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Stablecoin devaluation risk

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ABSTRACT

Reliance of stablecoin issuers on centralized custodians introduces devaluation risk similar to that observed in traditional currencies under pegged exchange rate regimes. We construct market-based measures of stablecoin devaluation risk using spot and futures prices for Tether. Conditional on full default, our estimates suggest an average devaluation probability of 60 basis points annually, rising to over 200 basis points during the 2022 Terra-Luna crash. In contrast, the probability of a partial default, defined as a 5% devaluation (trading at 95 cents), is approximately 12 percentage points on an annualized basis. Key risk factors include market volatility and transaction velocity. While elevated interest rates suggest heightened devaluation risk, deviations from covered interest parity indicate segmentation between traditional and stablecoin markets, reflecting the effects of leverage trading and arbitrage costs. To mitigate these risks, our findings suggest the importance of greater transparency and regulatory oversight.

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1. Introduction and motivation

Stablecoins are popular onramps and offramps for purchases and sales in the digital sphere. They are widely used as vehicles for transactions in popular cryptocurrencies such as Bitcoin (BTC), and account for over two thirds of recorded cryptocurrency transactions.[1] At their peak in late 2024, US dollar-based stablecoins reached a combined market capitalization of over $200 billion, demonstrating their importance in facilitating transactions in the cryptocurrency ecosystem.[2] They find some use for remittances and other cross-border transactions (Adams et al. 2023; von Luckner, Reinhart, and Rogoff 2023). Their advocates suggest that they will gain broader acceptance in financial and commercial transactions. An important question in light of their increasing importance is the risks they transmit to users.[3] This question motivates the adoption of regulations such as Europe's Markets in Crypto Assets Regulation (MiCA), designed to prevent stablecoin risks from infecting the broader economy.[4]

The leading stablecoins rely on a centralized custodian of assets held as collateral or reserves. These assets are held off-chain. In some cases, such assets, or a portion thereof, are less liquid than the custodian's liabilities–that is, than the stablecoin itself. This resembles the liquidity mismatch that characterizes the balance sheet of a bank whose business is maturity transformation. It thus gives rise to a problem of run risk analogous to that to which banks are subject. Relatedly, there is an analogy between a run on the reserves of a central bank seeking to maintain a set value for a national currency (seeking to defend a currency peg), something that, if sufficiently intense, can result in the currency's devaluation, and a run on a centralized custodian seeking to maintain a set value for a stablecoin against a national currency, something that similarly can force that set value to be abandoned.

It follows that stablecoin devaluation risk can be priced using futures contracts in the same way the risk that a national currency will be devalued can be priced using forward foreign exchange contracts. Our analysis of this

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relationship focuses on Tether, the most actively traded stablecoin and the only one with traded futures during our period of study.[5] We use these futures to construct a measure of devaluation risk, which we define as the probability of a speculative attack on the stablecoin peg.

Tether futures regularly trade at a discount to spot prices. We show that, on average, the devaluation risk implicit in this discount is priced at approximately 60 basis points annually. This corresponds to full default, defined as a complete collapse of the peg. This probability exhibits significant time variation, reaching a peak of 200 basis points during periods of market stress through mid-2022. In addition to full default risk, our framework captures partial default scenarios. For example, the annualized probability of a 5% devaluation, defined as Tether trading at or below 95 cents, is estimated at 12.4 percentage points.

This devaluation risk is increasing in Bitcoin volatility. Higher volatility may induce more transactions by investors who have taken leveraged positions in Bitcoin, particularly those using stablecoins as margin collateral. When volatility spikes, margin calls and forced unwinds trigger redemptions of the stablecoin, leading to increased outflows and liquidity stress for the issuer. In turn, this requires the centralized custodian to liquidate reserve assets to meet redemptions. Since liquidating collateral is operationally complex and may involve liquidity mismatches or price impacts, this need–and the uncertainty it creates–shows up as an increase in the perceived probability of devaluation.

Another mechanism linking Bitcoin volatility to stablecoin risk arises from valuation effects on the issuer's balance sheet. If the stablecoin issuer holds Bitcoin directly as part of its reserves, as in the case of Tether, declines in Bitcoin prices can reduce the mark-to-market value of those assets, weakening reserve coverage. This amplifies concerns about the issuer's ability to maintain the peg, particularly when other less liquid or opaque assets are also on the balance sheet. Thus, Bitcoin volatility contributes to devaluation risk both through investor behavior and through direct balance sheet exposure.

Network characteristics such as stablecoin velocity (the turnover rate) and redemptions are key predictors of devaluation risk. Higher velocity reflects heightened market activity and investor attention to the custodian's balance sheet, while increased redemptions amplify the risk of runs.[6] An Analysis of Variance (ANOVA) shows velocity to be the most significant driver, explaining 14.8% to 16.1% of the variation in devaluation risk, emphasizing the role of trading intensity in signaling run risk.

Two case studies illustrate these connections. One is the TerraUSD crash of May 9th, 2022, when Tether's price fell to 95 cents in intra-day trading. We document a 200 basis point probability of Tether devaluation. We observe an increase in velocity and redemption behavior as investors exited the cryptocurrency market and re-balanced their portfolios toward other cryptocurrencies.

The second case is USDC stablecoin de-pegging when Silicon Valley Bank (SVB) went bust in March 2023. This event raised concerns about whether USDC was fully backed, given that it held reserves at SVB. At one point, USDC fell to 87 cents. This rise in perceived devaluation risk was accompanied by a rise in monetary velocity, as in the TerraUSD crash. USDC stabilized when it transferred cash reserves at SVB to other banking partners. Redemptions following the event then helped stabilize the coin's secondary market value.

Investors can be compensated for devaluation risk through stablecoin lending, where interest rates reflect this risk (Gorton, Klee, et al. 2022). We analyze the behavior of Tether's borrowing and lending rates, showing how they respond to devaluation risk while controlling for factors like the Crypto Fear and Greed Index and USD money market rates. Our findings reveal that a one percentage point increase in devaluation risk corresponds to a similar rise in Tether interest rates on platforms like Compound and Aave, indicating that these rates serve as compensation for risk.

Along with devaluation risk, market sentiment is as a key driver of stablecoin interest rates. A strong positive correlation between the Crypto Fear and Greed Index and stablecoin rates suggests that market optimism increases borrowing demand as traders take leveraged positions. Conversely, we observe a negative relationship between stablecoin rates and USD money market rates, in contrast to the expected positive pass-through from monetary policy to traditional money markets. An ANOVA confirms that market sentiment is the dominant factor, explaining 22% of rate variation, while devaluation risk and money market rates account for just 3.5% and 1%, respectively. These results highlight a disconnect between traditional financial markets and the dynamics of stablecoin lending.

Finally, we conduct a formal test of market integration by constructing a measure of covered interest parity (CIP). This condition uses futures contracts to compare rates after hedging exchange rate risk. We find that stablecoin interest rates are systematically higher than money market rates after hedging exchange rate risk. There are systematic deviations from CIP, in other words. As explanations, we point to market segmentation due to the presence of leveraged trading and limits to arbitrage between the two markets. Such limits include lack of term structure in decentralized finance (DeFi) interest rates, lack of arbitrage capital in cryptocurrency markets, and gas fees charged to validate transactions on the blockchain.

We conduct a series of robustness tests to validate our baseline estimates. First, we compare our model-implied partial default probabilities to market-implied probabilities from Polymarket, a decentralized prediction market platform. Polymarket's contract on a potential USDT de-pegging in 2025 assigns a probability of 14–18% to a devaluation event defined as Tether trading below 98 cents for a full 24-hour period. By comparison, our estimates imply a 31.1% annualized probability for a comparable 2% devaluation threshold, suggesting that Polymarket may understate the risk of partial default. This difference partially reflects Polymarket's stricter resolution criteria, which require the de-pegging to persist over a full 24-hour period.

We also test the robustness of our results using funding rates from USDT and USDC perpetual futures contracts. Perpetual futures provide an alternative to fixed-maturity contracts by using funding rates–recurring payments between long and short positions–to keep futures prices anchored to spot prices. For USDT, negative funding rates during stress periods–such as the Terra-Luna collapse–correspond to elevated devaluation risk, and funding rate dynamics align with the same drivers identified in our baseline regressions. For USDC, by contrast, weaker results are observed due to lower market liquidity, a more conservative reserve composition, and an absence of stress episodes during the sample period.

Over time, stablecoins could potentially come to be used more widely for remittances and other payments, leading to closer connections between stablecoin markets and traditional financial markets. If these connections strengthen, concerns may arise about volatility in stablecoin markets spilling over into conventional financial systems. The question is what to do about this. On response might be to limit stablecoin volatility through real-time audits using proof-of-reserve systems. These systems, powered by smart contracts, allow new tokens to be minted only when verified reserve balances increase, providing real-time detection of custodial issues.[7]

Another approach would be for regulatory authorities to license stablecoin platforms, impose capital and liquidity requirements, and conduct regular audits of their balance sheets, similar to how banks are regulated. Alternative private money arrangements, such as tokenized deposits and reserve-backed tokens, could preserve monetary stability by ensuring that issuers operate as narrow banks with fully backed assets (Garratt and Shin 2023; Goel 2024). We analyze these options further in Appendix A.

