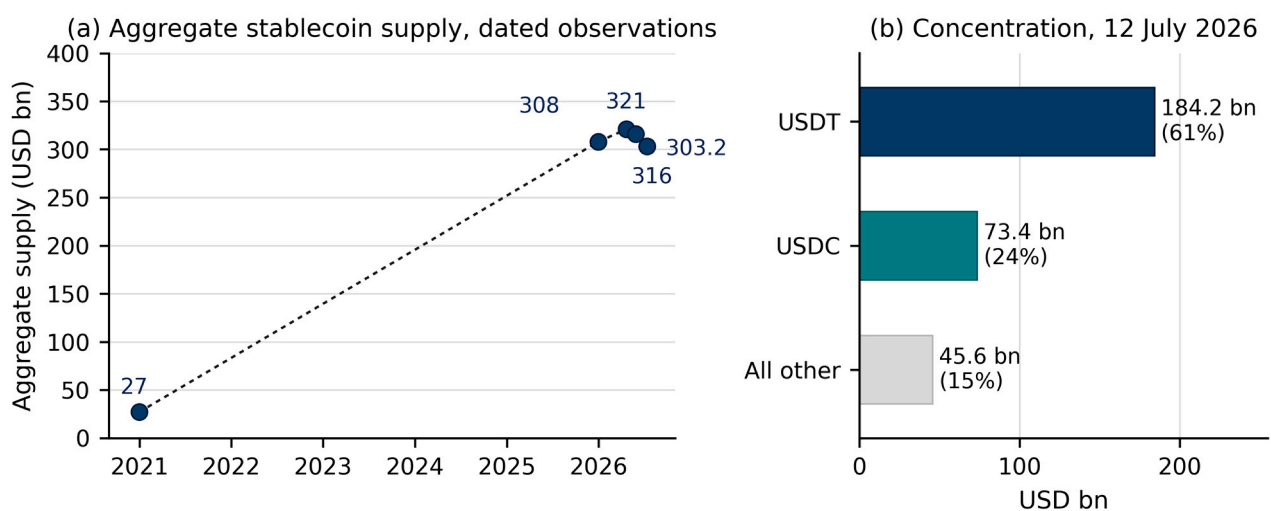


Figure 4. Scale and concentration of the stablecoin market. (a) Date-stamped data on aggregate supply (points); the dotted line is illustrative only and not a series of interpolated observations because intermediate points are inconsistently reported. (b) Shares of issuers on 12 July 2026. Source: The author's own elaboration based on aggregate and individual supply data reported by DefiLlama [44].

Table 8. Structure of the stablecoin market. Data on aggregate supply and issuer shares provided by DefiLlama as of 12 July 2026; early anchor points as date-stamped.

Measure	Value	Share of Total	Date
Aggregate supply	USD 27 bn	—	31 December 2020
Aggregate supply	USD 308 bn	—	31 December 2025
Aggregate supply (record)	USD 321 bn	—	21 April 2026
Aggregate supply	USD 303.2 bn	—	12 July 2026

Table 8. *Cont.*

Measure	Value	Share of Total	Date
USDT (Tether)	USD 184.2 bn	61%	12 July 2026
USDC (Circle)	USD 73.4 bn	24%	12 July 2026
Top two issuers combined	USD 257.6 bn	85%	12 July 2026
Top five issuers combined	—	≈89%	Q1 2026
Reported range across trackers	USD 270–321 bn	—	March–July 2026

Source: The author's own compilation from DefiLlama [44]; the range represents differences across independent trackers, including the smaller aggregate supply of [45].

Another aspect worth mentioning is asymmetry. The outstanding supply and the transactional share do not always coincide. The largest stablecoin in terms of outstanding supply does not have to be the largest in terms of settled volume. Shares on centralized exchanges and on-chain volumes differ as well. Supervision-wise, these are two different questions: outstanding supply determines the size of the redemption liability, whereas settled volume determines the disruptive effect of loss of confidence in the corresponding token. A systemically important arrangement in the latter respect may appear moderate in the former.

5.2. Design of Reserves, Disclosure of Reserves, and Quality of the Backing

Design determines risk. Stablecoins may be backed by cash and highly liquid reserves, by more diverse reserve portfolios, by crypto-collateral, or by algorithmic systems. Literature makes a distinction between these models due to their implications regarding the dynamic of confidence and redeemability [10–12,26]. Although a token with a reserve backing may seem quite straightforward, the stability of such a stablecoin depends on liquidity, valuations, custodial arrangement and legal segregation of the reserves, and credibility of the redeemability process. The algorithmic model faces a different challenge—failure of the stabilization mechanism may occur exactly because of the collapse of confidence and disappearance of any endogenous supportive mechanisms.

Figure 5 and Table 9 contrast the two most popular reserve designs, as they are disclosed in 2026. They have approximately four-fifths of reserves invested in short-term government paper, reverse repurchase agreements, or government money-market funds. However, they differ in three ways under stress. First, one model holds the residual fifth in bank deposits, while the other model invests in assets such as gold, bitcoin, secured loans, and others, whose mark-to-market value depends on very same conditions that trigger redemptions. Second, assurance of reserves is different—monthly review by one of the Big Four accounting firms is quite different from quarterly agreed upon procedures attestation. Third, access to redeemability is different—although direct redemption is available to institutional counterparties above a certain minimum level, retail holders have to leave via secondary market where price can deviate from par even with sufficient reserves.

It is the third part that is relevant analytically. The stabilization mechanism via arbitrage does not happen automatically but involves a specific set of agents with the ability to redeem the tokens, sufficient balance sheet capacity, and willingness to hold them over the course of the settlement process. If any of the above are lacking, a fully-backed (in an accounting sense) stablecoin can still trade substantially below its par value, the magnitude of the price divergence reflecting the constraint on arbitrage. Viewing the price departure

from par as a sign of insolvency thus constitutes a category mistake, which is the reason for the pair of indicators used in the proposed framework (Section 12).

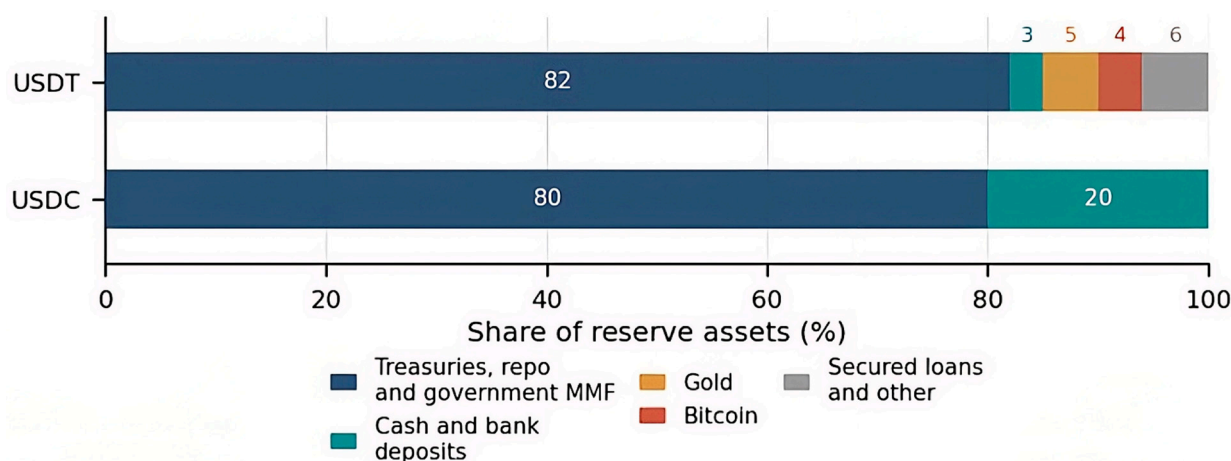


Figure 5. Composition of the reserves of the two largest reserve-backed stablecoins as disclosed for Q1 2026. Shares are approximate and consistent with issuer disclosure category, which is not completely standardized among issuers. Source: author’s elaboration based on issuer reserve disclosures and examinations reports for Q1 2026 (see Table 9).

Table 9. Reserve design, assurance, and access to redeemability of the two largest reserve-backed stablecoins as disclosed for Q1 2026.

Dimension	USDT (Tether)	USDC (Circle)
Treasuries, repo, and government MMF	≈82% of reserves	≈80% via an SEC-registered government money-market fund
Cash and bank deposits	Low single-digit share	≈20%, held at globally systemically important banks
Non-qualifying reserve assets	Gold ≈ 5%, bitcoin ≈ 4%, secured loans and other ≈ 6%	None disclosed
Assurance	Quarterly agreed-upon-procedures attestation	Monthly attestation by a large audit firm
Holdings transparency	Periodic composition summary	Daily fund holdings published at instrument level
Direct redemption	Verified institutional counterparties above a size minimum	Institutional access; retail exit via venues
Correlation of residual reserve with crypto conditions	Material (gold and bitcoin)	Limited

Sources: Own compilation from issuer reserve disclosures, examination, and attestation reports for Q1 2026.

5.3. Monetary Substitution and Circulation of Liquidity

From the financial stability perspective, the key issue here is a change of nature from a promise of stable value to a backing portfolio. If the size of redemptions is low, a stablecoin issuer can handle them with cash or routine asset sales. However, under the run scenario, the pace of redemptions exceeds the liquidity of the reserve portfolio. Such sales of the backing portfolio will then transmit stress beyond the crypto environment if the size of the stablecoin has increased relative to the market size of instruments that compose it. That is the reason why recent institutional analysis emphasizes the importance of the quality of reserves, redemption rights, disclosure, governance, and fire-sale externalities [3,4,112,116].

Stablecoins present a monetary substitution issue too. In economies with volatile domestic currency or restricted access to dollar banking systems, a widely available stablecoin denominated in dollars can become a substitute for the store of value and a means of payments, and the cross-border flow statistics suggest that such use of the technology is unevenly distributed across jurisdictions and not strongly related to traditional gravity factors [140]. Users' private gain can thus be at odds with potential public concerns regarding monetary sovereignty, management of capital flows, and monetary policy transmission. If a foreign-denominated stablecoin substitutes domestic balances, the circulation of purchasing power domestically will change in ways that conventional monetary aggregates fail to reflect, along with the relationship between the latter and domestic price level [141].

The most powerful existing test of monetary substitution is not cross-border flow statistics but the only known case of adoption of an unbacked crypto-asset as legal tender by a sovereign state. In September 2021, El Salvador adopted Bitcoin as legal tender, in addition to the US dollar, using the state-backed wallet, enrolment bonuses, and a network of conversion points [142]. What makes this example instructive is precisely the fact that it takes away all barriers to adoption. It was shown in a nationally representative study that usage of Bitcoin was confined to the enrolment period and involved younger, banked, and educated individuals; that a very large majority of individuals who downloaded the state wallet did not transact after spending the bonus; and that the portion of firms that accepted the asset and the taxes and remittances paid in this currency was insignificant despite its legal tender status.

Three conclusions are drawn from this example for the argument of this review. First, the example provides support for the position taken in Section 1 that the currency-or-asset question should be answered layer by layer: even when there is legal compulsion, the unbacked asset does not play the role of a unit of account, whereas the dollar-denominated tokens considered in Section 5 have already been circulating for the purpose of payment transactions without having a legal tender status. Second, the fiscal and prudential implications of the national adoption were sufficient for the program negotiations between the government and international financial institutions, resulting in commitments reducing the exposure of the public sector and making the acceptance mandatory [143]. This is the clearest possible illustration of the externality asymmetry described in Section 9: while the balance-sheet risk was domestic, the supervision and finance instruments were international. Third, and most importantly for the transmission chain, this example shows where the pressure for monetary substitution exists. If the domestic currency is volatile or dollar banking is constrained, the monetary substitute is not the unbacked crypto-asset but the dollar-denominated stablecoin, which has the store-of-value and payment functions that the unbacked asset lacks [29,140]. The monetary sovereignty problem posed in Section 5.3 is therefore the stablecoin problem, and the El Salvador example provides proof of this fact.

It is thus true that the policy challenge cannot simply be framed as an 'innovation versus prohibition' dichotomy. Instead, it requires a proportional consideration of scale, backing, application, and cross-border substitutability, along with a clear decision about which of the roles served by the tool the regulators seek to regulate. A token used largely as trading collateral in a closed ecosystem is not the same issue as one used as a means of remittance, despite the technological identity of the two.

6. The Anatomy of Stablecoin Stress: Evidence from Two Episodes

That stablecoins can indeed be the carriers of stress is a matter of theoretical consensus. What the present period contributes is the demonstration of two distinct scenarios in terms of their outcome, allowing the parameters for containment to be discerned, not assumed.

Table 10 provides a summary of the documented parameters of both these episodes, along with three smaller de-pegging events that took place at the same time as the latter.

Table 10. Documented stablecoin stress episodes: design, trigger, magnitude, and outcome.

Instrument	Design	Trough Price	Trigger	Outcome
TerraUSD (UST), May 2022	Algorithmic, endogenous collateral	≈USD 0.02	Large withdrawals from a yield protocol holding most of supply	No recovery; ecosystem value of roughly USD 40–50 bn destroyed
USD Coin (USDC), March 2023	Reserve-backed	USD 0.8726	Notice of the presence of ≈USD 3.3 billion of reserves (≈8%) held at a bank that had gone out of business	Par restored within ≈72 h after a public deposit backstop
DAI, March 2023	Crypto-collateralized	≈USD 0.89	Collateral exposure to the affected stablecoin	Recovered within ≈48 h
FRAX, March 2023	Partially collateralized	≈USD 0.88	Collateral and liquidity linkage	Recovered
USDD, March 2023	Algorithmic-hybrid	Below par	Correlated confidence effect	Recovered

Source: Own author compilation of the two documented episodes and the correlated de-pegging events [46,48].

6.1. TerraUSD, May 2022: Failure Without an External Anchor

The TerraUSD design was algorithmic, with the stability being supported through minting and burning of a companion token, rather than through an external reserve. The demand had been sustained by a lending protocol with yields of close to twenty percent, which accounted for the lion's share of the supply. An in-depth on-chain analysis of the crisis shows that the run began with large withdrawals from the protocol on 7 May 2022 and spread across several chains and assets, driven by growing doubts about the sustainability of the system, rather than concentrated manipulation of a single participant [46]. Over several days, the token fell progressively without recovering; the supply of the companion token grew by four orders of magnitude, with the stabilization mechanism working precisely as intended and destroying the value that it relied upon.

There are two unique aspects of this particular crisis from an analytical perspective. Firstly, there was no external anchor—since the collateral was endogenous, the stabilization mechanism was most robust exactly when it was most unneeded, and vice versa. Secondly, it relates to the informational environment—on-chain transparency enabled participants to observe each other's withdrawals in real time, thus, accelerating rather than dampening the run. Usually, transparency is considered to be stabilizing due to its effect on reducing uncertainty about fundamentals; in this case, transparency was destabilizing as it reduced uncertainty about behavior of other depositors, which is the variable in question for a run.

6.2. USD Coin, March 2023: Reserve Exposure with Successful Containment

In contrast to TerraUSD, the second example was structurally different—the USD Coin was a reserve-backed stablecoin, with its issuer disclosing that close to eight percent, or roughly USD 3.3 billion of reserves, were held at a bank, which was placed under receiver-

ship. The secondary market price fell to USD 0.8726 on 11 March 2023 but subsequently recovered to USD 0.9918 on 13 March, after the announcement of the full compensation of depositors in the failed bank. Correlated de-pegging was observed in tokens with the stablecoin in question as collateral, with the price of the associated instruments falling to between USD 0.88 and USD 0.89 [48]. The decentralized exchange volumes increased as a result, and significant outflows from the centralized venues took place over the same period. Figure 6 contrasts the price paths of the two episodes.