Related Literature. Our work contributes to a growing literature on stablecoin and cryptocurrency markets. Empirical studies have examined stablecoin properties and compared them with traditional financial assets (Arner, Auer, and Frost 2020; Barthelemy, Gardin, and Nguyen 2021; Berentsen and Schär 2019; Bullmann, Klemm, and Pinna 2019; Dell'Erba 2019; ECB 2020; Eichengreen 2019; Frost, Shin, and Wierts 2020; Oefele, Baur, and Smales 2024a, 2024b), explored arbitrage opportunities in cryptocurrency markets (Borri and Shakhnov 2023; Hautsch, Scheuch, and Voigt 2024; Kozhan and Viswanath-Natraj 2021; Lyons and Viswanath-Natraj 2023; Ma, Zeng, and Zhang 2023; Makarov and Schoar 2019, 2020; Pernice 2021), stablecoin price dynamics (Baumohl and Vỳrost 2020; Baur and Hoang 2020; Bianchi, Iacopini, and Rossini 2020; Duan and Urquhart 2023; Gloede and Moser 2021; Hoang and Baur 2024; Nguyen et al. 2022; Wang, Ma, and Wu 2020), the macroeconomic and financial stability implications of stablecoins (Allen, Gu, and Jagtiani 2022; Barthelemy, Gardin, and Nguyen 2021; Catalini and de Gortari 2021; Catalini and Shah 2021; Charoenwong, Kirby, and Reiter 2023; Cong and Mayer 2022; Dionysopoulos, Marra, and Urquhart 2024; Gorton and Zhang 2023; Gorton, Ross, and Ross 2022; Kim 2022; Jiageng Liu, Makarov, and Schoar 2023; Maex and Slavov 2024; Martin 2022; Murakami and Viswanath-Natraj 2021), and understanding cryptocurrency market risks, including trading patterns, discontinuous price movements, and spillover effects from monetary policy (Elsayed and Sousa 2024; Gkillas et al. 2024; Anqi Liu et al. 2023; Urquhart and Yarovaya 2024).

Our work is most closely related to Gorton, Ross, and Ross (2022); Gorton, Klee, et al. (2022), who discuss the concept of stablecoin inconvenience yields, suggesting that stablecoins require higher interest rates due to their imperfect substitutability with conventional money. Complementary to this, Gorton, Klee, et al. (2022)

provide a global games framework for understanding stablecoin runs. Their paper establishes that a decrease in demand for the cryptocurrency or an increase in the issuer's riskiness pushes the stablecoin price below its peg. While these authors use perpetual funding rates to proxy for risk premia, we utilize a more direct measure of peg risk derived from futures prices. Our approach has the advantage of capturing risk related to the issuer and beliefs about peg fundamentals rather than broader cryptocurrency market sentiment. Perpetual funding rates, as in Gorton, Klee, et al. (2022), may reflect a combination of speculative demand and market sentiment, which can make it challenging to isolate run risk. For instance, high stablecoin interest rates could result from optimism-driven borrowing activity rather than concerns about devaluation or capital flight. In contrast, futures prices explicitly reflect expectations of peg deviations under current market conditions, enabling us to tie devaluation risk more directly to observable drivers such as market volatility, redemption activity, and speculative demand.

Theoretically, our study complements research on stablecoin price dynamics, reserve buffers, and over-collateralization aimed at preventing speculative attacks and peg discounts (Aldasoro, Ahmed, and Duley 2023; Bertsch 2023; Cong, Li, and Wang 2021; d'Avernas, Maurin, and Vandeweyer 2022; Kwon et al. 2021; Li and Mayer 2022; Routledge and Zetlin-Jones 2022; Uhlig 2022). Our findings support the framework of stablecoin runs proposed by Bertsch (2023), while extending it with empirical evidence on the interaction between market fundamentals and investor beliefs.

Finally, our paper relates to the broader literature on speculative attacks on pegged exchange rates and models of devaluation risk in currency boards (Asici and Wyplosz 2003; Chamley 2003; Drapeau, Wang, and Wang 2021; Eichengreen, Rose, and Wyplosz 1995; Obstfeld 1996). Theoretical models of speculative attacks and fixed exchange rate regimes emphasize the role of beliefs and fundamentals in driving devaluation risk (e.g. Krugman 1979; Morris and Shin 1998; Obstfeld 1996). Complementary to these studies, we use futures prices to estimate devaluation risk, applying this approach to stablecoins while highlighting the importance of belief-driven channels in shaping peg price dynamics.

In Section 2, we introduce a taxonomy of stablecoin risks, outline our data sources, and construct a market-based measure of run-risk using spot and futures data. Section 3 analyzes the determinants of run-risk, incorporating both econometric and case-study evidence, and examines the behavior of stablecoin interest rates on DeFi lending protocols. Finally, Section 4 concludes and discusses the implications of our findings for policymakers.

2. Definitions and data

2.1. Stablecoin taxonomy

Stablecoins operate on the blockchain and are typically pegged at parity to the U.S. dollar. U.S. dollar-denominated stablecoins reached a peak market capitalization of over $150 billion in late 2021, and are dominated by Tether, USDC, Binance USD, and DAI, as shown in Panel A of Figure 1. They serve as vehicles for trading crypto assets generally, owing to the fact that they, like other crypto assets, operate on the blockchain, thereby reducing intermediation and transactions costs.[8] Specific use cases include serving as a vehicle currency on centralized exchanges like Binance, decentralized exchanges like Uniswap (an open-source protocol for trading tokens without intermediaries), and DeFi lending protocols for leveraged trading. Stablecoins are also used, though to a lesser extent, for remittances and cross-border payments. Additionally, residents of developing countries may use stablecoins to evade capital controls and hedge against high domestic inflation (Adams et al. 2023).

Stablecoins typically follow three designs, as outlined in Panel B of Figure 1. A first type, as in the case of Tether, is backed by collateral held off chain by a custodian. In Tether's case, the custodian is centralized. It is responsible for managing Tether's fixed peg to the dollar, and can be thought of analogously to a currency board that manages a fixed currency peg to the dollar. The second-largest stablecoin, USDC, has decentralized governance, with multiple custodians providing and redeeming tokens.

Not all dollar reserves are held in the form of cash or cash-equivalents. Historically, Tether and USDC's balance sheets have included commercial paper and other assets that may become illiquid during risk-off events.

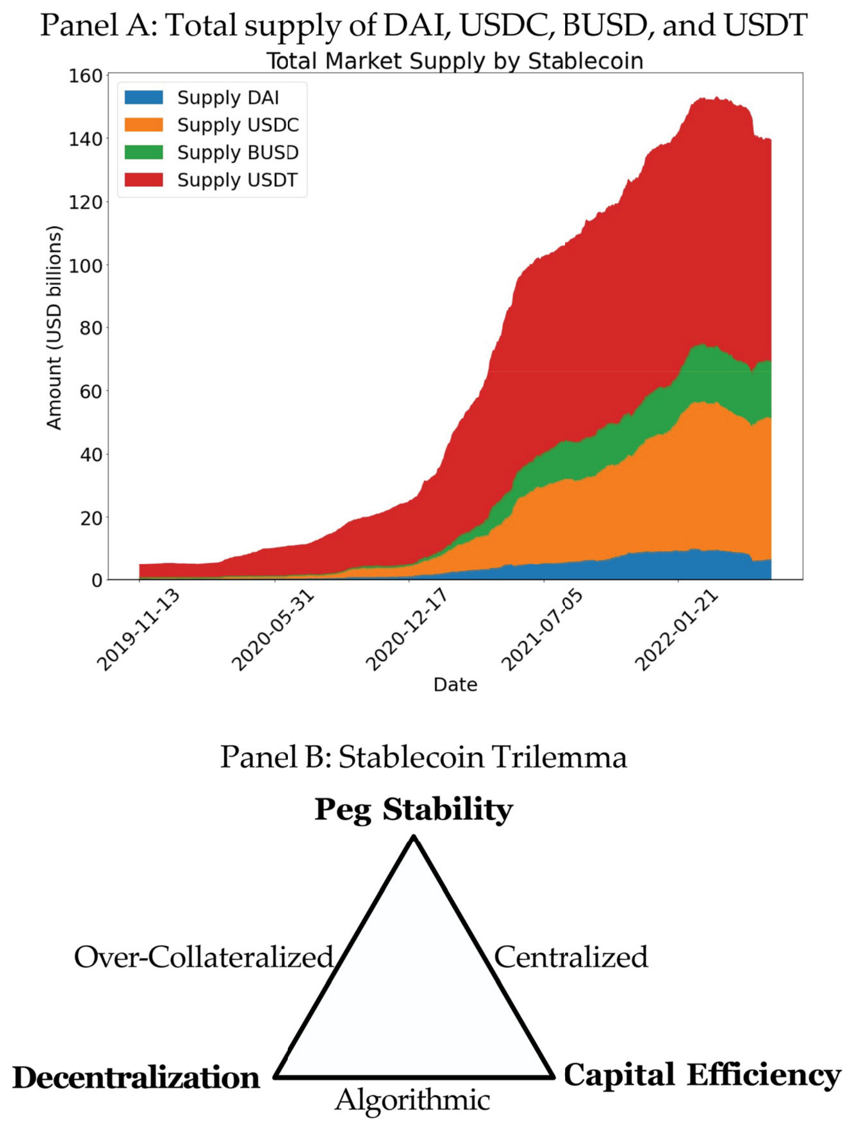

Figure 1. Stablecoin ecosystem. (a) Panel A: Total supply of DAI, USDC, BUSD, and USDT and (b) Panel B: Stablecoin Trilemma.

Note: Panel A reports the aggregate free float supply of stablecoins Tether (USDT), USDC, BUSD and DAI, in Billions USD. Panel B reports the trilemma, which states that stablecoins face a trade-off between three objectives: peg stability, decentralization, and capital efficiency. Stablecoin designs can be categorized into centralized, over-collateralized (decentralized), and algorithmic stablecoins based on which objectives they achieve.

A second design is decentralized, cryptocurrency (over) collateralized, and custodian free, as in the case of MakerDAO's DAI. DAI tokens are generated when an investor deposits collateral, typically Ether (ETH), into a collateralized debt position (CDP). Based on the value of collateral, an investor can issue (borrow) a certain amount of DAI tokens. The number of DAI they can borrow is limited by a smart (auto-executing) contract.[9] This approach is capital inefficient since positions are over-collateralized.

A third design is algorithmic. In this case there may be zero collateral. The algorithm managing the system is programmed to increase and reduce the supply of the stablecoin as its value rises and falls relative to parity. A leading algorithmic stablecoin is TerraUSD, which reached a peak market capitalization of 40 USD billion in April 2022. TerraUSD is entirely backed by Luna, the native token of the Terra blockchain. Users can create 1 USD worth of TerraUSD by burning 1 USD of Luna. The Luna token is used to pay fees for validating transactions on the blockchain, staking tokens in governance votes, and earning yields on DeFi lending protocols.

This third approach economizes on capital costs (since there is no capital) but is prone to instability, as evident in the substantial discounts at which algorithmically collateralized stablecoins sometimes trade. An example is when the TerraUSD peg was broken on May 12th, 2022, triggering loss of confidence in the Terra blockchain and governance token. This triggered a spiral of falling Luna and TerraUSD prices; on May 12th, 2022 the ratio of the value of Luna to the circulating supply of TerraUSD declined to approximately 0.1.

Compared to dollar-backed stablecoins like Tether and over-collateralized crypto-backed coins like as DAI, algorithmically-backed stablecoins such as TerraUSD suffer from absence of an effective arbitrage mechanism between primary and secondary markets. The governance token Luna is unsuitable as collateral backing since it is systemically dependent on the value of the TerraUSD token and hence on the growth of the Terra blockchain.

In practice, the distinctions between these designs are not always clear-cut. Many stablecoins now adopt hybrid approaches, combining features from multiple categories. For example, Frax is a partially collateralized stablecoin that uses a mix of on-chain crypto assets and algorithmic mechanisms to maintain its peg. Frax's system includes a collateral ratio that adjusts dynamically based on market conditions: it increases collateralization during periods of instability while relying more on algorithmic stabilization during normal conditions. Additionally, Frax employs Algorithmic Market Operations (AMOs), which allow for minting and redeeming FRAX tokens on decentralized exchanges and other protocols to maintain the peg through predefined algorithms.[10] This hybrid design balances the capital efficiency of algorithmic stablecoins with the relative stability of collateralized systems.

A similar evolution can be observed with the DAI stablecoin. While DAI was initially designed to accept only on-chain collateral, its collateral structure has diversified significantly since 2022 to include real-world assets (RWAs). The largest RWA vaults backing DAI include U.S. Treasury securities, credit assets such as consumer receivables and real estate finance, and USDC-backed assets. These RWAs are managed through special purpose vehicles (SPVs) and overseen by trustees, enabling MakerDAO to interface with traditional financial markets without formal legal standing. Although this approach allows DAI to diversify its collateral base, it also brings the system closer to a hybrid stablecoin design.

2.2. Stablecoin risks

It is useful to distinguish four risks associated with stablecoins: custodial risk, devaluation risk, systemic risk, and payments risk.

- *Custodial risk*: This can arise when a centralized issuer responsible for reserve management absconds with funds.
- *Devaluation risk*: This can arise when reserves or backing are less than 100 percent of the value of issuance or less than perfectly liquid.
- *Systemic risk*: Stablecoins used in cryptocurrency markets can increase risk exposures of financial intermediaries. Because stablecoin issuers hold traditional assets, a run on stablecoins can lead to systemic risks to the financial sector and financial intermediation, for example when they are forced to engage in fire sales of commercial paper and other assets held by stablecoin issuers as collateral.
- *Payment risk*: If a firm or other entity has receivables denominated in stablecoins, its flows are subject to devaluation risk.[11] This is similar to the exchange rate risk that occurs when firms denominate liabilities in foreign currency and are subject to a revaluation of foreign debt when the local currency depreciates (Eichengreen, Hausmann, and Panizza 2007).

We illustrate these risks in the context of Tether, the stablecoin that is the focus of our empirical analysis. Since March 2021, Tether has provided a breakdown of its reserves, which are subject to quarterly attestation reports, initially by the accounting firm Moore Cayman, and subsequently by BDO since June 2022. Tether's first

Table 1. Q1 2023 tether attestation: consolidated reserves report.

Assets	Amount (USD Billion)	% Balance Sheet
US T-Bills	53.04	64.78%
Overnight Reverse Repo Agreements	7.50	9.17%
Term Reverse Repo Agreements	0.79	0.97%
Money Market Funds	7.45	9.08%
Cash and Bank Deposits	0.48	0.59%
Non-U.S. T-Bills	0.05	0.06%
Cash or Cash Equivalents Sub-Total (1)	69.31	84.65%
Corporate Bonds	0.14	0.17%
Precious Metals	3.39	4.14%
Bitcoin	1.50	1.83%
Other investments	2.14	2.62%
Secured loans	5.35	6.54%
Non-Cash or Cash Equivalents Sub-Total (2)	12.52	15.35%
Total (1)+(2)	81.83	100.00%

Note: This table presents Tether attestation by accounting firm BDO for Quarter 1 2023. Balance sheet breaks down all assets held by Tether into categories. For more details and the full attestation, see Tether's press release (link).

statement of March 2021 revealed that it was only 75.6% backed by cash or cash equivalents (less liquid asset categories such as commercial paper, fiduciary deposits and treasury bills).[12] In its 2023 Q1 quarterly attestation, Tether had fully liquidated its commercial paper holdings. However, only 84.65% of its assets were held in cash or cash equivalents, while the remaining 15.35% were allocated to less liquid assets such as corporate bonds, precious metals, and cryptocurrencies, including Bitcoin (Table 1).

In the absence of 100 percent liquid reserves, Tether can be susceptible to bank-run-like problems. If demands to redeem Tether exceed liquid reserves, Tether must suspend redemptions or sell less liquid assets at a loss. This is analogous to how, at the height of the Global Financial Crisis in 2008, money market funds were forced to 'break the buck' due to a fall in the value and liquidity of their commercial paper holdings.

An issue here is Tether's holdings of Bitcoin, whose price is volatile. While these holdings constituted just a small fraction (1.8%) of Tether's balance sheet on March 31st, 2023, they made the value of Tether's backing subject to fluctuations. A crash in the value of cryptocurrencies, such as Bitcoin, can reduce the value of Tether's assets. This decline in asset value can trigger redemptions, as demonstrated by the link between the profitability of Tether's balance sheet and stablecoin growth in Dionysopoulos, Marra, and Urquhart (2024). We study this market risk in Section 3.2.

While our study focuses on Tether, concerns about the valuation of assets and the extent of collateralization are relevant to other stablecoins as well. For example, Liao (2022) highlights significant differences in asset composition across stablecoins. Tether diversifies its balance sheet by holding a fraction of its reserves in less liquid assets, including cryptocurrencies, corporate bonds, and precious metals. In contrast, USDC, managed by Circle, adopts a model closer to 'tokenized cash,' where reserves are fully backed by highly liquid and secure assets. These include U.S. Treasury securities, repurchase agreements, and cash held in segregated accounts at regulated financial institutions.