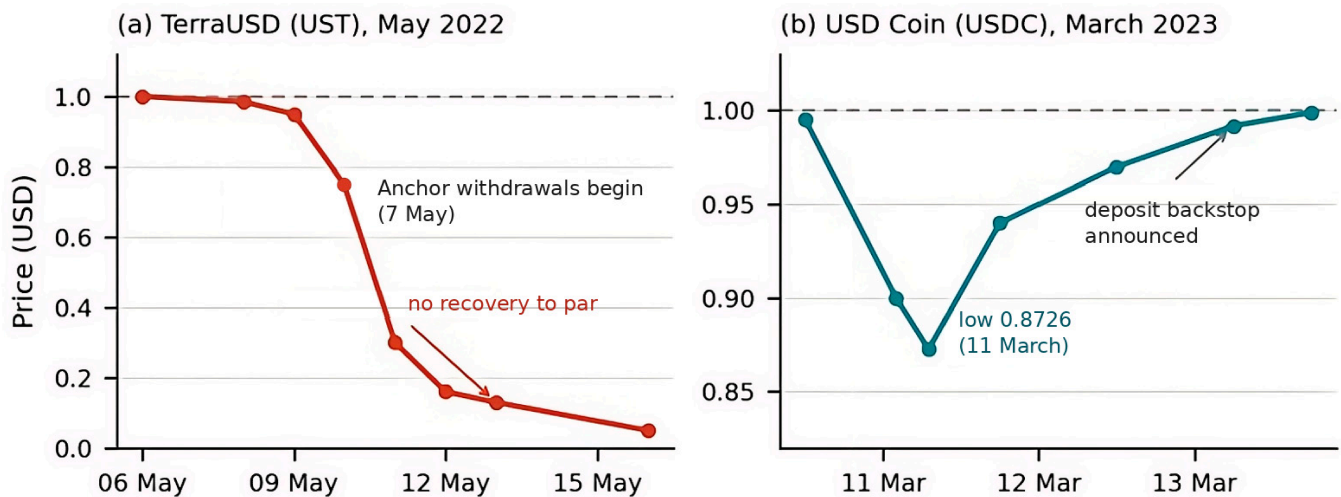


Figure 6. Price paths during two stablecoin stress episodes. Note the difference in the vertical axes: (a) shows the full range; (b) roughly thirteen percent. Points show price observations, the dashed line marks par (USD 1.00), and the arrows point to the annotated events. Source: Author's own elaboration based on price observations for the two episodes [46,48].

This contrast is important precisely because the two graphs are constructed on a different scale. The first crisis was a collapse. The second was a seventy-two hour disruption of some thirteen percent of the system at its nadir. What is different about the two is not the initial size of the shock relative to the reserve—a reserve impairment of eight percent is large—but the availability of a credible external backstop and the fact that the remainder of the reserves was in instruments that could be sold off without loss. This is the lesson of a conditional claim: reserve-backed systems are robust to shocks of significant magnitude when the remainder of the reserve is liquid and the resolution of the impairment is rapid and credible.

6.3. What the Two Episodes Together Identify

Taken together, the two episodes allow the isolation of three distinct failure mechanisms that are often confused with each other. The first is a solvency failure, in which reserves are inadequate to meet the redemption promise. The second is a liquidity failure, in which reserves are adequate but cannot be converted quickly enough at a large enough scale. The third is a coordination failure, in which reserves are both adequate and liquid but are withdrawn due to rational fears of being last. The first episode suffered from all three, since the design blurred the distinction between the collateral and the claim. The second was driven only by the latter problem, which was resolved through an announcement changing expectations rather than a change in the reserve composition.

The implications for regulation are clear: disclosure requirements deal with the solvency issue, reserve composition requirements deal with the liquidity problem, and only a credible commitment mechanism—whether contractual, legal or public—deals with the coordination problem. A regulatory regime that meets the first two criteria but fails the

third will generate arrangements that are sound on paper and vulnerable to a run nevertheless. Equally, an analytical approach based solely on monitoring reserve quality is bound to miss a class of episode like the second.

7. Decentralized Finance, Leverage, and Endogenous Contagion

DeFi extends crypto finance from asset trading to a broader set of intermediation services. Smart contract platforms facilitate market making, collateralized lending, derivatives, liquidity provision, and composable financial products [13,14]. The promise is of lower intermediation costs, transparency, and openness. Yet the composability that generates efficiencies may give rise to dependencies. An asset may serve at the same time as the collateral in one protocol, as a pool element in another, and as the reference asset in a derivative.

The economics of DeFi, therefore, are well-known, despite its novel technological implementation. Leverage creates asymmetric gains and losses; collateral requirements give rise to nonlinearity in liquidation; maturity and liquidity mismatch can emerge in the absence of a typical bank; and information asymmetry is merely partially solved by on-chain transparency. Smart contracts are visible, but governance mechanisms, oracle systems, protocol updates, bridging security, and concentration of token holdings offer opaque bases for control. The literature on DeFi vis-à-vis traditional intermediation stresses the opportunities for reduced costs alongside continued rents, concentration, and risks [91,95].

Table 11 and Figure 7 put the size of the industry in cyclical context. Total value locked reached a high of about USD 177 billion in November 2021, dropped to around USD 38 billion by August 2023, rose back up to about USD 171 billion in October 2025, and subsequently fell by almost fifty-eight percent in a bit less than eight months to about USD 72 billion in June 2026 [44]. Two conclusions can be drawn. First, the industry has now experienced two complete cycles of similar magnitude, so that the 2021 expansion period should no longer be treated as a unique one-time phenomenon. Second, the indicator itself is a stock of deposited capital, rather than a flow of productive activity, and is thus vulnerable to asset valuation: a decline in total value locked will also reflect a decrease in the value of the assets deposited rather than an outflow of participants. Interpreted as a stress indicator, the indicator series must be decomposed into a price effect and a quantity effect.

Table 11. Decentralized finance: total value locked at cycle milestones (DefiLlama, all chains).

Milestone	Date	TVL (USD bn)	Change from Prior Milestone
First cycle peak	9 November 2021	177.5	—
Post-collapse trough	August 2023	≈38.0	−79%
Recovery interim	April 2025	≈87.0	+129%
Second cycle peak	7 October 2025	171.0	+97%
Year-end baseline	20 December 2025	116.3	−32%
Year-to-date high	18 January 2026	127.8	+10%
Mid-year level	18 June 2026	71.8	−44%

Source: Author's own compilation from DefiLlama, all chains [44].

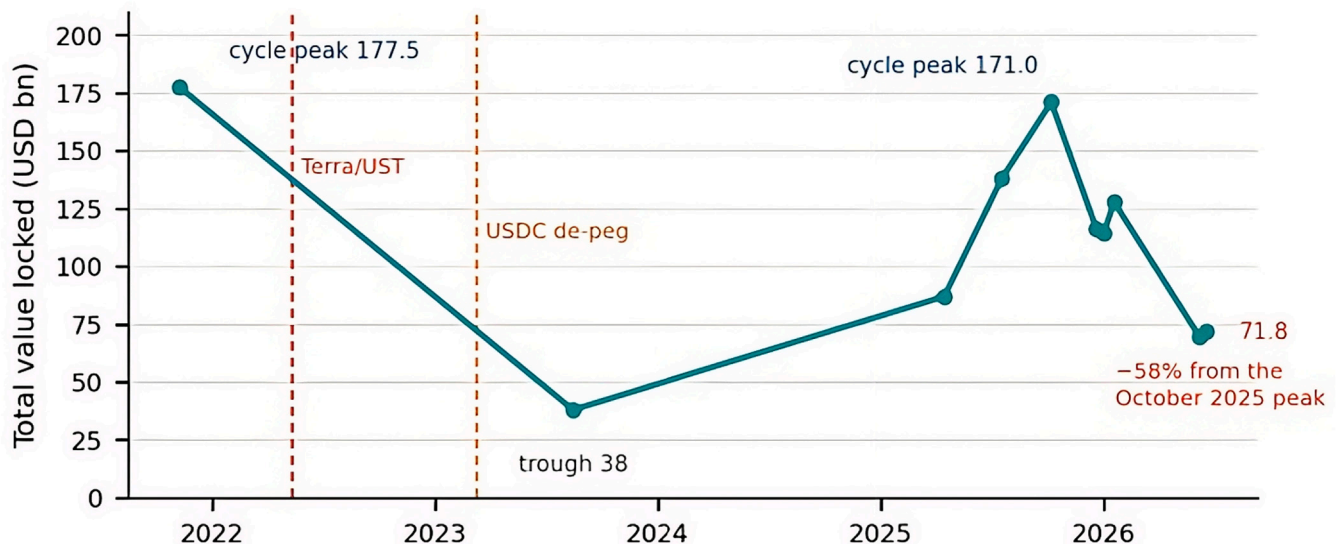


Figure 7. Decentralized finance total value locked at dated observations, all chains. Points show the reported observations, and the dashed vertical lines mark the two stress episodes analyzed in Section 6 (May 2022 and March 2023); the connecting line connects reported observations and does not reflect continuous data. Source: Author's own construction using total value locked observations reported by DefiLlama [44].

It goes without saying that the process by which an impact on a valuation is turned into a liquidity event is automated liquidation. With prices of collateral dropping, positions go beyond defined thresholds and are liquidated, lowering prices even further, causing even more liquidations. Stablecoins may act as a buffer against this process by providing liquidity, or they may facilitate it if they themselves are affected, as was the case in March 2023. Thus, the entire mechanism works as follows and consists of three stages. It is endogenous, since it is generated by the interaction between the prices and the rules of contract, rather than discretionary decision-making, and it is fast, since smart contracts work non-stop, rather than waiting for balance sheet committee. Section 12 formalizes each stage as a distinct quantifiable process.

8. Interconnectedness with Traditional Finance

The importance of crypto finance to the economy is not measured by market cap but rather by the extent of connection with the traditional system in terms of balance sheet and liquidity links. There are several important channels: banks can offer custody and payments service to crypto finance institutions; institutional investors may own crypto linked securities; stablecoin issuers may have government bills and bank deposits on their balance sheets; payments companies may adopt stablecoins; households can switch between deposit, cash, and tokenized claims.

Portfolio analysis indicates that crypto-assets might be good diversifiers under some regimes and also be positively correlated with risky assets in stress conditions [80,82,98,99]. This is important since financial integration alters the nature of shock transmission. Shock remains confined if the ownership and financing is confined. However, the shock becomes macro-financial if it causes margin calls, liquidity hoarding, sale of reserve assets, and loss of confidence in intermediaries that operate in both crypto and conventional segments.

There is a direct connection between the sectors via reserve portfolios of stablecoins, and it has been estimated, rather than assumed before. Using daily data and exploiting the variation in issuance at the token-blockchain level, inflows into stablecoins decrease three-month Treasury bill yield by approximately 2.5–3.5 basis points, with the impact

limited to shorter maturities only and no spillover to long-term yields [45]. There are two features of that estimation that are crucial for the analysis. First, it is state dependent. The reduction increases to 5–8 basis points during periods of bill scarcity and cannot be distinguished from zero during the periods of bill abundance. Second, it is asymmetric, since outflows increase yield by two to three times more than comparable inflows reduce it.

Asymmetry is an analytically important result, since it means that the impact of the reserve-asset channel cannot be described by a linear model. Calibration of the linear model on the expansion phase will underestimate the impact of contraction by a factor of two or more, and calibration on a period of abundant bills will underestimate the impact in a period of bill scarcity. Therefore, any framework that would try to predict spillovers from liquidity stress in crypto to conventional funding markets needs to be set up with state and sign dependence incorporated, rather than used as a robustness check after. This is the empirical justification of the discrete state structure chosen in Section 12.

It is also true when it comes to the direction of causality. Studies of money flows at the national level have demonstrated that the effect of a certain financial system on economic performance is contingent upon the structure of the national economy, not the instrument itself [144]. For stablecoins, this means that the systemic importance of the quantity of tokenized claims to dollars will vary depending on the depth of the markets where their redemptions will be liquidated, and the depth of those markets can change over time.

Furthermore, the effect of a stablecoin might depend upon its relationship to tokenized deposits and securities. Even though these types of assets differ conceptually from privately issued stablecoins, market actors might use them as substitutes in payments and collateral management. In other words, regulatory approaches should consider redemption promise, issuer balance sheets, settlement finality, and legal claim rather than just calling them tokens, coins, or digital assets.

This substitution effect cannot be analyzed in isolation from developments in public digital money. The research on the digitalization of money analyzes the competition between private tokens, commercial bank deposits, and prospective central bank digital currencies for the transaction demand [117,118], whereas studies on retail central bank digital currency design analyze technological and institutional decisions that determine whether this instrument will complement or substitute for private money [119–121]. A tiered interest rate structure is one example of the effort to reduce the disintermediation of bank financing that unrestricted access to public digital money could cause [122]. What is important for the current argument is that the scale of the stablecoin sector is partially contingent upon the lack of a good public substitute. If there is a well-designed public instrument, the demand curve of the private issuer changes, as does the amount of outstanding claims that would need to be liquidated via the markets of reserves.

9. Regulation, Market Integrity, and Financial-Stability Design

9.1. The Classification Problem and the Functional Response

A problem of classification emerges when it comes to designing regulation of crypto finance since it includes elements of payments, securities, banking, commodities, custody, and market infrastructure. It is thus advisable to adopt a functional approach. A token promising par redemption on its portfolio of reserves needs to be analyzed for the risks connected with reserves, liquidity, governance, custody, and disclosure. A token offering financing for some venture needs to be analyzed from the viewpoint of securities law and investor protection. A leveraged DeFi protocol raises collateral, liquidation, market integrity, and operational resilience issues.

Some international policy efforts are based around the following key principles: same activity, same risk, same regulation; holistic approach; effective redemption rights for

stablecoins; high-quality reserves; transparent disclosure; cross-border cooperation; and interconnectedness [3,4,112,116]. Macro-financial regulation includes monitoring of leverage, concentration, adoption, currency substitution, and risks to regulated intermediaries [5]. This set of principles is not technology neutral in the literal sense—technological characteristics are important if they affect the speed of settlement, transparency, operational dependence, or regulatory capabilities.

9.2. Two Frameworks Compared

During the considered period, the crypto industry shifted from being without dedicated regulation to having such regulation established in two main jurisdictions. In the EU, the Markets in Crypto-Assets Regulation provides the requirements for asset-referenced tokens, e-money tokens, and crypto-asset service providers [25]. The U.S. adopted a federal law regulating payment-stablecoins in July 2025 imposing restrictions on issuance to authorized issuers, requiring 100% reserve backing in a very limited range of high-quality liquid assets, forbidding rehypothecation of reserves, monthly public disclosure of the reserve composition, along with independent audit and executive certification, and payment of any yield or interest to token holders [24]. Anti-money laundering and counter-terrorist financing requirements continue to be crucial in both of the regulations because pseudonymity and cross-border use make supervision harder [107]. Table 12 compares the two regimes and international recommendations against which both of them are commonly benchmarked.

Table 12. Comparison of the two principal dedicated regimes for payment stablecoins, against the international recommendations.

Dimension	EU: MiCA (Reg. 2023/1114)	US: GENIUS Act (Pub. L. 119–27)	FSB Recommendations
Instrument scope	Asset-referenced and e-money tokens; service providers	US payment stablecoins that are issued or offered for sale in the US	Global stablecoin arrangements
Issuer gating	Issuer or credit institute authorization	Permitted issuers only; federal or certified state route	Comprehensive governance
Reserve requirement	Segregated reserves with prescribed deposit floors	1:1 backing in a narrow list of high-quality liquid assets	High-quality, liquid
Rehypothecation	Restricted	Prohibited, with limited exceptions	Restricted
Disclosure cadence	At least monthly composition reporting	Monthly composition, independent examination, executive certification	Clear and regular
Yield to holders	Interest prohibited on e-money tokens	Yield or interest prohibited	Not specified
Redemption right	At par, legally enforceable	Disclosed policy required	Effective redemption at par
Proportionality trigger	Significance designation	State route below a consolidated issuance threshold	Systemic importance
Third-country reach	Partial	Comparability route for foreign issuers	Cross-border coordination

Source: Author's own comparison of the primary legal instruments and the international recommendations [4,24,25].

There are three important observations to be made with regards to the comparison of the two regimes. First, both of them require high-quality reserves and disclosure but disagree on interest payments that have direct impact on the competitiveness: prohibition

on yield payment for the token while allowing for the payment of the return on reserve portfolio to the issuer makes issuance profitable depending on the policy rate, and the profit stays with the issuer. Second, both regimes have a threshold component that creates the incentive not to exceed the relevant threshold, and therefore, the problem of measurement for the supervisor because the quantity determining which regime should apply is provided by the entity being regulated. Finally, and most importantly, extraterritorial scope of application of both of them is incomplete: a token issued outside the jurisdiction and used mainly outside of it will still not be subject to either regime, even if it holds its reserves in the currency of one of the jurisdictions.

This third point identifies the core asymmetry of the current regulatory system. The financial stability externality created by a large stablecoin arises through the market for its reserve assets, which are denominated in the currency of the reference currency's jurisdiction. Yet the supervisory power over the issuer lies with the jurisdiction of incorporation. If the two differ, then the jurisdiction that bears the externality is not the jurisdiction that wields the supervisory instrument. As a well-known challenge of international financial regulation, this problem is intensified by the quick redemption and concentration discussed above in Section 5.

9.3. Proportionality and the Behavioral Response to Rules

A proportionate regulatory regime needs to differentiate between individual failure and systemic significance. An experimentally small project should not be subject to the same prudential demands as payment systems that operate at scale, but a systemic stablecoin should not be handled like any other software product. Proportionality can be accomplished through increased demands based on circulation, transactions, reserves, interconnectedness, and substitutability in payments. This allows for innovation to take place, while acknowledging the possibility of public externalities through a privately issued liquidity instrument.

Yet the design of a proportional regime must take into account that entities subject to regulation behave according to the rules and not merely conform to them. Where a requirement is triggered by a quantifiable threshold, the behavior that will affect whether that threshold is breached becomes itself an object of choice, and the activity moves towards the category of business that is treated more lightly. This is a general principle, namely, that the design of the public and fiscal rules influences the allocation of the activities of the entities subject to them, rather than just constraining them [145]. It means that a stablecoin regime must be judged according to the pattern of activity that it elicits, rather than by the conformity of the entities that stay inside it.

There lies a broader issue of governance beyond the technical details. Decisions about which private claims may serve as money-like instruments, and on what terms, define the allocation of seigniorage and risks between private issuers and the public balance sheet, and decide whether the money-like instrument will compete with or subordinate public money. This explains why questions of interest payments, reserve remuneration, and access to central-bank facilities have been among the most contentious aspects of the new frameworks.

10. Illicit Finance, Market Integrity, and the Criminal Use of Crypto-Assets

In this review, market integrity will be considered as an element of financial stability and not as an additional area of compliance. The rationale is practical, rather than ethical. All actions to sanction illicit use target one of the variables in the framework presented in Section 12: the sanctions designation eliminates venues and thus eliminates liquidity;

the freeze of a stablecoin balance eliminates the relevant liquidity point; the shutdown of a mixing service diverts the flow and modifies connectedness; and the manipulation of trading volume directly affects the liquidity time series. An indicator of liquidity calculated ignoring these consequences would credit market forces with moves caused by enforcement or fraud. This section will thus consider the four main types of illicit use described in Table 13 and their effects on the framework.

10.1. Money Laundering and the International Response

The anonymity of the public ledger generates an odd imbalance: identities remain concealed, but the transaction history becomes permanently visible. Previous quantitative analysis based on the visibility used the estimate that a considerable amount of early Bitcoin transactional activity was linked to criminal trade and introduced the methods of transaction-graph clustering subsequently used for estimation [66]. The following analysis described the laundering operations in such an environment as a dialectical process, whereby every measure results in a countermeasure—chain-hopping, mixing services, privacy coins, decentralized exchanges, and recently, the growing usage of stablecoins as the settlement leg [104,105]. This phenomenon is particularly relevant to the analysis, since it places the liquidity layer identified as such by this review into the center of the integrity issues.

The international effort is based on the expansion of the risk-based approach to virtual asset service providers and includes the measures of customer due diligence and the exchange of originator and beneficiary information with transfers [107]. Implementation varies, and the regular assessments of progress reveal significant deficiencies both in the number of jurisdictions regulating providers and in the effectiveness of cross-border information exchange [108]. For the purpose of stability analysis, this implies that the perimeter of observation of liquidity does not match its perimeter of circulation.

10.2. Sanctions Evasion

Sanctions evasion differs from laundering in both intent and its impact on stability. Evasion is intended to find a different settlement rail that is not controlled by institutions under the restriction of some sanction measure. Crypto-asset rails are particularly appealing for that purpose in that the settlement does not depend on correspondent banking relations, while dollar stablecoins are particularly appealing because of their unit of account stability. Enforcement threat assessments highlight the role of these rails in transactions of sanctioned parties and state-connected actors and also note the prevalence of large thefts among those actors [109,111].

The supervisory reaction has been the designation of certain services and addressees instead of the technology itself, and this is where the interplay with liquidity becomes more direct. Because the stablecoins in question have reserves with the issuers capable of freezing them, a designation results in immobilization of a certain part of the outstanding stock. This is both a tool of control and a vulnerability point: It creates a situation in which the issuer's compliance system is recognized as a perimeter of financial stability, and a designation event will be reflected in the redemption and supply time series of Section 12 as an administrative disruption, not a behavioral one. Failure to distinguish between these cases will result in misclassifying a law enforcement measure as a run.

10.3. Theft, Ransomware, and the Manipulation of Reported Activity

Service and protocol theft are measured in Section 11 and are the most significant realized loss category in the review period. Its criminal element cannot be separated from its operational element since the transition from protocol attacks to private key and signing process attacks discussed in the section is as much a criminal method evolution as it is an

operational attack evolution. Ransomware attacks comprise a second category, with the end-to-end tracking of the payments showing that the proceeds from such activities are accumulated in the hands of only a few people and that the scheme relies on only a few cash-out locations [103]. In general, the classification of crypto-enabled crime brings these two categories together as part of a systematic crime rather than an incidental one [102].

The fourth type of crimes against crypto-economics is different from the first three since it harms the evidence rather than the parties. Systematic analysis of the trading data finds that a large proportion of volume reported by unregulated exchanges is fake and made through wash trading in order to increase the volume and rankings of the exchange [106]. Similar studies on the ecosystem of the crypto-economics show the impact of trading concentration on the prices [64,65]. However, the implication of these findings for this review is that any measure of liquidity is distorted because volume is used as a denominator of the measurement of liquidity, and if a significant portion of it is created on the venues where the level of supervision is low, then any indicator of liquidity or stress based on the volume will overstate the liquidity on precisely those venues where the liquidity is highly questionable. That is why the Crypto Liquidity Stress Index discussed in Section 12 uses supply, price deviation, and redemption quantities for its computation.

Financial activities that are conducted using crypto-assets represent another aspect of market integrity and financial stability in view of their possible influence on liquidity situation, transactions, and market information. Money laundering, sanctions circumvention, theft and ransomware, and manipulations of trading reports have different mechanisms and present diverse problems for regulation and market supervision. Table 13 provides examples of such illicit activities along with their mechanisms, supervisory reactions, and effects on liquidity indicators. This consideration reveals the ways in which illegal activities may influence liquidity situation by disrupting asset flows, redemption procedures, collateral possibilities, and trading volumes, which adds to the necessity of including market integrity in the assessment of liquidity of cryptocurrencies.

Table 13. Forms of illicit use of crypto-assets: mechanism, evidence, supervisory response, and effect on the liquidity variables.

Form	Mechanism	Supervisory Response	Effect on Liquidity Variables
Money laundering	Layering through mixers, chain-hopping, decentralized exchange; stablecoins increasingly used as the settlement leg	Risk-based approach extended to virtual asset service providers; originator and beneficiary information with transfers	Circulation outside the supervised perimeter; observed supply is not the same as circulating supply
Sanctions evasion	Settlement outside correspondent banking; dollar-denominated tokens supply the stable unit of account	Designation of services and addresses; issuer freezing of balances	Administrative discontinuities in supply and redemption series that resemble runs
Theft and ransomware	Protocol exploitation; key and signer compromise; extortion proceeds concentrated among few operators and cash-out venues	Custody and key-management standards; incident reporting; venue supervision	Heavy-tailed, realized losses; abrupt withdrawal of deposited collateral
Manipulation of reported activity	Wash trading to inflate apparent volume and ranking on unregulated venues	Market-integrity requirements within dedicated regimes; venue-level surveillance	Overstated depth; volume-based liquidity measures biased upward where supervision is weakest

Source: Authors' own elaboration based on [66,102–109,111].

10.4. Consequences for the Liquidity Framework

Three implications follow. First, integrity of venues affects measurement, and when applied, the framework should limit its price and volume input to venues under supervision or explicitly filter wash detected in venues. Second, enforcement generates exogenous variation and thus should be handled as such. Designation, freeze, and venue closure

decisions are likely to be exogenous to the state of the crypto liquidity cycle, and thus, Section 13 suggests treating designation, freezes, and venue closures as identifying variables and not noise. Third, the ability to perform a freeze imposes a dependency on supervision, and thus, the issue should find its place in the matrix from Section 12.4 because the very same operational control that makes a stablecoin issuer a good partner for enforcement renders it a single point of failure for a material portion of the settlement asset of the ecosystem.

11. Sustainability and Operational Resilience

The financial valuation of crypto-assets is incomplete if operational costs and environmental impacts are treated as externalities. Proof-of-work requires significant energy input, and there is empirical work on the electricity used and carbon footprint incurred in Bitcoin mining [146–149]. Estimates depend on assumptions made about hardware efficiency, geographic distribution of mining, energy mix, and network dynamics, but the economic principle remains valid: consensus designs can impose significant resource cost. Different consensus mechanisms have very different energy intensity; thus, a technology-specific analysis is required and not an overall characterization of distributed ledgers [150]. Resource costs interact with finance via regulatory, reputational, mandated investment, and mining location issues [151].

Resilience is another essential feature that on the evidence of the review period, exceeds resource costs in terms of quantitative realization of loss. Table 14 and Figure 8 present annual amounts of crypto funds stolen by hackers from crypto services. This series does not demonstrate any consistent trend. The theft peak was around USD 3.8 billion in 2022, dropped by more than half in 2023, and grew again to USD 3.4 billion in 2025 [110]. What changes is the attack vector. Attacks exploiting vulnerabilities in smart contract logic dominating in 2021–2023 were superseded by thefts resulting from key, signer, and operator compromise at custodial venues. Theft from decentralized protocols, while falling, was accompanied by the rise in the value of assets deposited in them. While theft from the protocol level declined, a centralized venue compromise in 2025 accounted for close to forty-four percent of theft volume, and the top three thefts from centralized venues accounted for nearly seventy percent of losses in that year.

Table 14. Stolen funds from crypto services by year and shifting attack vector. Figures are annual aggregates for service and protocol compromise.

Year	Stolen (USD bn)	DPRK-Linked Share	Dominant Attack Surface
2021	3.3	—	Protocol and bridge exploitation
2022	3.8	—	Bridge exploitation; record annual total
2023	1.7	≈37%	Declining protocol exploitation
2024	2.2	≈61%	Key and signer compromise at custodial venues
2025	3.4	≈76%	Concentrated venue breaches; top three incidents ≈69% of total

Source: Author’s own compilation based on Chainalysis data [110]. Figures are annual aggregates for service and protocol compromise and do not include consumer-facing fraud, which is separately estimated.

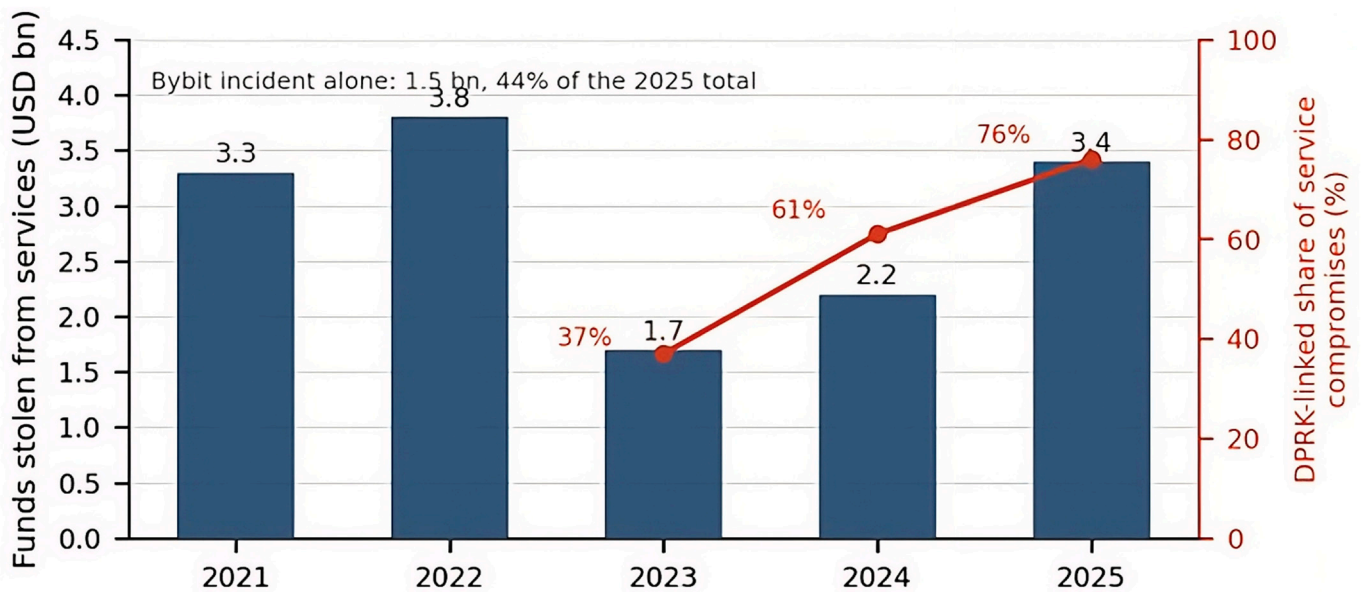


Figure 8. Annual amount of funds stolen from crypto services (bars, left axis) and percentage share of service compromises by DPRK-linked actors (line with points, right axis; not reported for 2021 and 2022). Source: Author's own elaboration based on annual stolen-fund aggregates and attack vectors reported by Chainalysis [110].