To illustrate, as of November 2024, Circle reported reserves exceeding \$39 billion, ensuring 1:1 backing for USDC tokens.[13] This robust reserve composition has contributed to the relative stability of USDC, even during periods of market stress. However, USDC is not entirely immune to external shocks, as demonstrated by the March 2023 de-pegging event triggered by the collapse of Silicon Valley Bank. The bank, which held a portion of USDC's cash reserves, went bankrupt, leading to temporary disruptions in USDC's peg. The market response was similar to that observed for Tether during other stress events, with liquidity constraints and redemption pressures driving price volatility.

Thus, in Section 3.2.2, we highlight the role of Silicon Valley Bank's collapse in triggering a USDC de-pegging event that occurred in March 2023, when the bank, which held cash reserves for USDC, went bankrupt. The reaction of USDC in this episode was much like the reaction of Tether in other instances.

2.3. Stablecoin risk management

Opacity and lack of auditing requirements can heighten the risks enumerated above. For example, because Tether's assets are kept off-chain, investors are unable to confirm that its balance sheet is fully collateralized in real time. Attestations are done only once a quarter. Doubts about the value of collateral can then give rise to mass redemptions as holders seek to avoid being last in the queue, a la Diamond and Dybvig (1983).

Real-time audits using third-party proof-of-reserve systems such as Chainlink are one possible solution to this problem. These audits provide transparency with regard to collateral values and alert stakeholders to anomalies. Auditing is conducted at a high frequency, in contrast to Tether and USDC, which provide audit reports on a monthly or quarterly basis. By more tightly connecting the minting of new tokens to reserves, such systems enforce full collateralization, thereby reducing the risk of a stablecoin run. However, concerns about oracle risk remain; who audits the auditor, in other words? A possible solution here is to require decentralized consensus among oracles.[14]

Regulatory frameworks have also been proposed to address stablecoin devaluation risk. These frameworks potentially entail capital requirements, access to central bank liquidity facilities, and potential insurance for stablecoin users. Stablecoin issuers might be required to align with Basel regulations on capital requirements for banks.

Finally, alternative stablecoin designs are proposed to mitigate devaluation risks. These include tokenized deposits and reserve-backed tokens (RBTs). Tokenized deposits, as outlined by Garratt and Shin (2023), operate on a non-bearer instrument model, ensuring singleness of value within a platform by settling transactions on a central bank's balance sheet, eliminating credit exposures across institutions. Reserve-backed tokens, discussed by Goel (2024), involve issuers holding asset reserves with a central bank. RBTs promise financial stability, independence from custodians, and reduced risk through full backing by safe assets.

We provide additional detail on these risk management solutions in Appendix A.

2.4. Data

2.4.1. Network measures

Tables 2 and 3 present definitions and summary statistics for the variables used in our analysis. Network measures are from Coin Metrics, a blockchain data company providing transfer value and related variables for major cryptocurrencies. We classify transactions that are 'sent' as deposits, and transactions when the Treasury receives Tether as redemptions. We only consider Tether circulation net of supply held by the Treasury; this is labeled free float supply in the Coin Metrics database. We construct the measure of Tether in circulation for three blockchains that account for over 95% of Tether creation: Omni, Ethereum and Tron. For each platform, we utilize data on transactions of the Tether Treasury with secondary market wallets. Panel A of Figure 2 plots Tether supplied on each blockchain. While Tether was initially issued on the Omni blockchain, the two primary blockchains since 2019 have been Ethereum and Tron. Tether's move to the Ethereum and Tron blockchain is driven by several factors, including ability to serve a larger number of cryptocurrency investors, facilitate exchange with Ethereum (ERC20) and Tron (TRX) tokens, enable faster arbitrage opportunities, and reduce transaction costs.[15] Cryptocurrency exchanges like Bittrex and Huobi recognize the benefits of the Ethereum blockchain for Tether.[16]

In addition to the quantity of Tether in circulation, we employ a measure of velocity: the ratio of value transferred in the trailing year divided by the current supply at the end of the period. This can be thought of as turnover – as the number of times that an average native unit has been transferred in the past year. Panel B of Figure 2 plots velocity across all 3 blockchains, together with a value-weighted measure. As value on the Omni network declined, so did the velocity of transactions. In contrast, we see an increasing trend in velocity on the Tron blockchain, followed by an increase in the value-weighted measure.

2.4.2. Spot and futures prices

For USDT spot and futures prices, we draw data from Coinapi, which gives historical cryptocurrency OHLCV (Open, High, Low, Close and Volume) data through an API.[17] Prices for Tether futures are available from the FTX exchange from February 28th 2020 until June 18th, 2022.[18]

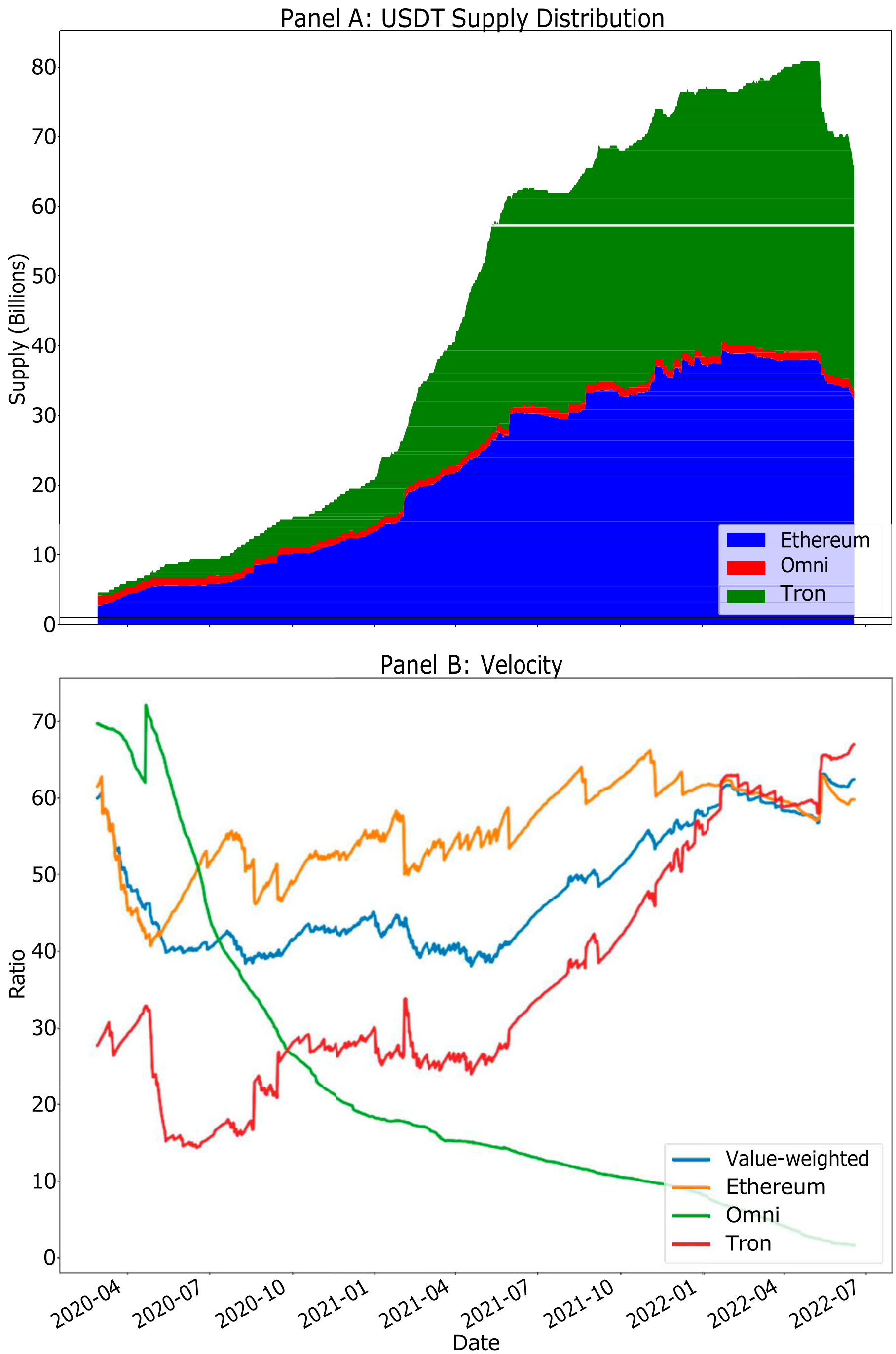

Figure 2. Stablecoin network characteristics.

Note: Panel A reports the total free float supply of Tether across blockchains Omni, Tron and Ethereum, in Billions USD. Panel B reports the velocity of Tether transactions on Omni, Tron and Ethereum blockchains. Free float supply is measured as Tether in circulation held by wallets net of Treasury balances. Velocity is defined as the ratio of the value transferred (i.e. the aggregate size of all transfers) divided in the last year to date. It can be interpreted as the number of times that an average native unit has been transferred in the past 1 year.

Table 2. Variables used in regression analysis.

Variable	Description
s	Closing spot price of USDT in units of USD.
f	Closing future price of USDT in units of USD.
$f_t - s_t$	The difference between spot and future price of USDT, referred to as the futures-spot basis.
$BidAsk_{px}$	The difference between bid and ask future price of USDT, referred to as the bid-ask spread, measured in basis points.
$\mathcal{P}_{baseline}$	The probability of default of USDT based on the baseline specification in Equation (6), measured in percentage points.
$\mathcal{P}_{lin}$	The probability of default of USDT based on linear interpolation, measured in percentage points.
Velocity	The ratio of the value transferred (i.e. the aggregate size of all transfers) divided in the last year to date. It can be interpreted as the number of times that an average native unit has been transferred in the past 1 year.
σ_{BTC}	BTC volatility, calculated as the square root of the sum of square hourly returns over a daily interval, measured in percentage points.
$D_{Redemption}$	Takes value of 1 if there is a decline in the free float supply of USDT compared to the previous day, and 0 otherwise.
i^{borrow}_{USDT}	USDT borrow rate (annualized). Value-weighted average of USDT rates on Compound and Aavev2, measured in percentage points.
i^{supply}_{USDT}	USDT supply rate (annualized). Value-weighted average of USDT rates on Compound and Aavev2, measured in percentage points.
FG_{index}	Crypto fear and greed index measures market sentiment by analyzing factors such as volatility, market volume, and social media.
i_{USD}	USD 3 month OIS interest rate, measured in percentage points.

Table 3. Summary statistics.

	Mean	Std	25%	50%	75%	Min	Max	Count
s (USD)	1.000	0.001	1.000	1.000	1.001	0.995	1.012	842
f (USD)	0.999	0.001	0.998	0.999	0.999	0.995	1.005	791
Basis (USD)	−0.002	0.001	−0.003	−0.002	−0.001	−0.012	0.004	791
$f_{bid}(USD)$	0.998	0.001	0.998	0.999	0.999	0.991	1.003	794
$f_{ask}(USD)$	0.999	0.001	0.998	0.999	1.000	0.995	1.007	794
$BidAsk_{px}$ (bps)	3.770	5.002	1.000	2.000	5.000	1.000	81.000	794
Volume (USDT Million)	0.345	1.420	0.000	0.031	0.197	0.000	26.861	792
$\mathcal{P}_{baseline}$ (%)	0.573	0.459	0.240	0.520	0.720	−0.000	2.160	791
$\mathcal{P}_{lin}$ (%)	0.621	0.506	0.240	0.600	0.771	−0.000	3.646	791
Velocity	48.072	7.834	40.917	44.580	56.405	38.000	63.105	842
$D_{Redemption}$	0.189	0.392	0.000	0.000	0.000	0.000	1.000	842
σ_{BTC} (%)	3.284	1.922	2.128	3.041	3.892	0.000	16.599	842
i^{USDT}_{borrow} (%)	4.911	3.221	3.321	3.979	4.891	2.244	36.808	318
i^{USDT}_{supply} (%)	3.620	2.839	2.051	2.917	3.830	1.024	32.093	318
FG_{index}	48.385	26.032	24.000	44.000	73.000	6.000	95.000	842
i^{OIS}_{USD} (%)	0.229	0.371	0.075	0.080	0.095	0.044	2.022	842
cip^{USDT}_{borrow} (%)	4.426	3.423	2.858	3.632	4.589	0.269	36.571	317
cip^{USDT}_{supply} (%)	3.139	3.057	1.582	2.575	3.540	−0.950	31.876	317

Closing futures prices are at a daily frequency. To control for futures prices approaching spot at the expiry of the contract, we create a constant maturity series by linearly interpolating between successive futures contracts. For spot prices the earliest historical series for Tether is obtained from the Kraken exchange, the most liquid exchange for spot USDT/USD trading, which is available from April 2017.

Figure 3 plots spot and futures prices, along with the basis, defined as the difference between futures and spot rates. The basis is typically negative, consistent with investors pricing devaluation risk. For market volatility risk, we use a measure of intra-day volatility for Bitcoin, calculated as the square root of the sum of squared hourly returns for each day, consistent with standard realized volatility measures.

2.4.3. Interest rates

For interest rates on Tether we use borrowing and lending rates from Compound and Aavev2, available from the Kaiko API, which provides data from August 5 2021.[19] These are the two major lending protocols during our sample period, and we use them to construct a value-weighted borrowing and lending interest rate for our

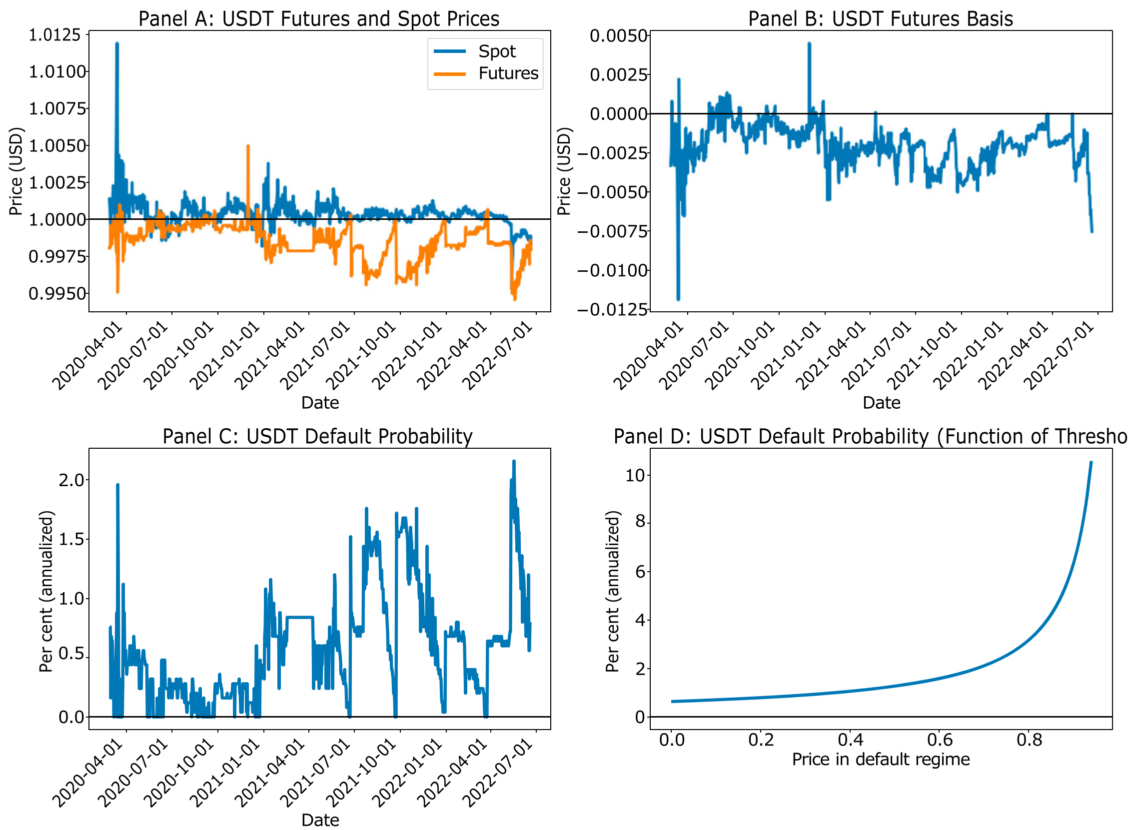

Figure 3. USDT futures and spot prices on FTX exchange.

Note: This figure presents time series of futures, spot and devaluation risk probabilities for the USDT/USD pair. Panel A reports USDT futures and spot prices on the FTX exchange. Panel B reports the difference between futures and spot prices, which is referred to as the basis. Panel C plots implied default probabilities based on spot, futures prices and the average mean reversion coefficient, for threshold value $\underline{s} = 0$ in default state. Panel D plots average default probability over the sample period conditional on different values of $\underline{s}$ in the default state. For panels A to C, the sample runs from February 28th, 2020, to June 18th, 2022.

analysis in Section 3. These rates are compounded every block (approximately every 15 seconds on the Ethereum blockchain) and are determined by the utilization percentage in the market, which is the percentage of the asset supplied to the protocol that is borrowed.[20] For money market rates, we use the 3 month USD OIS rate from Bloomberg. The 3 month maturity matches the term structure of 3 month futures USDT/USD contracts.

2.4.4. *Market sentiment*

To measure market sentiment, we use the Crypto Fear and Greed Index.[21] This is designed to quantify the emotional sentiment in the cryptocurrency market, specifically focusing on Bitcoin. The index is calculated on a scale from 0 to 100, where 0 indicates 'Extreme Fear' and 100 indicates 'Extreme Greed.'