Two implications arise from the framework set up here. One is that risk in the sector is heavy-tailed and increasingly concentrated—an annual total composed largely or entirely of one or three events cannot be characterized in terms of its mean, and a regulatory statistic based on annual average losses will understate the capital impact of the tail of the distribution. Another implication is that any improvement in the one control domain does not reduce total loss if the attacker re-allocates activity therefrom. The reduction in protocol-exploitation risks is consistent with improved smart-contract security practices, but total loss increased because the limiting factor became key management and human authorization. Traditional financial institutions separate market, credit, operational, and settlement risks institutionally. Crypto-based finance could collapse those categories into the same protocol stack, where governance and incident-response capabilities become an essential part of financial stability.

12. An Integrated Crypto Liquidity Stress Framework

12.1. From Volatility to Liquidity Stress

As discussed above, the best organizing factor here is not simply volatility but the process by which volatility is turned into liquidity demands. A drop in the value of an unbacked crypto-asset may be only a valuation event if the losses are absorbed by investors who do not have to sell. However, the same event becomes a liquidity event when leveraged positions need liquidation, collateral levels dip below some threshold, and users want to redeem their stablecoins. Furthermore, the event becomes a financial-stability problem if the issuers or intermediaries of stablecoins have to sell their reserves to stressed markets. This section outlines each transition and defines it as a measurable quantity so that the chain of events can be tested, not asserted.

As the framework involves the use of amounts based on price information, as well as other on-chain information and issuer's disclosures, the notation is compiled in Table 15 prior to deriving the components. Each variable is defined at that point and is referred to in the same way afterwards, where t indicates the observation period.

Table 15. Notation used in the Crypto Liquidity Stress framework, with the equation in which each symbol is introduced.

Symbol	Definition	Units or Range	Equation
r_s	Logarithmic return over interval s	Dimensionless	(1)
h	Number of intervals in the estimation window	Positive integer	(1)
σ_t	Annualized realized volatility of the crypto index	Proportion per annum	(1)
$P_{j,t}$	Secondary-market price of stablecoin j	Units of the reference currency	(2)
$S_{j,t}$	Outstanding supply of stablecoin j	Currency value	(2)
$\omega_{j,t}$	Supply weight of stablecoin j in the aggregate	0 to 1; sums to unity	(2)
D_t	Supply-weighted absolute deviation from par	Proportion; zero at par	(2)
R_t	Redemption pressure: truncated contraction rate of supply	Proportion; zero when supply grows	(3)
$C_{i,t}, B_{i,t}$	Collateral value and borrowed value of position i	Currency value	(4)
λ_i	Protocol liquidation parameter for position i	Greater than 0, at most 1	(4)
$HF_{i,t}$	Health factor of position i ; liquidation below unity	Ratio	(4)
$q_{i,t}, Q_t$	Collateral liquidated on position i ; aggregate liquidated value	Currency value	(5)
TVL_{t-1}	Lagged total value locked, used as scaling denominator	Currency value	(5)
L_t	Liquidation intensity	Proportion of lagged locked value	(5)
$\tilde{\theta}_{ij}(H)$	Normalized contribution of variable j to the forecast-error variance of i at horizon H	0 to 1	(6)
C_t	Total connectedness (spillover) index	0 to 100	(6)
μ_i, σ_i	Full-sample mean and standard deviation of component i	Component units	(7)
$Z(x_{i,t})$	Standardized value of component i	Standard deviations	(7)
w_i	Weight on component i in the composite	0 to 1; sums to unity	(8)
$CLSI_t$	Composite Crypto Liquidity Stress Index	Weighted standard deviations	(8)
φ_k	Liquidity haircut applied to reserve asset class k	0 to 1	(9)
$A_{k,t}$	Book value of reserve holdings of class k	Currency value	(9)

Table 15. Cont.

Symbol	Definition	Units or Range	Equation
ρ	Stressed redemption rate assumed in the scenario	Proportion of outstanding supply	(9), (10)
Λ_t	Reserve coverage ratio; inadequate below unity	Ratio	(9)
M_t	Market depth of the reserve-asset segment	Currency value	(10)
κ	State- and sign-dependent price-impact coefficient	Basis points per unit of relative flow	(10)
Δy_t	Yield impact in the reserve-asset market	Basis points	(10)
c_s	Threshold separating escalation state s from state $s + 1$	Index units	(11)
Ψ_t	Escalation state of the system	Integer, 1 to 4	(11), (12)
X_t	Vector of conditioning variables	Mixed	(12)
$\Phi(\cdot)$	Standard normal cumulative distribution function	0 to 1	(12)

Source: Authors' own elaboration.

The first element is the shock itself. Let r_s denote the log return in interval s . Volatility over h intervals, annualized on the assumption of continuous trading with 252 intervals per year, is given by

$$\sigma_t = \sqrt{\frac{252}{h} \sum_{s=t-h+1}^t r_s^2} \quad (1)$$

They are defined as follows. The summation is performed over the h most recent intervals up to time t , thus, making σ_t a backwards-looking window estimate and not a forward one; r_s is the log return of the crypto market capitalization weighted index during interval s ; and $252/h$ transforms the squared sum of returns into an annualized number. Squares of returns rather than absolute deviations from the sample mean are used since the sample mean of returns over short windows cannot be estimated with precision, and adding it causes variance without eliminating bias.

This measure uses the continuous-trading convention deliberately. Crypto exchanges are open all the time, so the count of intervals is a modeling choice rather than a real one. Furthermore, any comparison between crypto and conventional asset volatilities will inherit this choice. The continuous-trading convention should be stated explicitly and be the same across assets in order to make cross-asset comparisons made in Section 4 commensurable.

The second variable is the degree to which the liquidity buffer is no longer performing at par. Given a collection of J stablecoins with outstanding supply $S_{j,t}$ and secondary market prices $P_{j,t}$, the supply-weighted absolute deviation from par is

$$D_t = \sum_{j=1}^J \omega_{j,t} |1 - P_{j,t}|, \quad \omega_{j,t} = \frac{S_{j,t}}{\sum_{k=1}^J S_{k,t}} \quad (2)$$

Supply weighting is necessary and not merely cosmetic because an equal-weighted average of deviations among all tokens would be biased by smaller and less liquid instruments whose price dynamics have nothing to do with the state of the system, while the

economically interesting quantity is the total value of par commitments currently selling at a discount. This indicator is also responsive to the skewness described in Section 5 because a particular deviation of the largest token matters much more than an identical deviation of a marginal one, which is the proper behavior for a stability indicator.

Since price deviation also carries the weight of arbitrage limitations alongside the weight of doubts regarding backing, a quantity component is needed as well. The outstanding supply is denoted S_t . The redemption pressure is defined as the rate of reduction in the outstanding supply, clipped below at zero so that the indicator reflects net redemptions and not issuance:

$$R_t = \max\left(0, -\frac{S_t - S_{t-1}}{S_{t-1}}\right) \quad (3)$$

It is the combination of D_t and R_t that makes the difference between an arbitrage constraint and a run. If there is a deviation from par but small net redemptions, then it implies that people do not want or cannot engage in arbitrage but not exit; and if there is a deviation from par and rapid reductions in supply, then it means that the redemption channel is utilized on a wide scale. The March 2023 event fits the former in its early stages and the latter thereafter, which is why a single indicator was unsuitable for describing this event.

12.2. Leverage, Liquidation, and Connectedness

The third component addresses the mechanism through which valuation losses translate into forced transactions. For a collateralized position i with a collateral value of $C_{i,t}$, a borrowed value of $B_{i,t}$, and a liquidation parameter defined by the protocol λ_i , we define a health factor

$$HF_{i,t} = \frac{\lambda_i C_{i,t}}{B_{i,t}}, \text{ liquidation if } HF_{i,t} < 1 \quad (4)$$

In Equation (4), the liquidation threshold of parameter λ_i is determined by the protocol and refers to the proportion of the collateral value above which borrowing is allowed, in relation to the collateral type being used in the position i ; for example, a liquidation threshold of 0.8 means that borrowing will be allowed up to 80 percent of the value of the collateral, and liquidation will occur once the pledged value drops below this level. Therefore, the health factor represents the distance to liquidation in normalized form rather than solvency, and the threshold of unity is just a protocol convention.

The health factor can be observed on chain for each open position—an information advantage over traditional intermediation, where the analogous margin positions are known only to the parties involved. A liquidation-intensity measure, aggregating liquidated quantities $q_{i,t}$ among the N positions that breach the threshold, and scaled by the level of deposited capital, is then calculated as

$$L_t = \frac{Q_t}{TVL_{t-1}}, \quad Q_t = \sum_{i=1}^N q_{i,t} 1(HF_{i,t} < 1) \quad (5)$$

In Equation (5), $1(\cdot)$ is the indicator function, equal to one when the health factor of position i is below unity and zero otherwise. Scaling with respect to a lagged level of value locked as opposed to contemporaneous value prevents a mechanical artifact—liquidations lower the denominator, making a contemporaneous scaling indicate an increase in intensity solely on account of the liquidations measured in the numerator. As with the liquidity stock, care must be taken in the interpretation of the latter, as mentioned in Section 7, because it confounds a price effect with a quantity one.

The fourth component measures to what extent shocks have propagated rather than remained localized. Through a generalized forecast-error variance decomposition up to

horizon H , using normalized contributions of variable j to the forecast error variance of variable i , a total connectedness index is then calculated as

$$C_t = \frac{100}{N} \sum_{i=1}^N \sum_{j=1}^N \tilde{\theta}_{ij}(H), \quad i \neq j \quad (6)$$

It is the standard spillover index from the forecast error decomposition literature [100], widely used in studies of returns in crypto-assets [96–98]. It is used here to distinguish between a shock that is confined to a single asset/protocol from one that has developed into a common factor. The list of variables should contain both crypto and conventional assets, since an increase in within-crypto connectedness alongside no change in crypto-conventional connectedness implies different dynamics from both increasing.

12.3. The Composite Index and the Escalation Mechanism

The five components are expressed in different units and have different unconditional distributions; therefore, each one is standardized relative to its own mean and standard deviation:

$$Z(x_{i,t}) = \frac{x_{i,t} - \mu_i}{\sigma_i} \quad (7)$$

In Equation (7), μ_i and σ_i represent the mean and standard deviation of component i , calculated using the entire sample for estimation instead of a rolling window. This makes a difference. In case of rolling standardization, the stress measure will normalize the level of stress based on the most recent observations, which implies that it will identify an extended period of high stress as normal. The disadvantage of using full sample standardization is that the measure will change as the sample increases.

The crypto liquidity stress index is then defined as a convex combination of the standardized components:

$$CLSI_t = \sum_{i=1}^5 w_i Z(x_{i,t}), \quad \sum_{i=1}^5 w_i = 1, \quad w_i \geq 0 \quad (8)$$

where the five components are realized volatility σ_t , the supply weighted deviation from par D_t , redemption pressure R_t , liquidation intensity L_t , and connectedness C_t . The weights could be fixed to achieve maximum transparency or obtained by principal components, entropy, or a predictive optimization approach. Table 16 provides information about the component itself, its proxy, data source, and sign with which it enters the index formula. The index is intentionally modular and thus allows for changes according to the specific jurisdiction and data availability; for instance, the jurisdiction that lacks reliable data on liquidation activity could use a four-component index, while the interpretation of the rest would remain unchanged.

Table 16. Components of the Crypto Liquidity Stress Index: proxy, source, and expected sign.

Symbol	Component	Proxy	Data Source	Sign
σ_t	Realized volatility	Annualized realized volatility of a market-cap-weighted crypto index	Exchange price data	+
D_t	Deviation from par	Supply-weighted absolute deviation of stablecoin prices from par	Venue and on-chain prices	+

Table 16. Cont.

Symbol	Component	Proxy	Data Source	Sign
R_t	Redemption pressure	Truncated contraction rate of outstanding stablecoin supply	On-chain supply series	+
L_t	Liquidation intensity	Liquidated collateral value scaled by lagged total value locked	Protocol event logs	+
C_t	Connectedness	Total spillover index from a generalized variance decomposition	Crypto and conventional returns	+
Λ_t	Reserve coverage	Haircut-weighted liquid reserves over stressed redemption (auxiliary)	Issuer attestations	−

Source: Author's own elaboration.

Two additional factors link the index to the channel of externalities. An issuer's ability to pay off its liabilities without liquidations rests upon the liquidity of its reserves, not their book value. The liquidity haircut factor per reserve asset class $A_{k,t}$ is denoted by φ_k , while ρ is the stressed redemption rate relative to the outstanding stock, and the reserve coverage ratio is

$$\Lambda_t = \frac{\sum_{k=1}^K \varphi_k A_{k,t}}{\rho S_t} \quad (9)$$

When values for Λ_t are less than one, then it means that the redemption of the assumed magnitude cannot be satisfied through the liquid resources available after adjusting the haircut factor. The vector of haircuts is the area where the compositional differences in reserves discussed in Table 9 become quantified, as any instrument that has a positive correlation with the crypto-markets needs to have its own state-dependent haircut.

The price effect that results from the reserve asset market is given by the following expression in relation to the volume that needs to be absorbed and market depth (M_t):

$$\Delta y_t = \kappa \frac{\rho S_t}{M_t} \quad (10)$$

From the empirical literature presented in Section 8, we know that κ is not constant. When there is a lack of reserve instruments in supply, κ increases. κ is twice or thrice larger when there is an outflow compared to the case of an inflow [45]. Calibration that assumes κ to have one value will underestimate the effect on spillover at the very times when this approach should provide insights.

Because of this, the model divides the states into distinct categories as opposed to simply reporting the index value. For the thresholds $c_0 < c_1 < c_2 < c_3 < c_4$, the index is mapped into four states, corresponding to valuation stress, liquidity stress, contagion across protocols, and spillover effects to external markets. Figure 9 shows the structure of escalation. The key thing here is that escalation is not preordained: the framework does not state that a crypto shock escalates to become systemic but rather that each transition is a separate proposition that can be tested empirically. Formally, the state of the system in period t is defined as follows:

$$\Psi_t = s \text{ if } c_{s-1} \leq CLSI_t < c_s, \quad s = 1, \dots, 4 \quad (11)$$

Escalation is not automatic: each transition is a separate testable hypothesis

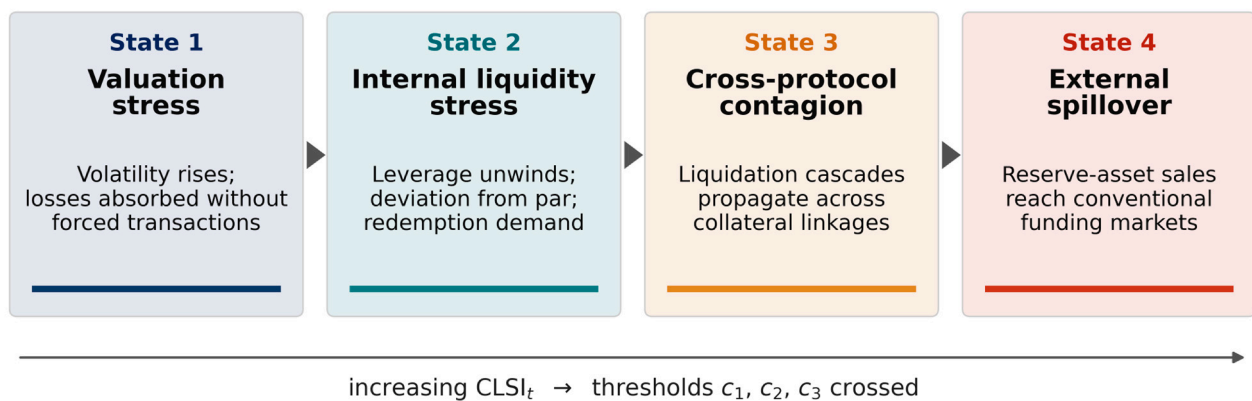


Figure 9. Structure of escalation of the Crypto Liquidity Stress Index. Transitions between states are separate empirical propositions, not an assumed sequence. Arrows indicate a possible transition to the next state when the index crosses the next threshold; colors only distinguish the four states. Source: Elaborated by the author.