The index combines data from five sources. Volatility, accounting for 25% of the index, compares Bitcoin's current volatility and maximum drawdowns against its 30- and 90-day historical averages to assess market fear. Market Momentum and Volume, also contributing 25%, evaluate daily trading activity relative to historical trends to identify market greed. Social Media, weighted at 15%, analyzes Twitter activity and engagement rates to measure public interest and sentiment. Dominance, comprising 10%, reflects Bitcoin's market cap dominance as an indicator of market fear or greed, particularly in relation to altcoins. Finally, Trends, making up the remaining 10%, leverages Google Trends data to track changes in search volumes for Bitcoin-related queries, signaling shifts in market sentiment.

3. Model and evidence

3.1. Model of devaluation risk

Our model of devaluation risk follows the literature that estimates the currency risk of the Hong Kong Currency Board (Blagov and Funke 2016; Drapeau, Wang, and Wang 2021; Schmukler and Servén 2002; Zhang and Drapeau 2022). Define s_t, f_t as the spot and futures rates, expressed as the dollar price of a unit of Tether. Assume that the spot price follows an AR(1) process with mean-reversion coefficient ρ in Equation (1).[22]

$$s_{t+1} = 1 + \rho(s_t - 1) + \epsilon_{t+1}, \quad 0 < \rho < 1 \tag{1}$$

Stability requires $\rho < 1$. The coefficient ρ provides an estimate of the half-life of the system.[23] The reduced form dynamics of the peg capture an arbitrage mechanism through which peg-price deviations are reduced and eliminated. Intuitively, a positive peg premium increases stablecoin supply through arbitrage flows, having a stabilizing effect on the price. Practically, half-life typically is short, 1 to 5 days for major stablecoins (Lyons and Viswanath-Natraj 2023).

The AR(1) process provides a tractable mapping between the spot price today and its value at expiry.[24]

At expiry $t+h$, the spot rate follows Equation (2). With probability $\mathcal{P}$, the stablecoin regime collapses, and the spot rate falls to $\underline{s} < 1$, with full default corresponding to $\underline{s} = 0$. With probability $1 - \mathcal{P}$, the spot rate is determined by iterating Equation (1) forward. In this case, the future spot price follows an exponential decay of peg-price deviations, incorporating a series of shocks discounted by the mean reversion coefficient ρ and a discounted sum of Tether-specific shocks ϵ_{t+s}.

$$s_{t+h} = \begin{cases} 1 + \rho^h(s_t - 1) + \sum_{s=1}^{h} \rho^{h-s}\epsilon_{t+s}, & \text{with probability } 1 - \mathcal{P} \\ \underline{s}, & \text{with probability } \mathcal{P} \end{cases} \tag{2}$$

Under the expectations hypothesis, the futures price for a contract expiring h periods from now is equal to the expectation of the spot rate h periods from now. The futures contract at expiry is given by Equation (3).

$$f_t = \mathbb{E}_t[s_{t+h}] \tag{3}$$

$$= (1 - \mathcal{P}) \times \left(\mathbb{E}_t[s_{t+h}]|\text{No Default}\right) + \mathcal{P} \times \left(\mathbb{E}_t[s_{t+h}]|\text{Default}\right) \tag{4}$$

$$= (1 - \mathcal{P}) \times \left(1 + \rho^h(s_t - 1)\right) + \mathcal{P} \times \underline{s} \tag{5}$$

Utilizing the probabilities of the 'default' and 'no-default' states, we can show that stablecoin futures equal the expected price.

The probability of a run is captured by Equation (6).

$$\mathcal{P}_t = \frac{1 + \rho^h(s_t - 1) - f_t}{1 + \rho^h(s_t - 1) - \underline{s}} \tag{6}$$

This probability can be estimated using observable spot and futures rates. It is decreasing in the futures rate and increasing in the spot rate. It is inversely related to the futures-spot basis $f_t - s_t$. As the horizon of the futures contract $h \to \infty$, when the exchange rate in the devaluation state is $\underline{s} = 0$ the equation simplifies to $\mathcal{P} = 1 - f_t$.

We show our measure of devaluation risk in Panel C of Figure 3.[25] There is significant time variation in the implied probability, with a peak of 2% (annualized). The two local peaks are the 'Black Thursday' March 12th, 2020 Crypto crash, when the prices of major currencies such as Bitcoin fell by 50%; and the TerraUSD crash on May 9th, 2022, when investors priced an increase in the probability of a Tether-de-pegging event. We discuss the TerraUSD crash further in Section 3.2.

In Panel D of Figure 3, we measure the average default probability conditional on different degrees of devaluation $\underline{s}$. The default probability has an average of 62 basis points for the baseline specification of $\underline{s} = 0$, suggesting there is an approximate 0.6% probability (annualized) of complete default. In contrast, the probability of partial default of 5% devaluation ($\underline{s} = 0.95$) is 12.4 percentage points annualized.[26]

Table 4. Determinants of probability of default.

	$\mathcal{P}$ (baseline)				$\mathcal{P}$ (linear interpolation)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Velocity	0.024∗∗∗			0.024∗∗∗	0.030∗∗∗			0.028∗∗∗
	(0.003)			(0.002)	(0.003)			(0.003)
σ_{BTC}		0.032∗∗∗		0.034∗∗∗		0.060∗∗∗		0.060∗∗∗
		(0.010)		(0.009)		(0.015)		(0.012)
$D_{redemption}$			0.227∗∗∗	0.078∗			0.357∗∗∗	0.169∗∗∗
			(0.052)	(0.047)			(0.069)	(0.053)
$BidAsk_{px}$	−0.004	−0.005	−0.003	−0.005	−0.007∗	−0.008	−0.005	−0.007∗
	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Intercept	0.577∗∗∗	0.486∗∗∗	0.540∗∗∗	0.451∗∗∗	0.633∗∗∗	0.455∗∗∗	0.569∗∗∗	0.404∗∗∗
	(0.025)	(0.042)	(0.030)	(0.036)	(0.027)	(0.051)	(0.029)	(0.045)
R-squared	0.176	0.022	0.040	0.205	0.212	0.059	0.082	0.292
Nr. obs.	791	791	791	791	791	791	791	791

Note: This table uses a regression analysis to identify determinants of USDT default probability. Columns (1) to (4) use the baseline value of devaluation risk estimated in Equation (6). Columns (5) to (8) use a measure of devaluation risk based on linear interpolation of futures contracts. Both measures are measured in percentage points. *V elocity* is the ratio of the value transferred (i.e. the aggregate size of all transfers) divided in the last year to date, with the mean subtracted to account for average activity. It can be interpreted as the number of times that an average native unit has been transferred in the past year, relative to the mean. σ_{BTC} is the intra-day volatility of BTC, measured in percentage points. $D_{redemption}$ is equal to 1 if there is a decline in the free float supply of USDT compared to the previous day, and 0 otherwise. $BidAsk_{px}$ measures the bid-ask spread of the USDT-USD 3 month futures contract, reflecting its market liquidity, in basis points. The sample specification is from February 28th, 2020, to June 18th, 2022. Newey-West standard errors, which adjust for heteroscedasticity and autocorrelation, are reported in parentheses. ∗∗∗ denotes significance at the 1 percent level, ∗∗ at the 5 percent level, and ∗ at the 10 percent level.

3.2. Correlates of run risk

We test for the determinants of the probability of a stablecoin devaluation using Equation (7). Explanatory variables include network measures such as the rate of turnover (also referred to as monetary velocity). For this analysis, velocity is de-meaned, meaning the average velocity over the sample period is subtracted from daily observations. Proxies for market volatility includes a measure of intra-day volatility of Bitcoin. Finally, we consider a variable capturing periods of net redemptions of Tether, that is, periods when the supply of Tether (net of Treasury) falls.

$$\mathcal{P}_t = \beta_0 + \beta_1 Velocity_t + \beta_2 \sigma_{BTC\,t} + \beta_3 D_{redemption_t} + \epsilon_t \tag{7}$$

Table 4 presents the results. Columns (1) to (4) use the baseline measure of devaluation risk based on Equation (7). Columns (5) to (8) use the devaluation risk measure based on linear interpolation of futures contracts. Our findings are robust to using both devaluation risk measures. Velocity is positively associated with devaluation risk. In our full specifications in columns (4) and (8), a unit increase in velocity increases the devaluation risk measures by 2.4 and 2.8 basis points respectively. This result is suggestive of the central role of trading intensity in signaling run risk, as heightened velocity reflects periods of increased market activity, potentially associated with investor concerns about the coin's stability or panic-driven attempts to redeem at par.

In addition, devaluation risk is associated with high Bitcoin volatility. Periods of high Bitcoin volatility can increase devaluation risk due to investor concerns about the role of Tether as a vehicle for transactions in Bitcoin and related cryptocurrencies. In columns (4) and (8), a 1 percentage point increase in Bitcoin volatility increases the devaluation risk measures by 3.4 and 6.0 basis points respectively. Finally, we control for the redemption behavior of investors. We find that periods of redemptions are associated with an increase in devaluation risk. Based on our full specifications in columns (4) and (8), such periods are associated with an 7.8 and 16.9 basis point increase in our measures of devaluation risk.