Expression (11) is a step function and requires thorough explanation, since the value of the framework lies in it. Its argument is the composite index $CLSI_t$ from Equation (8); its value Ψ_t is an integer label of a state taking on values one through four; and the four thresholds $c_1 < c_2 < c_3 < c_4$ along with the lower bound c_0 mark four thresholds of the index that split the real line into four intervals. The equation implies that the state of the system in period t is state s if the index lies in the interval that goes from c_{s-1} to c_s on the index scale. As the components of the index are standardized, the thresholds are specified in terms of weighted standard deviations of the composite index and can be compared across periods and jurisdictions once the sample of estimation is fixed.

The four states carry a substantive meaning and do not merely constitute an ordering. State 1, valuation stress, occurs in the situation when the volatility component is high, but there is no significant par deviation, redemption pressure, or liquidation intensity—prices are changing, but there is no forcing. State 2, liquidity stress, additionally implies a significant contribution from par deviation and redemption pressure, which means that the settlement asset no longer works at par, and its holders are leaving the market, not marking down. State 3, protocol contagion, includes liquidation intensity and connectedness in crypto, which means that the disturbance becomes self-sustaining through collateral instead of just re-pricing. State 4, external spillover, is attained if the connectedness with traditional assets rises together with the decline in the reserve coverage ratio from Equation (9) to unity, which means that the disturbance starts to spill over through the reserve asset markets.

There are three features of the specification that require special attention. First, the thresholds are not structural parameters and have to be calibrated rather than specified a priori; the most natural way of doing so is to set them at the quantiles of the historical distribution of the index in the sample of estimation and check the result against the episodes described in Sections 6 and 11, such that the May 2022 and March 2023 events will be properly classified. Second, the classification is deterministic given the index, so the uncertainty in the framework is captured only by the weights in Equation (8) and by the thresholds, which is an advantage in reporting: both are declared quantities. Third, the discretization is not an approximation of a continuous measure of the severity of stress, but a substantive assumption about the process, taken due to the state- and sign-dependent nature of the relationship between reserve and asset in Equation (10) [45]. Linear index would imply a constant marginal effect of the stress in a range where the actual elasticity is known to change by a factor of two or more, so the step function is the minimal form that

does not suffer from misspecification. The escalation scheme is presented in Figure 9. The probability of the transition can be modeled as an ordered response to the index and a set of conditioning variables X_t :

$$\Pr(\Psi_{t+1} = s + 1 | \Psi_t = s) = \Phi(\alpha_s + \beta_s CLSI_t + \gamma_s' X_t) \quad (12)$$

This formulation allows posing the main question raised in this review as an empirically testable proposition: do the components carry information about the transition that cannot be found in volatility alone, and how does the conditioning on state dependence, particularly market depth of reserve assets, affect the probability of the transition as per the mechanism?

The terms of Equation (12) are as follows. $\Phi(\cdot)$ is the standard normal cumulative distribution function, which maps the linear index into a probability; α_s is a state-specific intercept, so that the baseline propensity to escalate may differ between states; β_s is the coefficient on the composite index and is the parameter of principal interest, since a value significantly different from zero after conditioning would establish that the composite carries information about escalation; and γ_s is a vector of coefficients on the conditioning variables X_t , which comprise at minimum the depth of the reserve-asset market, the prevailing regulatory regime, the concentration of stablecoin supply, and the venue-integrity adjustment discussed in Section 10.4. Estimation is by ordered probit on the state sequence, with standard errors clustered by episode; the specification is stated in this form so that the framework's central claim is refutable by a null result on β_s .

12.4. Monetary Circulation and Macro-Financial Interpretation

An alternative macro-financial viewpoint focuses on the circulation of liquidity in the economy, the rules of transactions within institutions, and the influence of monetary policy incentives on keeping or escaping from the financial assets. From this perspective, stablecoins appear as an extra liquidity circuit, where funds flow from bank money into tokenized claims, then circulate across various exchanges and protocols and return via redemptions. The amount of liquidity staying inside the circuit and its speed of departure depend on frictions, incentives, and confidence. Literature on application of the circulation indices to the national economy offers a benchmark for comparison of how effectively a particular system of relations recirculates purchasing power and the insight that structurally similar economies may differ on that metric significantly [152].

It is a valuable approach, as it highlights the interplay between stocks and flows. The outstanding supply of stablecoins is a stock, and their issuance, transfers, and redemptions constitute flows, the pace of which could be very important under stress scenarios. This distinction is not just an exercise in classification—in fact, the components of the index introduced above are split exactly along these lines, with the first two being stock-related and the latter two being flow-related. A setup can prove healthy with respect to all stock indicators while quickly deteriorating with all flow indicators; and the time span between the two is the time during which supervision is still feasible.

In other words, the policy recommendation here is to monitor not only prices but also balance sheets and flows. Price stability at par is a prerequisite for the asset's safety, yet it does not suffice as the evidence of the latter—a stablecoin can be trading at close to par while its reserves are becoming more concentrated, there are queues in redemptions, or leverage increases. In contrast, a short deviation from par may prove to be manageable without any further ramifications in case of adequate liquidity and confidence among users, as was evident in the March 2023 event. Table 17 provides a mapping of the components of the proposed framework into the corresponding supervisory variables.

Table 17. Supervisory matrix: risk domain, safeguard, and monitoring signal.

Risk Domain	Primary Object	Core Safeguard	Supervisory Signal
Liquidity and redemption	Stablecoins	Legally enforceable redemption; liquid reserve buffers with state-dependent haircuts	Net redemption volume, reserve maturity, price-to-par gap
Market integrity	Exchanges and tokens	Manipulation detection controls, venue transparency rules	Cross-venue price disparities, unusual volumes, concentration
Leverage and collateral	DeFi and derivatives	Risk-sensitive collateral parameters and liquidation governance	Utilization, liquidation intensity, recursive collateral use
Operational resilience	Protocols, bridges, custodians	Audits, incident response, key-management and signer controls	Exploit losses, downtime, signer concentration
Systemic linkages	Large issuers and intermediaries	Enhanced prudential oversight and reporting	Reserve-asset concentration, bill market depth, payment share
Financial integrity	Service providers and transfer services	Risk-based AML/CFT controls	High-risk flows, sanctions exposure, control failures
Sustainability	Consensus and infrastructure	Transparent energy and emissions metrics where material	Energy use, emissions intensity, location concentration

Source: Author's own elaboration, based on international policy recommendations [4,112].

13. Discussion, Implications, and Research Agenda

13.1. Synthesis of Findings in Relation to the Research Questions

The findings are provided below with reference to the four questions introduced in Section 1, thus making the mapping from the gathered data to the subsequent claims obvious. With respect to RQ1 asking whether there has been progress in efficiency and fragility in the same direction, the answer is negative. The literature overview on efficiency in Sections 2.1 and 4.1 suggests that progress took place during the period in question with dynamic tests revealing alternation and overall trend towards weak-form efficiency [39–41]. Simultaneously, the volatility literature of Section 4.2 suggests that the level of annualized realized volatility decreased from triple digit figures to a range between thirty-five and forty percent as of April 2026. During the same period, the connectivity of the markets in question with the conventional assets increased and the reserve portfolios of the largest issuers grew to account for a material share of the short-term government securities holdings. While pricing improved, funding fragility did not—that is what the divergence discussed in Section 2.1 is all about.

With respect to RQ2 asking what differentiates the contained from the uncontained de-pegging, the comparison in Section 6 finds three distinguishing conditions and rejects a fourth one. An external reserve is necessary because the algorithmic design of the token in question failed since its stabilization mechanism relied on trust in another token whose value was determined by that very trust. The critical element is the liquidity of the reserve rather than the book value of the latter: the March 2023 token was fully reserved in terms of the accounting but traded for USD 0.8726, because those who were entitled to redeem it

could not do so when the relevant bank channel was closed. The credibility of the resolution process determines the period: parity was restored within roughly seventy-two hours after deposit backstop was announced publicly rather than due to any changes in the reserve itself. The condition that is rejected concerns the size of the initial impairment, which was around eight percent of reserves in the case that restored parity and one hundred percent in the case that did not.

With respect to RQ3 asking through which channels and in what functional form stress is transmitted, Section 8 finds that the dominant quantified channel is the reserve portfolio, and the form is non-linear in two ways. The channel is state-dependent, implying that the yield response to stablecoin flows is several times larger during times of bill scarcity than times of abundance, and sign-dependent, with outflows having impact on the yield twice or three times larger than inflows of the comparable size [45]. A model calibrated to the expansion phase underpredicts contraction by at least a factor of two. The reason is not a prior methodological preference but rather the aforementioned result, which renders the discrete-state framework of Section 12 inevitable.

With respect to RQ4 asking whether the layer-specific indicators can be integrated into a computable diagnostic, Section 12 proves that the integration is possible and shows exactly what would be needed for the validation of the result. The index is based on supply, price deviation, redemption quantity, on-chain liquidation, and connectivity rather than reported trading volume due to the reasoning in Section 10.3. Four-state escalation framework is empirical propositions rather than assumptions, and Table 18 specifies the identification variation that each of the propositions requires.

The comprehensive evidence presented leads to the following conclusions. First, the crypto assets are heterogeneous—the mechanisms of the token's economics are different from those of the reserve-backed stablecoin or a collateralized lending mechanism. Regulatory efforts and empirical models would suffer when these are considered in a haphazard manner together. Second, stablecoins are crucial in that they convert a highly volatile environment into one capable of supporting leveraging, settlements, and collateral management. Third, contagion will likely follow a non-linear path, due to the interaction of protocols, leverage, and confidence and due to the non-symmetric functioning of the reserve-asset channel.

Moreover, the review explains why discussions based on the question whether Bitcoin is a safe haven can be too restrictive. The issue of portfolio diversification refers to investors, while the issue of financial stability belongs to systems. An asset can help investors optimize their risk/reward trade-off in the long run but can add to the stress level in the system in case it is leveraged or involved in illiquid financing. Similarly, a stablecoin can reduce costs and improve settlement while causing the risk of runs in case of ill-conceived reserve mechanisms. The decreasing volatility analyzed in Section 4 is an example here—the asset became less volatile on average just because during this period its connections to conventional finance grew stronger.

13.2. Theoretical Implications

The following three implications arise for the relevant literature. First, concerning the efficiency literature, if the efficiency of these markets depends on the trading architecture and the amount of arbitrage capital available [34–36], the increase in efficiency throughout the period under consideration is properly understood as the information about the structure rather than about the process of information processing. Thus, the appropriate empirical approach is joint rather than sequential: measures of efficiency should be estimated together with liquidity rather than separately reported as a measure of efficiency [33].

Second, concerning the run theory, according to which the classical explanation of the instability is based on the sequential service constraint applied to a demandable liability [1], in the case of the March 2023 run, there is an additional reason for the run that is not present in the classical case: the token was always 100% backed and was still technically demandable, but there was a deviation from par because the number of the agents who could redeem the tokens was limited in size, in capital, and disconnected from the redemption channel. In other words, this was a limits-of-arbitrage problem [36] in a par-convertible security, and the practical conclusion is stated in Section 5.2: a deviation from par is not a sign of insolvency; hence, a proper framework must involve the quantity signal.

Finally, with respect to the relation between market integrity and market stability, in the existing literature and in most of the supervisory architectures, these two objectives have been seen as separate ones. The analysis performed in Section 10 proves that in the case under study, they are inseparable: the integrity problem influences the measurement of the liquidity. Namely, if a considerable part of the trading volume is faked [106], the quantity used by stability analysis as a denominator is affected by the integrity misconduct.

13.3. Policy and Practical Implications

Implications for policy are specific to the particular results, not generic to the nature of the topic at hand, and reflect the latter accordingly. First, since liquidity is crucial rather than book value in the March 2023 case, the existing reserve requirements, which are expressed as an asset to liability coverage ratio, are inadequate. The requirement is that of haircut-adjusted coverage described in Equation (9) with respect to a certain stressed rate of redemptions and where there are state-dependent haircuts to any reserve asset whose market value depends on the state of the crypto-market. In Table 9, it is demonstrated that this is not a trivial point: one of the two biggest issuers has nine percent of their reserves in gold and bitcoin, whose mark-to-market value decreases when the condition triggering redemptions occur.

Second, since containment in March 2023 occurred via the credible announcement of a public backstop rather than via the reserve itself, supervisors should identify the instrument of resolution applicable to every arrangement and make that known. The result is precise: reserve affected the end result, but the announcement determined the duration. Arrangement for which the instrument of resolution is not predetermined in advance is an arrangement in which the duration of any de-pegging is indefinite.

Third, due to the extreme concentration of power—by July 2026, the share of outstanding supplies held by two issuers amounted to about eighty-five percent and by top five—about eighty-nine percent; the failure of a single issuer would not be a diversifiable event, and hence, the prudential categorization into idiosyncratic and systemic risk is not relevant in its usual sense. The consequence is that systemic designation should take into account not only outstanding supply but also settled volume, as Section 5.1 shows that the two rankings are different and pose different supervisory issues.

Fourth, due to the asymmetry and state dependence of the reserve-asset channel, exercises of stress testing calibrated on average conditions would underestimate the effect of contraction at the critical juncture. Supervisors performing tests of the channel should use different calibration for scarcity regimes and for outflow episodes, with the latter treated as a pair of parameter values. Fifth, since enforcement actions have direct effects on supply and redemption series, the monitoring framework should differentiate between administrative breaks and behavioral discontinuities. Failure to do so might mean that freezing would be registered as a run. Sixth, since the operational capability that makes issuers effective enforcement partners makes issuers control substantial portion of the settlement asset, this capability itself should be subject to governance and disclosure

requirements. The entire mapping from risk domains to safeguards and monitoring signals is provided in Table 17.

Another consequence concerns the balance between regimes. Comparison of Section 9 shows that the problem is not with the strictness of standards but with the mismatch of jurisdictions responsible for imposing those standards and the jurisdictions affected by the externality of the activities conducted therein. Too permissive standards allow for creation of run-prone private money and opacity of leverage; too restrictive standards relocate the activity without destroying it, and the elasticity of such relocation seems quite high. Consequently, risk-based escalation is called for—where requirements become stricter as the monetary, levered, interconnected, or substitutable for domestic money arrangements become—and its evaluation requires measurement of where the activity relocated, rather than just what happens within the perimeter. Influence of organized interests in shaping these standards is a determinant of the outcome and has been observed elsewhere [145].

13.4. Limitations

The limitations of the review design are recognized in Section 3.8 and are not repeated below. There are three limitations that apply to the results. Firstly, the comparative analysis in Section 6 is based on two instances, which can be used for identifying the necessary conditions but are insufficient for evaluating their relative importance because the minor de-pegging events associated with the reserve assets in March 2023 carry some useful information but are not independent of the main event. Secondly, the estimates of reserve asset composition underlying the asymmetry result are based on a single stream of literature [45]; although the methodology seems convincing, it has not been independently replicated yet. Thirdly, the approach described in Section 12 has not been estimated yet; all of its elements are observable, but their weights and thresholds remain unknown.

13.5. Future Research Directions

Firstly, future empirical analysis should focus on developing a multi-layer dataset. It should include high-frequency crypto-prices, issuance/redemption of stablecoins, on-chain liquidations, exchange activity, reserve information, liquidity measures of government securities, and the indicators of traditional financial stress. De-pegging event studies will be able to identify the immediate effects, while local projections/structural vector autoregressions will help to study persistence. Network analysis will quantify how shocks propagate between the protocols and collateral relations. Table 18 states the resulting testable propositions and the identifying variation required for each proposition separately.

Extending the theoretical and analytical framework presented in the previous sections of the analysis, this study develops a series of hypotheses which would help in testing the dynamics of liquidity in cryptocurrencies and systemic risk transmission. Hypotheses are stated in terms of the relationships between parity deviations, liquidation efforts, redemption pressures, spillover effects through reserve assets, financial interconnection, and regulation effects that condition them. Specific attention is paid to distinguishing among various transmission channels and to detecting the differences in observables that would be necessary to make an empirical distinction between them. Table 18 lists the six hypotheses together with their dependent variables and identification strategies needed for testing them.

Table 18. Testable propositions implied by the framework, with the identifying variation each would require.

No.	Proposition	Dependent Variable	Identifying Variation
P1	Deviation from par predicts subsequent liquidation intensity beyond volatility	Liquidation volume scaled by lagged TVL	High-frequency ordering around de-peg onsets
P2	Redemption pressure, not price deviation alone, distinguishes runs from arbitrage constraints	Indicator of unrecovered de-peg	Episodes with comparable price deviation but differing supply contraction
P3	Reserve-asset spillover is asymmetric in sign and state	Short-maturity bill yields	Instrumented issuance variation; bill-scarcity regimes
P4	Concentration raises the systemic loss given a single issuer failure	Aggregate market liquidity measures	Cross-sectional variation in issuer share
P5	Regime application reduces transition probabilities to higher stress states	Ordered state indicator	Staggered application dates across jurisdictions
P6	The composite index outperforms single-indicator benchmarks out of sample	Realized stress episodes	Pseudo-out-of-sample evaluation with provider robustness

Source: Author's own elaboration.

Secondly, there is an agenda regarding identification. Crypto markets operate constantly and react quickly to global news, thus making before-and-after comparisons easily confounded. Plausibly exogenous regulatory announcements, exchange interruptions, exploits in protocols, and changes in redemption rules may provide better identification. Cross-jurisdictional design may use differences in regulatory enforcement, but the proper measurement of adoption and market access is required here. The comparison of the two regimes analyzed in Section 9 provides especially clear evidence since some tokens were regulated in one jurisdiction and remained unregulated in another.

Thirdly, there is an agenda related to the measurement, and the dispersion mentioned in Section 3 shows why it is crucial. The new index should be verified using historically important stress cases and compared with some benchmarks such as realized volatility or deviation from a price alone. It should be tested in terms of ability to predict liquidations, exchange outflows, reserve asset sales, and overall market stress. Researchers should investigate how the result depends on the choice of the data provider. A simple weighting scheme is better at the beginning, while complicated machine-learning weights should be applied only if needed and interpreted easily.

Finally, research should explore proportionality of regulations. Regulations that are too lax may allow run-prone private money or opaque leverage, while regulations that are too strict can push business to move to more accommodating jurisdictions or protocols, and the available literature on regulatory arbitrage in the field suggests that this is quite elastic. The best approach appears to be risk-based escalation, which would have more stringent requirements for a crypto-money arrangement as it becomes more monetary, more leveraged, more interconnected, or more systematically substitutable. To assess such a system, one needs to evaluate where the business relocates and not just what happens inside the perimeter [145].

In addition to the data, identification, and measurement priorities listed above, four particular directions emerge from the results and are outlined below with an emphasis

on the design they would require. First, the estimation and validation of the index itself: estimate the five components at daily frequency for the review time horizon, calibrate the thresholds of Equation (11) at quantiles of the estimation sample, and validate the classification with respect to the episodes described in Sections 6 and 11 in a pseudo-out-of-sample fashion. The weighting scheme would have to be tested from equally-weighted to principal components and optimally predictive ones. The baseline would be single-indicator alternatives to the index in question, as failing to outperform the realized volatility would not justify its extra data needs.

Second, independent replication of the reserve asset asymmetry using an alternative instrument for the issuance variation and a wider sample covering not only the United States bill market but also sovereign debt markets of other reserve currencies should be performed. Since the result in question underlies much of the theory put forward in the review, its replicability remains an important question. A corollary of this is whether the parameter κ depends not only on market depth but also on issuer concentration.

Third, use enforcement actions as the source of identifying variation, as suggested in Section 10.4. Designations of sanctions, closure of venues, and freezing are arguably exogenous to the state of the crypto liquidity cycle and create discontinuities in the supply and redemption series. The use of an event study around such episodes would allow the distinction between administrative and behavioral contraction in crypto liquidity, which is a necessary precondition for the interpretation of the redemption-based index. The design would allow an initial estimate of the elasticity of relocation needed for the proportionality argument of Section 13.3.

Fourth, outline the boundaries of this literature with respect to its immediate surroundings. The relationship between the circulation of stablecoins and the domestic monetary aggregate has been considered for the case of the unbacked asset in the context of legal tender adoption [142] but not for dollar-denominated tokens in the jurisdictions subject to the strongest substitution pressure. The framework based on the circulation of stablecoins, as suggested in Section 12.4, provides a tractable way to do so [141,144,152,153]. Two further extensions warrant explicit mention. First, whether the data protection regulations influence the availability of the on-chain information and the possibility of implementing the monitoring suggested in the review is still an open question, with the experience of data protection regimes providing some clues [154]. Second, the condition of technological capability of a jurisdiction in determining its supervisory possibilities could be explored using the macroeconomic evidence of the relation between technology and growth [155]. Finally, confidence dynamics remain the least tractable part of the framework and the most important one: March 2023 recovery was conditioned on the announcement, and the relevant literature provides the natural starting point for modeling this effect [156].

14. Conclusions

The crypto finance industry has grown into its own financial system, complete with crypto money-like assets, trading platforms, leverage mechanisms, and settlement systems. The key issue of financial stability is no longer whether each and every crypto asset is volatile—this is already well-established. As the literature compiled here indicates, the volatility of crypto-assets is decreasing. A much more important question is how volatility is translated into liquidity demand and how it travels through stablecoins, DeFi protocols, centralized intermediaries, and the conventional reserve assets.

Stablecoins play the role of a main conduit in the above transmission chain. Stablecoins deliver clear functional benefits in reducing settlement costs and providing a common unit of account. At the same time, they rely on redemption, liquidity of reserve, governance, and the legal backing of the latter. Two episodes explored in Section 6 show that the

deciding factor is not the magnitude of the initial disturbance of reserves but whether the remaining reserve liquidity and the public credibility of the resolution process are preserved. DeFi makes the process even more complex as it increases automation of leverage and collateral adjustment.

The suggested Crypto Liquidity Stress Index provides a concise tool to study the empirical relationship between the above components in practice. With the combination of volatility, deviation from par, redemption pressure, leverage, and connectedness in an explicit four-state framework, the approach turns the focus from standalone asset prices to the conditions under which price disturbances become liquidity disturbances. While the use of discrete states rather than of a single continuous measure of severity is a stylistic choice, it stems from the fact that the reserve asset channel is both state and sign dependent and cannot therefore be captured by a linear specification.

For the policymakers, the above observations translate into the principle of functional and proportional regulation, namely, the supervision of stablecoins as liquidity providers, DeFi as financial intermediation, and large interconnected arrangements as generators of externalities. A comparison of the two leading regulatory approaches suggests that the real challenge is not in the standards applied to entities inside the perimeter but in the mismatch between the jurisdiction that faces the externality and the jurisdiction holding the instrument of supervision. For the researchers, a priority is to have integrated data showing the route of crypto market stresses into financial conditions and sufficient transparency of data sources to compare results of different studies.

However, the regulatory considerations do not end here. Given that the arrangements under discussion are released in one jurisdiction, communicated to a wide audience, and underwritten by the sovereign debt of a third party, the misalignment between the locus of the externality and the locus of the supervisory instrument cannot be addressed solely through legislation regardless of its quality. The institutional structure of dealing with this misalignment is in place already. Recommendations on global stablecoin architectures and a summary of crypto-asset policy concerning monetary and stability mandates have already been issued [4,112]; prudential regulation of bank exposure has already been reached [113]; recommendations on crypto- and digital-asset markets have been adopted by securities regulators [114]; and principles for financial market infrastructures have already been applied to stablecoin arrangements [115]. The thing that is missing here is not the standard itself but its operational articulation in observable terms and its uniform implementation across jurisdictions.

There are three natural steps that follow from the analysis provided above. First of all, a reporting template should be established, which will include supply, redemption volumes, reserve composition by haircut type, settled volume by venue, and the frequency and provider methodology of this report. The variance described in Section 3.7, where independent trackers show differences greater than fifteen percent in estimating the size of the sector, is the supervisory conclusion in itself and is solvable through disclosure and not analysis. Second, there should be a framework of cross-border resolution, according to which it is determined in advance who takes the responsibility in the case where the arrangement issued in one jurisdiction harms the participants of another jurisdiction. Third, the development of common escalation vocabulary as suggested in Section 12 should be pursued to allow supervisors in different jurisdictions to use identical terminology for identical conditions. This can be carried out in the Bank for International Settlements, whose research already sets the agenda of the next generation monetary and financial system [116], and the Financial Stability Board with the coordinating mandate. Nothing new in terms of institutions has to be created; it has to be said what thresholds of quantities are implied by these recommendations.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/fintech5040096/s1>, Table S1: PRISMA 2020 checklist; Table S2: PRISMA 2020 for Abstracts checklist; Table S3: Full search strategies as run in Scopus and the Web of Science Core Collection; Table S4: Sources included in the review, by type, strand, and route of identification; Data S1: Records retrieved by the database searches (9009 unique records), with the included sources flagged.

Author Contributions: Conceptualization, C.C.; methodology, C.C.; software, C.C.; validation, C.C.; formal analysis, C.C.; investigation, C.C.; resources, C.C., N.E., D.V. and K.M.; data curation, C.C. and D.V.; writing—original draft, C.C.; writing—review and editing, C.C.; visualization, C.C., N.E., and D.V.; supervision, C.C., N.E., and D.V.; project administration, C.C., N.E. and K.M.; funding acquisition, N.E. and D.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new empirical dataset was created for this review. All quantities reported in the tables and figures are drawn from the published sources identified in Table 6 and in the reference list and are stated with their observation dates. Market aggregates are provider-dependent and subject to revision; where independent providers report materially different values, the range is reported in the text. The PRISMA checklists, the full search strategies, the list of included sources, and the list of records retrieved by the database searches, with the deduplication rules, are provided as Supplementary Materials (Tables S1–S4 and Data S1). No separate data-collection form and no analytic code were used for the synthesis.

Acknowledgments: The authors thank the scholarly community whose empirical and theoretical work forms the basis of this integrative review.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following acronyms have been used in this article:

AML/CFT	Anti-Money Laundering/Countering the Financing of Terrorism
ART	Asset-Referenced Token
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
CBDC	Central Bank Digital Currency
CLSI	Crypto Liquidity Stress Index
CPMI	Committee on Payments and Market Infrastructures
DeFi	Decentralized Finance
DLT	Distributed Ledger Technology
EMT	E-Money Token
FATF	Financial Action Task Force
FSB	Financial Stability Board
GENIUS Act	Guiding and Establishing National Innovation for U.S. Stablecoins Act
HQLA	High-Quality Liquid Assets
ICO	Initial Coin Offering
IOSCO	International Organization of Securities Commissions
MiCA	Markets in Crypto-Assets Regulation
MMF	Money Market Fund
TVL	Total Value Locked
UST	TerraUSD
VASP	Virtual Asset Service Provider