To further explore the relative importance of these predictors, we conducted an ANOVA for both our baseline and linear interpolation measures of devaluation risk in Appendix C. The results show that velocity is the most important driver, explaining 14.8% and 16.1% of the variation, respectively. This highlights the critical role of trading intensity in signaling run risk. Elevated velocity likely reflects heightened market uncertainty, as investors rebalance portfolios or rush to redeem stablecoins amid concerns of overvaluation or peg instability.

By comparison, market volatility explains 1.8% and 5.0%, while redemption activity contributes 3.2% and 6.2% of the explained variation. The relatively lower contribution of market volatility aligns with Tether's limited exposure to Bitcoin price fluctuations, which, based on public attestations, accounts for approximately 2% of its total assets. Furthermore, Bitcoin volatility can also coincide with favorable market conditions, driving up Tether usage as a vehicle currency, thereby mitigating negative pressure on the peg.

Redemption activity, while a direct signal of liquidity stress, explains a modest share of variability, partly due to its infrequent occurrence. The mean value of the redemption indicator in our sample is 0.19, indicating that only 19% of days feature net redemptions. Moreover, not all redemption episodes reflect concerns about peg sustainability; some may simply indicate reduced transactional demand for Tether as a vehicle currency in periods of subdued trading activity.

Overall, these findings align with theoretical models of stablecoin devaluation risk (Bertsch 2023; d'Avernas, Maurin, and Vandeweyer 2022; Gorton, Klee, et al. 2022; Li and Mayer 2022; Routledge and Zetlin-Jones 2022), which emphasize the importance of cryptocurrency-related fundamentals. Trading intensity emerges as the dominant predictor, suggesting that heightened activity serves as an early warning signal of run risk.

3.2.1. Case study: the May 9th, 2022, TerraUSD crash

TerraUSD is an algorithmic stablecoin backed by Luna, the native token of the Terra blockchain. (In other words, TerraUSD is not collateralized by dollar reserves. The TerraUSD treasury also holds reserves of Bitcoin for use in extremis, but only limited amounts.) TerraUSD is pegged to 1 USD by arbitrage. When the price of TerraUSD is above par, an investor can sell 1 USD worth of Luna and buy TerraUSD for 1 USD, and then sell TerraUSD in the secondary market for an arbitrage profit. Conversely, when the dollar price of TerraUSD is below one, an investor can buy TerraUSD on the exchange and sell TerraUSD for 1 USD worth of Luna tokens.

This arbitrage is not risk-free: investor profits are driven by expectations of the valuation of the governance token. It follows that algorithmic stablecoins such as TerraUSD are subject to instability (Briola et al. 2023; Jiageng Liu, Makarov, and Schoar 2023; Ma, Zeng, and Zhang 2023; Uhlig 2022). An instance of this problem was in May 2022, when TerraUSD traded at a large discount from the peg. This in turn triggered a loss of confidence in the blockchain and the governance token, resulting in a spiral of falling Luna and TerraUSD prices. The TerraUSD treasury's Bitcoin reserve was fully depleted.

Although design features affecting the TerraUSD peg were not shared by other stablecoins such as Tether, Tether fell to 95 cents USD intra-day on May 12th, 2022, three days after the initial TerraUSD collapse. This may have indicated investor expectations of reduced utility of stablecoins for cryptocurrency transactions. In addition, Liao (2022) documents a shift from Tether toward USDC, an alternative stablecoin with more transparent and extensive backing, suggestive of investor search for greater transparency and security.

Figure 4 shows the dynamics of Tether spot and futures prices, the implied probability of default, and various network characteristics around the event. While there was a decline in spot prices, futures prices fell by more and did not rebound as quickly. The implied probability of Tether default rose to 200 basis points annualized. The basis (futures less spot) took weeks to recover to levels prevailing prior to the TerraUSD collapse.

In addition there was an increase in Tether velocity and a consequent decline in the measure of free float supply of Tether in circulation. As investors exited, redemptions were required to stabilize the peg. The increase in velocity presumably reflected a tendency for investors to rebalance their portfolios toward other stablecoins such as USDC, consistent with the narrative in Liao (2022).

In the face of this negative shock, supply should be reduced commensurate with demand, and redemption mechanisms should operate so as to return the price to par. Following the de-pegging event, we in fact observe a -10 USD Billion change in the supply of Tether in circulation. This redemption mechanism is analogous to how a central bank defends an exchange rate peg. When the peg trades at a discount to par, arbitrageurs have an incentive to buy Tether in the secondary market and redeem at the Treasury at par. The consequent reduction in stablecoin supply stabilizes the price in the secondary market. However, limits to redemptions, such as fees and minimum withdrawals, can lead to inefficiency of this process.[27]

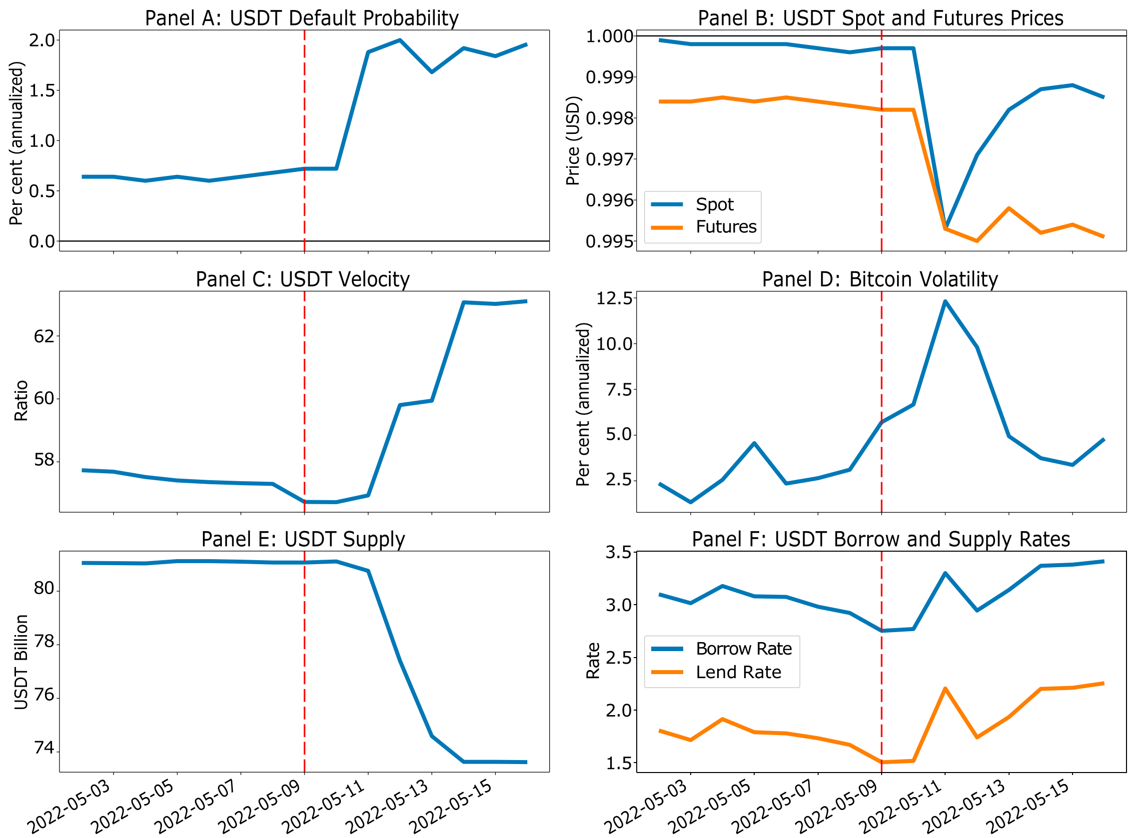

Figure 4. Event study: USDT peg collapse May 2022.

Note: This figure presents event study results for various variables during a window of one week before and after the USDT peg collapse in May 2022. The vertical dotted line marks the beginning of the Terra Luna crash on May 9th, 2022, with the USDT peg collapse occurring on May 12th, 2022. Panel A shows the USDT default probability, while Panels B, C, and E display USDT spot prices, velocity, and supply, respectively. Panel D reports Bitcoin volatility. Panel F presents USDT borrow and supply rates, calculated as value-weighted averages from Compound and Aavev2, based on the aggregate liquidity supplied in each protocol.