References

1. Diamond, D.W.; Dybvig, P.H. Bank Runs, Deposit Insurance, and Liquidity. *J. Polit. Econ.* **1983**, *91*, 401–419. [CrossRef]
2. Brunnermeier, M.K.; Pedersen, L.H. Market Liquidity and Funding Liquidity. *Rev. Financ. Stud.* **2009**, *22*, 2201–2238. [CrossRef]
3. International Monetary Fund. *Understanding Stablecoins*; IMF Departmental Paper; International Monetary Fund: Washington, DC, USA, 2025.
4. Financial Stability Board. *High-Level Recommendations for the Regulation, Supervision and Oversight of Global Stablecoin Arrangements*; FSB: Basel, Switzerland, 2023.
5. Hacibedel, B.; Perez-Saiz, H.; Banerjee, B.; Arregui, N. *Assessing Macrofinancial Risks from Crypto Assets*; IMF Working Paper WP/23/214; International Monetary Fund: Washington, DC, USA, 2023.
6. Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System. 2008. Available online: <https://bitcoin.org/bitcoin.pdf> (accessed on 10 August 2026).
7. Böhme, R.; Christin, N.; Edelman, B.; Moore, T. Bitcoin: Economics, Technology, and Governance. *J. Econ. Perspect.* **2015**, *29*, 213–238. [CrossRef]
8. Yermack, D. Is Bitcoin a Real Currency? An Economic Appraisal. In *Handbook of Digital Currency*; Chuen, D.L.K., Ed.; Academic Press: London, UK, 2015; pp. 31–43.
9. Berentsen, A.; Schär, F. A Short Introduction to the World of Cryptocurrencies. *Fed. Reserve Bank St. Louis Rev.* **2018**, *100*, 1–16. [CrossRef]
10. Moin, A.; Sekniqi, K.; Sirer, E.G. SoK: A Classification Framework for Stablecoin Designs. In *Financial Cryptography and Data Security*; Springer: Cham, Switzerland, 2020; pp. 174–197.
11. Arner, D.W.; Auer, R.; Frost, J. *Stablecoins: Risks, Potential and Regulation*; BIS Working Papers No. 905; Bank for International Settlements: Basel, Switzerland, 2020.
12. Bullmann, D.; Klemm, J.; Pinna, A. *Search for Stability in Crypto-Assets: Are Stablecoins the Solution?* ECB Occasional Paper Series No. 230; European Central Bank: Frankfurt, Germany, 2019.
13. Chen, Y.; Bellavitis, C. Blockchain Disruption and Decentralized Finance: The Rise of Decentralized Business Models. *J. Bus. Ventur. Insights* **2020**, *13*, e00151. [CrossRef]
14. Schär, F. Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets. *Fed. Reserve Bank St. Louis Rev.* **2021**, *103*, 153–174. [CrossRef]
15. Harvey, C.R.; Ramachandran, A.; Santoro, J. *DeFi and the Future of Finance*; John Wiley & Sons: Hoboken, NJ, USA, 2021.
16. Alamsyah, A.; Kusuma, G.N.W.; Ramadhani, D.P. A Review on Decentralized Finance Ecosystems. *Future Internet* **2024**, *16*, 76. [CrossRef]
17. Baur, D.G.; Hong, K.; Lee, A.D. Bitcoin: Medium of Exchange or Speculative Assets? *J. Int. Financ. Mark. Inst. Money* **2018**, *54*, 177–189. [CrossRef]
18. Glaser, F.; Zimmermann, K.; Haferkorn, M.; Weber, M.C.; Siering, M. Bitcoin—Asset or Currency? Revealing Users’ Hidden Intentions. In Proceedings of the 22nd European Conference on Information Systems (ECIS), Tel Aviv, Israel, 9–11 June 2014.
19. Selgin, G. Synthetic Commodity Money. *J. Financ. Stab.* **2015**, *17*, 92–99. [CrossRef]
20. Weber, B. Bitcoin and the Legitimacy of a Modern Private Currency. *Camb. J. Econ.* **2016**, *40*, 17–41.
21. Ammous, S. Can Cryptocurrencies Fulfil the Functions of Money? *Q. Rev. Econ. Financ.* **2018**, *70*, 38–51. [CrossRef]
22. Dyhrberg, A.H. Bitcoin, Gold and the Dollar—A GARCH Volatility Analysis. *Financ. Res. Lett.* **2016**, *16*, 85–92. [CrossRef]
23. Baur, D.G.; Dimpfl, T.; Kuck, K. Bitcoin, Gold and the US Dollar—A Replication and Extension. *Financ. Res. Lett.* **2018**, *25*, 103–110. [CrossRef]
24. United States Congress. Guiding and Establishing National Innovation for U.S. Stablecoins Act (GENIUS Act). Public Law 119–27, 139 Stat. 419. 18 July 2025. Available online: <https://www.govinfo.gov/app/details/PLAW-119publ27> (accessed on 10 August 2026).
25. European Parliament; Council of the European Union. Regulation (EU) 2023/1114 of 31 May 2023 on Markets in Crypto-Assets, and Amending Regulations (EU) No 1093/2010 and (EU) No 1095/2010 and Directives 2013/36/EU and (EU) 2019/1937. *Off. J. Eur. Union* **2023**, *L150*, 40–205.
26. Lyons, R.K.; Viswanath-Natraj, G. What Keeps Stablecoins Stable? *J. Int. Money Financ.* **2023**, *131*, 102777. [CrossRef]
27. Gorton, G.B.; Zhang, J.Y. Taming Wildcat Stablecoins. *Univ. Chic. Law Rev.* **2023**, *90*, 909–972.
28. Aldasoro, I.; Mehrling, P.; Neilson, D.H. On Par: A Money View of Stablecoins. *J. Financ. Mark. Infrastruct.* **2024**, *11*, 47–64.
29. Koutrouli, E.; Manousopoulos, P. Exploring the Use of Crypto-Assets for Payments. *FinTech* **2025**, *4*, 15. [CrossRef]
30. Fama, E.F. The Behavior of Stock-Market Prices. *J. Bus.* **1965**, *38*, 34–105. [CrossRef]
31. Fama, E.F. Efficient Capital Markets: A Review of Theory and Empirical Work. *J. Financ.* **1970**, *25*, 383–417. [CrossRef]
32. Grossman, S.J.; Stiglitz, J.E. On the Impossibility of Informationally Efficient Markets. *Am. Econ. Rev.* **1980**, *70*, 393–408.
33. Lo, A.W. The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective. *J. Portf. Manag.* **2004**, *30*, 15–29.
34. Amihud, Y. Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. *J. Financ. Mark.* **2002**, *5*, 31–56. [CrossRef]

35. Said, B.; Raza, M.W.; Elshahat, A. Does Market Microstructure Affect Time-Varying Efficiency? Evidence from Emerging Markets. *Res. Int. Bus. Financ.* **2024**, *70*, 102347. [\[CrossRef\]](#)
36. Shleifer, A.; Vishny, R.W. The Limits of Arbitrage. *J. Financ.* **1997**, *52*, 35–55. [\[CrossRef\]](#)
37. Urquhart, A. The Inefficiency of Bitcoin. *Econ. Lett.* **2016**, *148*, 80–82. [\[CrossRef\]](#)
38. Nadarajah, S.; Chu, J. On the Inefficiency of Bitcoin. *Econ. Lett.* **2017**, *150*, 6–9. [\[CrossRef\]](#)
39. Bariviera, A.F. The Inefficiency of Bitcoin Revisited: A Dynamic Approach. *Econ. Lett.* **2017**, *161*, 1–4. [\[CrossRef\]](#)
40. Tiwari, A.K.; Jana, R.K.; Das, D.; Roubaud, D. Informational Efficiency of Bitcoin—An Extension. *Econ. Lett.* **2018**, *163*, 106–109. [\[CrossRef\]](#)
41. Khuntia, S.; Pattanayak, J.K. Adaptive Market Hypothesis and Evolving Predictability of Bitcoin. *Econ. Lett.* **2018**, *167*, 26–28. [\[CrossRef\]](#)
42. Kristoufek, L. On Bitcoin Markets (In)efficiency and Its Evolution. *Phys. A Stat. Mech. Appl.* **2018**, *503*, 257–262. [\[CrossRef\]](#)
43. Kosse, A.; Glowka, M.; Mattei, I.; Rice, T. *Will the Real Stablecoin Please Stand Up?* BIS Papers No. 141; Bank for International Settlements: Basel, Switzerland, 2023.
44. DefiLlama. Stablecoins and Total Value Locked Dashboards. Available online: <https://defillama.com> (accessed on 10 August 2026).
45. Ahmed, R.; Aldasoro, I. *Stablecoins and Safe Asset Prices*; BIS Working Papers No. 1270; Bank for International Settlements: Basel, Switzerland, 2025; (revised February 2026).
46. Liu, J.; Makarov, I.; Schoar, A. Anatomy of a Run: The Terra Luna Crash. *J. Financ. Econ.* **2026**, *184*, 104359. [\[CrossRef\]](#)
47. Diop, P.O. An Econometric and Time Series Analysis of the USTC Depeg’s Impact on the LUNA Classic Price Crash During Spring 2022’s Crypto Market Turmoil. *Commodities* **2024**, *3*, 431–459. [\[CrossRef\]](#)
48. Diop, P.O.; Chevallier, J.; Sanhaji, B. Collapse of Silicon Valley Bank and USDC Depegging: A Machine Learning Experiment. *FinTech* **2024**, *3*, 569–590. [\[CrossRef\]](#)
49. Yousaf, I.; Riaz, Y.; Goodell, J.W. The Impact of the SVB Collapse on Global Financial Markets: Substantial but Narrow. *Financ. Res. Lett.* **2023**, *55*, 103948. [\[CrossRef\]](#)
50. Naifar, N.; Makni, M.S. Dynamics of Cryptocurrencies, DeFi Tokens, and Tech Stocks: Lessons from the FTX Collapse. *Int. J. Financ. Stud.* **2025**, *13*, 169. [\[CrossRef\]](#)
51. Adrian, T.; Brunnermeier, M.K. CoVaR. *Am. Econ. Rev.* **2016**, *106*, 1705–1741. [\[CrossRef\]](#)
52. Acharya, V.V.; Pedersen, L.H.; Philippon, T.; Richardson, M. Measuring Systemic Risk. *Rev. Financ. Stud.* **2017**, *30*, 2–47. [\[CrossRef\]](#)
53. Diebold, F.X.; Yilmaz, K. On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms. *J. Econom.* **2014**, *182*, 119–134. [\[CrossRef\]](#)
54. Naifar, N. Mapping Systemic Tail Risk in Crypto Markets: DeFi, Stablecoins, and Infrastructure Tokens. *J. Risk Financ. Manag.* **2025**, *18*, 329. [\[CrossRef\]](#)
55. Said, B.; Raza, M.W.; Elshahat, A.; Paltrinieri, A.; Oriani, M.E. Decoding the DNA of Stock Market Microstructure: A Comprehensive Bibliometric and Content Review Analysis. *Res. Int. Bus. Financ.* **2026**, *86*, 103384. [\[CrossRef\]](#)
56. Paltrinieri, A.; Hassan, M.K.; Bahoo, S.; Khan, A. A Bibliometric Review of Sukuk Literature. *Int. Rev. Econ. Financ.* **2023**, *86*, 897–918. [\[CrossRef\]](#)
57. Khan, A.; Goodell, J.W.; Hassan, M.K.; Paltrinieri, A. A Bibliometric Review of Finance Bibliometric Papers. *Financ. Res. Lett.* **2022**, *47*, 102520. [\[CrossRef\]](#)
58. Makarov, I.; Schoar, A. Trading and Arbitrage in Cryptocurrency Markets. *J. Financ. Econ.* **2020**, *135*, 293–319. [\[CrossRef\]](#)
59. Brauneis, A.; Mestel, R. Price Discovery of Cryptocurrencies: Bitcoin and Beyond. *Econ. Lett.* **2018**, *165*, 58–61. [\[CrossRef\]](#)
60. Brandvold, M.; Molnár, P.; Vagstad, K.; Valstad, O.C.A. Price Discovery on Bitcoin Exchanges. *J. Int. Financ. Mark. Inst. Money* **2015**, *36*, 18–35. [\[CrossRef\]](#)
61. Pieters, G.; Vivanco, S. Financial Regulations and Price Inconsistencies across Bitcoin Markets. *Inf. Econ. Policy* **2017**, *39*, 1–14. [\[CrossRef\]](#)
62. Bariviera, A.F.; Merediz-Solà, I. Where Do We Stand in Cryptocurrencies Economic Research? A Survey Based on Hybrid Analysis. *J. Econ. Surv.* **2021**, *35*, 377–407. [\[CrossRef\]](#)
63. Liu, Y.; Tsyvinski, A. Risks and Returns of Cryptocurrency. *Rev. Financ. Stud.* **2021**, *34*, 2689–2727. [\[CrossRef\]](#)
64. Griffin, J.M.; Shams, A. Is Bitcoin Really Untethered? *J. Finance* **2020**, *75*, 1913–1964. [\[CrossRef\]](#)
65. Gandal, N.; Hamrick, J.T.; Moore, T.; Oberman, T. Price Manipulation in the Bitcoin Ecosystem. *J. Monet. Econ.* **2018**, *95*, 86–96. [\[CrossRef\]](#)
66. Foley, S.; Karlsen, J.R.; Putniņš, T.J. Sex, Drugs, and Bitcoin: How Much Illegal Activity Is Financed Through Cryptocurrencies? *Rev. Financ. Stud.* **2019**, *32*, 1798–1853. [\[CrossRef\]](#)
67. Huberman, G.; Leshno, J.D.; Moallemi, C.C. Monopoly without a Monopolist: An Economic Analysis of the Bitcoin Payment System. *Rev. Financ. Stud.* **2021**, *34*, 3011–3040. [\[CrossRef\]](#)

68. Easley, D.; O'Hara, M.; Basu, S. From Mining to Markets: The Evolution of Bitcoin Transaction Fees. *J. Financ. Econ.* **2019**, *134*, 91–109. [\[CrossRef\]](#)
69. Schilling, L.; Uhlig, H. Some Simple Bitcoin Economics. *J. Monet. Econ.* **2019**, *106*, 16–26. [\[CrossRef\]](#)
70. Chiu, J.; Koeppl, T.V. Blockchain-Based Settlement for Asset Trading. *Rev. Financ. Stud.* **2019**, *32*, 1716–1753. [\[CrossRef\]](#)
71. Cong, L.W.; Li, Y.; Wang, N. Tokenomics: Dynamic Adoption and Valuation. *Rev. Financ. Stud.* **2021**, *34*, 1105–1155. [\[CrossRef\]](#)
72. Howell, S.T.; Niessner, M.; Yermack, D. Initial Coin Offerings: Financing Growth with Cryptocurrency Token Sales. *Rev. Financ. Stud.* **2020**, *33*, 3925–3974. [\[CrossRef\]](#)
73. Fisch, C. Initial Coin Offerings (ICOs) to Finance New Ventures. *J. Bus. Ventur.* **2019**, *34*, 1–22. [\[CrossRef\]](#)
74. Adhami, S.; Giudici, G.; Martinazzi, S. Why Do Businesses Go Crypto? An Empirical Analysis of Initial Coin Offerings. *J. Econ. Bus.* **2018**, *100*, 64–75. [\[CrossRef\]](#)
75. Catalini, C.; Gans, J.S. Some Simple Economics of the Blockchain. *Commun. ACM* **2020**, *63*, 80–90. [\[CrossRef\]](#)
76. Catalini, C.; Gans, J.S. *Initial Coin Offerings and the Value of Crypto Tokens*; NBER Working Paper No. 24418; National Bureau of Economic Research: Cambridge, MA, USA, 2018.
77. Katsiampa, P. Volatility Estimation for Bitcoin: A Comparison of GARCH Models. *Econ. Lett.* **2017**, *158*, 3–6. [\[CrossRef\]](#)
78. Phillip, A.; Chan, J.S.K.; Peiris, S. A New Look at Cryptocurrencies. *Econ. Lett.* **2018**, *163*, 6–9. [\[CrossRef\]](#)
79. Bouri, E.; Molnár, P.; Azzi, G.; Roubaud, D.; Hagfors, L.I. On the Hedge and Safe Haven Properties of Bitcoin: Is It Really More Than a Diversifier? *Financ. Res. Lett.* **2017**, *20*, 192–198. [\[CrossRef\]](#)
80. Corbet, S.; Meegan, A.; Larkin, C.; Lucey, B.; Yarovaya, L. Exploring the Dynamic Relationships between Cryptocurrencies and Other Financial Assets. *Econ. Lett.* **2018**, *165*, 28–34. [\[CrossRef\]](#)
81. Guesmi, K.; Saadi, S.; Abid, I.; Ftiti, Z. Portfolio Diversification with Virtual Currency: Evidence from Bitcoin. *Int. Rev. Financ. Anal.* **2019**, *63*, 431–437. [\[CrossRef\]](#)
82. Selmi, R.; Mensi, W.; Hammoudeh, S.; Bouoiyour, J. Is Bitcoin a Hedge, a Safe Haven or a Diversifier for Oil Price Movements? A Comparison with Gold. *Energy Econ.* **2018**, *74*, 787–801. [\[CrossRef\]](#)
83. Conlon, T.; McGee, R. Safe Haven or Risky Hazard? Bitcoin during the COVID-19 Bear Market. *Financ. Res. Lett.* **2020**, *35*, 101607. [\[CrossRef\]](#) [\[PubMed\]](#)
84. Corbet, S.; Larkin, C.; Lucey, B. The Contagion Effects of the COVID-19 Pandemic: Evidence from Gold and Cryptocurrencies. *Financ. Res. Lett.* **2020**, *35*, 101554. [\[CrossRef\]](#) [\[PubMed\]](#)
85. Goodell, J.W.; Goutte, S. Co-Movement of COVID-19 and Bitcoin: Evidence from Wavelet Coherence Analysis. *Financ. Res. Lett.* **2021**, *38*, 101625. [\[CrossRef\]](#) [\[PubMed\]](#)
86. Mnif, E.; Jarbou, A.; Mouakhar, K. How the Cryptocurrency Market Has Performed during COVID 19? A Multifractal Analysis. *Financ. Res. Lett.* **2020**, *36*, 101647. [\[CrossRef\]](#) [\[PubMed\]](#)
87. Choi, S.; Shin, J. Bitcoin: An Inflation Hedge but Not a Safe Haven. *Financ. Res. Lett.* **2022**, *46*, 102379. [\[CrossRef\]](#) [\[PubMed\]](#)
88. Conlon, T.; Corbet, S.; McGee, R.J. Are Cryptocurrencies a Safe Haven for Equity Markets? An International Perspective from the COVID-19 Pandemic. *Res. Int. Bus. Financ.* **2020**, *54*, 101248. [\[CrossRef\]](#) [\[PubMed\]](#)
89. Smales, L.A. Bitcoin as a Safe Haven: Is It Even Worth Considering? *Financ. Res. Lett.* **2019**, *30*, 385–393. [\[CrossRef\]](#)
90. Klein, T.; Thu, H.P.; Walther, T. Bitcoin Is Not the New Gold—A Comparison of Volatility, Correlation, and Portfolio Performance. *Int. Rev. Financ. Anal.* **2018**, *59*, 105–116. [\[CrossRef\]](#)
91. Makarov, I.; Schoar, A. Cryptocurrencies and Decentralized Finance (DeFi). *Brook. Pap. Econ. Act.* **2022**, *2022*, 141–215. [\[CrossRef\]](#)
92. Aramonte, S.; Huang, W.; Schrimpf, A. DeFi Risks and the Decentralisation Illusion. *BIS Q. Rev.* **2021**, *21*, 21–36.
93. Qin, K.; Zhou, L.; Gervais, A. An Empirical Study of DeFi Liquidations: Incentives, Risks, and Instabilities. In Proceedings of the 21st ACM Internet Measurement Conference (IMC '21), Virtual Event, 2–4 November 2021; pp. 336–350.
94. Gudgeon, L.; Perez, D.; Harz, D.; Livshits, B.; Gervais, A. The Decentralized Financial Crisis. In Proceedings of the 2020 Crypto Valley Conference on Blockchain Technology (CVCBT), Rotkreuz, Switzerland, 11–12 June 2020; pp. 1–15.
95. Aquilina, M.; Frost, J.; Schrimpf, A. Decentralized Finance (DeFi): A Functional Approach. *J. Financ. Regul.* **2024**, *10*, 1–27. [\[CrossRef\]](#)
96. Koutmos, D. Return and Volatility Spillovers among Cryptocurrencies. *Econ. Lett.* **2018**, *173*, 122–127. [\[CrossRef\]](#)
97. Yi, S.; Xu, Z.; Wang, G.-J. Volatility Connectedness in the Cryptocurrency Market: Is Bitcoin a Dominant Cryptocurrency? *Int. Rev. Financ. Anal.* **2018**, *60*, 98–114. [\[CrossRef\]](#)
98. Ji, Q.; Bouri, E.; Lau, C.K.M.; Roubaud, D. Dynamic Connectedness and Integration in Cryptocurrency Markets. *Int. Rev. Financ. Anal.* **2019**, *63*, 257–272. [\[CrossRef\]](#)
99. Katsiampa, P.; Corbet, S.; Lucey, B. High Frequency Volatility Co-Movements in Cryptocurrency Markets. *J. Int. Financ. Mark. Inst. Money* **2019**, *62*, 35–52. [\[CrossRef\]](#)
100. Diebold, F.X.; Yilmaz, K. Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers. *Int. J. Forecast.* **2012**, *28*, 57–66. [\[CrossRef\]](#)

101. Antonakakis, N.; Chatziantoniou, I.; Gabauer, D. Refined Measures of Dynamic Connectedness Based on Time-Varying Parameter Vector Autoregressions. *J. Risk Financ. Manag.* **2020**, *13*, 84. [\[CrossRef\]](#)
102. Cong, L.W.; Harvey, C.R.; Rabetti, D.; Wu, Z.-Y. An Anatomy of Crypto-Enabled Cybercrimes. *Manag. Sci.* **2025**, *71*, 3622–3633. [\[CrossRef\]](#)
103. Huang, D.Y.; Aliapoulos, M.M.; Li, V.G.; Invernizzi, L.; Bursztein, E.; McRoberts, K.; Levin, J.; Levchenko, K.; Snoeren, A.C.; McCoy, D. Tracking Ransomware End-to-End. In Proceedings of the 2018 IEEE Symposium on Security and Privacy (SP), San Francisco, CA, USA, 20–24 May 2018; pp. 618–631.
104. Trozze, A.; Kamps, J.; Akartuna, E.A.; Hetzel, F.J.; Kleinberg, B.; Davies, T.; Johnson, S.D. Cryptocurrencies and Future Financial Crime. *Crime Sci.* **2022**, *11*, 1. [\[CrossRef\]](#) [\[PubMed\]](#)
105. Dupuis, D.; Gleason, K. Money Laundering with Cryptocurrency: Open Doors and the Regulatory Dialectic. *J. Financ. Crime* **2021**, *28*, 60–74. [\[CrossRef\]](#)
106. Cong, L.W.; Li, X.; Tang, K.; Yang, Y. Crypto Wash Trading. *Manag. Sci.* **2023**, *69*, 6427–6454. [\[CrossRef\]](#)
107. Financial Action Task Force. *Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers*; FATF: Paris, France, 2021.
108. Financial Action Task Force. *Targeted Update on Implementation of the FATF Standards on Virtual Assets and Virtual Asset Service Providers*; FATF: Paris, France, 2024.
109. Europol. *Internet Organised Crime Threat Assessment (IOCTA)*; Publications Office of the European Union: Luxembourg, 2024.
110. Chainalysis. *Crypto Hacking and Stolen Funds Update*; Chainalysis: New York, NY, USA, 2026. Available online: <https://www.chainalysis.com/blog/crypto-hacking-stolen-funds-2026/> (accessed on 10 August 2026).
111. Chainalysis. *The Crypto Crime Report*; Chainalysis: New York, NY, USA, 2025. Available online: <https://www.chainalysis.com/blog/2025-crypto-crime-report-introduction/> (accessed on 10 August 2026).
112. International Monetary Fund; Financial Stability Board. *IMF-FSB Synthesis Paper: Policies for Crypto-Assets*; IMF/FSB: Washington, DC, USA, 2023.
113. Basel Committee on Banking Supervision. *Prudential Treatment of Cryptoasset Exposures*; Bank for International Settlements: Basel, Switzerland, 2022.
114. International Organization of Securities Commissions. *Policy Recommendations for Crypto and Digital Asset Markets: Final Report*; IOSCO: Madrid, Spain, 2023.
115. Committee on Payments and Market Infrastructures; International Organization of Securities Commissions. *Application of the Principles for Financial Market Infrastructures to Stablecoin Arrangements*; Bank for International Settlements: Basel, Switzerland, 2022.
116. Bank for International Settlements. The Next-Generation Monetary and Financial System. In *Annual Economic Report 2025*; BIS: Basel, Switzerland, 2025; Chapter III.
117. Adrian, T.; Mancini-Griffoli, T. The Rise of Digital Money. *Annu. Rev. Financ. Econ.* **2021**, *13*, 57–77. [\[CrossRef\]](#)
118. Brunnermeier, M.K.; James, H.; Landau, J.-P. *The Digitalization of Money*; NBER Working Paper No. 26300; National Bureau of Economic Research: Cambridge, MA, USA, 2019.
119. Auer, R.; Böhme, R. The Technology of Retail Central Bank Digital Currency. *BIS Q. Rev.* **2020**, 85–100.
120. Auer, R.; Cornelli, G.; Frost, J. *Rise of the Central Bank Digital Currencies: Drivers, Approaches and Technologies*; BIS Working Papers No. 880; Bank for International Settlements: Basel, Switzerland, 2020.
121. Kiff, J.; Alwazir, J.; Davidovic, S.; Farias, A.; Khan, A.; Khiaonarong, T.; Malaika, M.; Monroe, H.; Sugimoto, N.; Tourpe, H.; et al. *A Survey of Research on Retail Central Bank Digital Currency*; IMF Working Paper WP/20/104; International Monetary Fund: Washington, DC, USA, 2020.
122. Bindseil, U. *Tiered CBDC and the Financial System*; ECB Working Paper Series No. 2351; European Central Bank: Frankfurt, Germany, 2020.
123. Snyder, H. Literature Review as a Research Methodology: An Overview and Guidelines. *J. Bus. Res.* **2019**, *104*, 333–339. [\[CrossRef\]](#)
124. Torraco, R.J. Writing Integrative Literature Reviews: Guidelines and Examples. *Hum. Resour. Dev. Rev.* **2005**, *4*, 356–367. [\[CrossRef\]](#)
125. Donthu, N.; Kumar, S.; Mukherjee, D.; Pandey, N.; Lim, W.M. How to Conduct a Bibliometric Analysis: An Overview and Guidelines. *J. Bus. Res.* **2021**, *133*, 285–296. [\[CrossRef\]](#)
126. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ* **2021**, *372*, n71. [\[CrossRef\]](#) [\[PubMed\]](#)
127. Zupic, I.; Čater, T. Bibliometric Methods in Management and Organization. *Organ. Res. Methods* **2015**, *18*, 429–472. [\[CrossRef\]](#)
128. Mongeon, P.; Paul-Hus, A. The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. *Scientometrics* **2016**, *106*, 213–228. [\[CrossRef\]](#)

129. Martín-Martín, A.; Thelwall, M.; Orduna-Malea, E.; Delgado López-Cózar, E. Google Scholar, Microsoft Academic, Scopus, Dimensions, Web of Science, and OpenCitations' COCI: A Multidisciplinary Comparison of Coverage via Citations. *Scientometrics* **2021**, *126*, 871–906. [\[CrossRef\]](#) [\[PubMed\]](#)
130. Challoumis, C. The R.B.Q. (Rational, Behavioral and Quantified) Model. *Ekonomika* **2019**, *98*, 6–18. [\[CrossRef\]](#)
131. Cheah, E.-T.; Fry, J. Speculative Bubbles in Bitcoin Markets? An Empirical Investigation into the Fundamental Value of Bitcoin. *Econ. Lett.* **2015**, *130*, 32–36. [\[CrossRef\]](#)
132. Fry, J.; Cheah, E.-T. Negative Bubbles and Shocks in Cryptocurrency Markets. *Int. Rev. Financ. Anal.* **2016**, *47*, 343–352. [\[CrossRef\]](#)
133. Cagli, E.C. Explosive Behavior in the Prices of Bitcoin and Altcoins. *Financ. Res. Lett.* **2019**, *29*, 398–403. [\[CrossRef\]](#)
134. Ciaian, P.; Rajcaniova, M.; Kancs, d'A. The Economics of Bitcoin Price Formation. *Appl. Econ.* **2016**, *48*, 1799–1815. [\[CrossRef\]](#)
135. Kristoufek, L. What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis. *PLoS ONE* **2015**, *10*, e0123923. [\[CrossRef\]](#) [\[PubMed\]](#)
136. Li, X.; Wang, C.A. The Technology and Economic Determinants of Cryptocurrency Exchange Rates: The Case of Bitcoin. *Decis. Support Syst.* **2017**, *95*, 49–60. [\[CrossRef\]](#)
137. Blau, B.M. Price Dynamics and Speculative Trading in Bitcoin. *Res. Int. Bus. Financ.* **2017**, *41*, 493–499. [\[CrossRef\]](#)
138. Balcilar, M.; Bouri, E.; Gupta, R.; Roubaud, D. Can Volume Predict Bitcoin Returns and Volatility? A Quantiles-Based Approach. *Econ. Model.* **2017**, *64*, 74–81. [\[CrossRef\]](#)
139. Challoumis, C. Economocracy: Global Economic Governance. *Economies* **2025**, *13*, 230. [\[CrossRef\]](#)
140. Auer, R.; Lewrick, U.; Paulick, J. *DeFiying Gravity? An Empirical Analysis of Cross-Border Bitcoin, Ether and Stablecoin Flows*; BIS Working Papers No. 1265; Bank for International Settlements: Basel, Switzerland, 2025.
141. Challoumis, C. The Inflation According to the Cycle of Money (C.M.). *Econ. Altern.* **2025**, *2025*, 324–353. [\[CrossRef\]](#)
142. Alvarez, F.; Argente, D.; Van Patten, D. Are Cryptocurrencies Currencies? Bitcoin as Legal Tender in El Salvador. *Science* **2023**, *382*, eadd2844. [\[CrossRef\]](#) [\[PubMed\]](#)
143. International Monetary Fund. *El Salvador: Article IV Consultation—Staff Report*; IMF Country Report; International Monetary Fund: Washington, DC, USA, 2025.
144. Challoumis, C.; Eriotis, N.; Vasiliou, D. Index of the Cycle of Money: The Case of Cyprus. *Int. J. Financ. Stud.* **2026**, *14*, 27. [\[CrossRef\]](#)
145. Challoumis, C.; Eriotis, N.; Vasiliou, D. The Role of Pressure Groups in Greek Economic Structure. *World* **2025**, *6*, 150. [\[CrossRef\]](#)
146. de Vries, A. Bitcoin's Growing Energy Problem. *Joule* **2018**, *2*, 801–805. [\[CrossRef\]](#)
147. Mora, C.; Rollins, R.L.; Taladay, K.; Kantar, M.B.; Chock, M.K.; Shimada, M.; Franklin, E.C. Bitcoin Emissions Alone Could Push Global Warming above 2 °C. *Nat. Clim. Change* **2018**, *8*, 931–933. [\[CrossRef\]](#)
148. Stoll, C.; Klaaßen, L.; Gallersdörfer, U. The Carbon Footprint of Bitcoin. *Joule* **2019**, *3*, 1647–1661. [\[CrossRef\]](#)
149. Krause, M.J.; Tolaymat, T. Quantification of Energy and Carbon Costs for Mining Cryptocurrencies. *Nat. Sustain.* **2018**, *1*, 711–718. [\[CrossRef\]](#)
150. Sedlmeir, J.; Buhl, H.U.; Fridgen, G.; Keller, R. The Energy Consumption of Blockchain Technology: Beyond Myth. *Bus. Inf. Syst. Eng.* **2020**, *62*, 599–608. [\[CrossRef\]](#)
151. Truby, J. Decarbonizing Bitcoin: Law and Policy Choices for Reducing the Energy Consumption of Blockchain Technologies and Digital Currencies. *Energy Res. Soc. Sci.* **2018**, *44*, 399–410. [\[CrossRef\]](#)
152. Challoumis, C. The Index of the Cycle of Money: The Case of Switzerland. *J. Risk Financ. Manag.* **2024**, *17*, 135. [\[CrossRef\]](#)
153. Challoumis, C. Integrating Money Cycle Dynamics and Economocracy for Optimal Resource Allocation and Economic Stability. *J. Risk Financ. Manag.* **2024**, *17*, 422. [\[CrossRef\]](#)
154. Challoumis, C.; Eriotis, N.; Vasiliou, D.; Mavrommatis, K. GDPR and Economic Views from the Greek Case. *World* **2026**, *7*, 104. [\[CrossRef\]](#)
155. Challoumis, C.; Eriotis, N.; Vasiliou, D.; Mavrommatis, K. AI-Related Technological Capability and Economic Growth in Cyprus: Exploratory Macroeconomic Evidence. *Businesses* **2026**, *6*, 40. [\[CrossRef\]](#)
156. Challoumis, C.; Eriotis, N.; Vasiliou, D. Social Movements' Impact on the Greek Economy During the Financial Crisis. *Economies* **2025**, *13*, 269. [\[CrossRef\]](#)

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.