3.2.2. Case study: March 11th, 2023, the USDC de-pegging event

A second case is the USDC de-pegging event in March 2023, when Silicon Valley Bank, which held reserves for USDC, went bankrupt. USDC reportedly held some 3.3 USD billion of cash reserves at SVB. The run on SVB caused investor concern about whether these reserves would be lost, since they far exceeded the cap on federal deposit insurance. In turn this spawned questions about whether or not the coin was still fully backed. USDC fell to 87 cents on March 11th. Prices then stabilized on March 13th, when the Federal Deposit Insurance Corporation (FDIC) had announced that all deposits at SVB would be fully guaranteed and available, and USDC transferred its reserves to other banking partners.[28]

Although we lack futures data for the USDC stablecoin during this period, we can still assess the external validity of our interpretation by examining the behavior of related variables depicted in Figure 5. Using the estimated specification in Equation (6), we construct a counterfactual measure of USDC devaluation risk based on observables such as velocity, market volatility, and redemption behavior. We assume that these variables relate to USDC devaluation risk in a manner similar to Tether.

Our devaluation risk measure, in Panel A, shows an increase of up to 50 basis points following the USDC de-pegging event on March 11th, 2023. This rise in imputed devaluation risk coincides with a significant increase in velocity, indicating intensified secondary market trading as investors sought to exchange USDC for USD reserves. In the subsequent weeks, redemptions reduced the free float supply of USDC from 40 billion USD

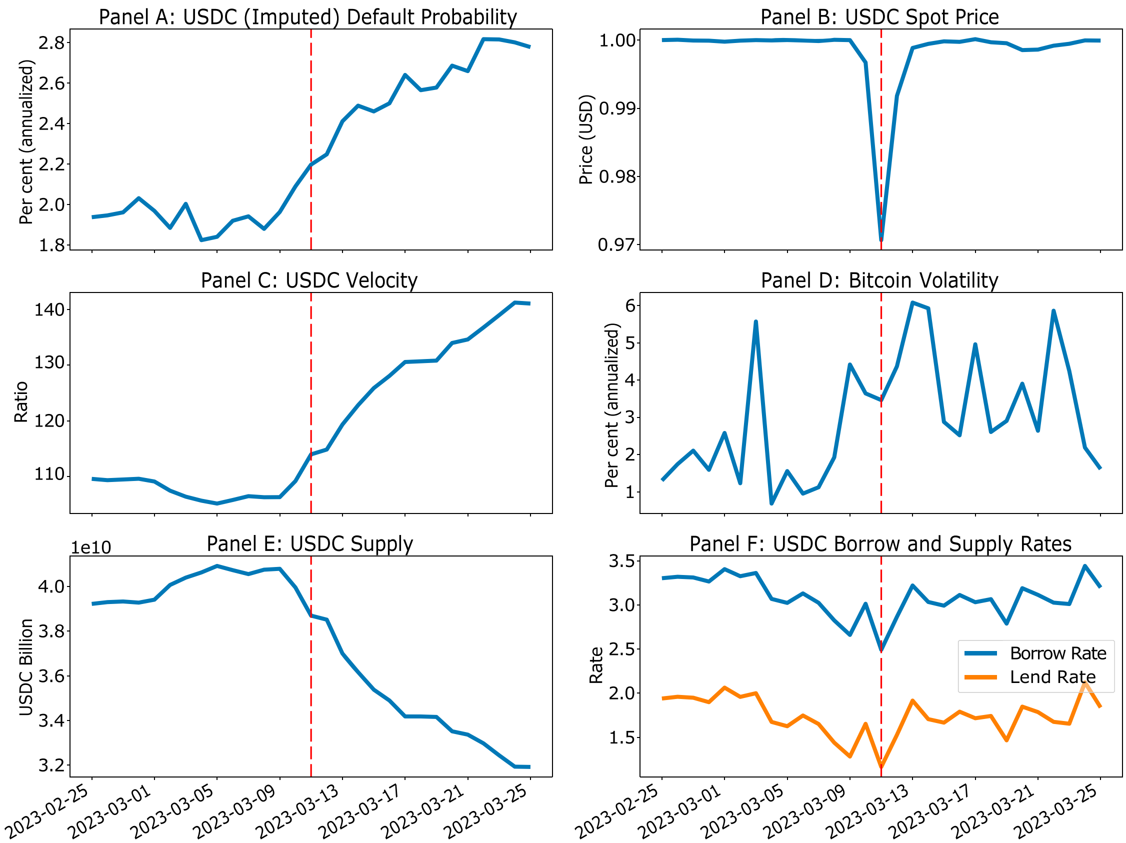

Figure 5. Event study: USDC crash March 2023.

Note: Figure reports event study for various variables during a window of 1 week before and after the USDC peg collapse in March 2023. The vertical line is the day of USDC peg collapse, which is 11th March 2023. Panel A plots the USDC imputed default probability, based on observables of USDC velocity, redemptions and Bitcoin volatility. USDC spot prices, velocity and supply are reported in Panels B, C and E. Bitcoin volatility is reported in Panel D. USDC borrow and supply rates are reported in Panel F, which are value-weighted average of rates in Compound and Aavev2 based on the aggregate liquidity supplied in each protocol.

to 32 billion USD, akin to the redemptions during Tether's de-pegging in May 2022. These actions helped to stabilize USDC's secondary market value at par by exerting upward pressure on prices.

The impact of market volatility was temporary and limited to the USDC peg without affecting the broader cryptocurrency market. During the de-pegging event, the substitutability between stablecoins played a crucial role, as noted by Oefele, Baur, and Smales (2024b). Investors transitioned to Tether, which has less exposure to U.S. banks, thereby limiting contagion from USDC's de-pegging to the broader market.

In sum, these patterns suggest a narrative consistent with the Tether de-pegging event discussed earlier.

3.2.3. USDT quarterly attestation reports

Understanding the impact of Tether's quarterly attestations is crucial for assessing the transparency and solvency of stablecoins. These attestations serve as key market signals, indicating whether Tether's reserves adequately back its token liabilities. Related literature on transparency measures and regulatory reporting suggests that such disclosures improve peg stability and increase issuance, as observed in data for five major stablecoins (Maex and Slavov 2024). Therefore, we hypothesize that the release of attestation reports reduces perceived devaluation risk by providing information on the stablecoin issuer's solvency.

Appendix E summarizes Tether's attestation history from Q1 2021 onward. Initially conducted by Moore Cayman and later by BDO, these attestations reflect increasing transparency, including significant reductions in commercial paper holdings and greater allocations to U.S. Treasuries. Recent reports also disclose alternative asset holdings, such as cryptocurrencies and gold, and highlight growing excess reserves and profitability.

An event study in Appendix E examines how devaluation risk responds to attestation releases. While immediate effects are negligible, we observe a gradual decline in devaluation risk in the weeks following each release, particularly during periods of balance sheet improvements (e.g. the reallocation to U.S. Treasuries from Q2 2021 to Q1 2022). However, the results suggest a delayed market reaction, potentially due to staggered news dissemination.

Despite these findings, concerns remain regarding the reliability of attestation reports. As point-in-time assessments, attestations confirm reserve sufficiency only at a specific date, leaving questions about the issuer's ongoing solvency. The absence of a standardized performance framework makes it difficult to assess the level of assurance and extent of work performed. As a result, regulators have cautioned investors against relying on attestation reports (Maex and Slavov 2024). Alternative transparency measures, such as Chainlink's proof of reserve, are discussed further in Appendix A.

3.3. Interest rates and devaluation risk

We now examine the determinants of interest rates and whether devaluation risk is priced. If stablecoins are subject to devaluation risk, it should be reflected in higher stablecoin interest rates. To test this, we analyze the determinants of Tether borrowing and lending rates using Equation (8). This specification regresses stablecoin interest rates on two measures of devaluation risk: the baseline measure and the linear interpolation measure. In controlled specifications, we also include the Crypto Fear and Greed Index (capturing market sentiment toward risky cryptocurrencies) and the USD 3-month OIS rate as a proxy for money market conditions.

$$i_{USDT,t} = \beta_0 + \beta_1 \mathcal{P}_t + \beta_2 FG_{index,t} + \beta_3 i_{USD,t} + \epsilon_t \tag{8}$$

Table 5 presents the results. Columns (1)–(4) use the USDT supply rate as the dependent variable, while columns (5)–(8) analyze the USDT borrow rate. Devaluation risk, measured using both the baseline and linear interpolation methods, is consistently priced into both supply and borrow rates. In the baseline specifications without controls (columns 1 and 5), a 1 percentage point increase in the baseline devaluation risk measure is associated with a 1.11 and 1.25 percentage point increase in the USDT supply and borrow rates, respectively. Adding controls (columns 2 and 6) reduces these estimates to 0.51 for supply rates and 0.58 for borrow rates, though they remain statistically significant. The linear interpolation measure yields similar results (columns 3, 4, 7, and 8), with coefficients ranging from 0.64 to 0.84. These findings indicate that stablecoin interest rates reflect compensation for devaluation risk, aligning with Gorton, Klee, et al. (2022), who argue that stablecoin rates compensate for leveraged positions.

The inclusion of controls provides further insight into the role of broader market conditions. While devaluation risk is priced in interest rates, an ANOVA estimation (Appendix C) shows that market sentiment explains 21–23% of the variation in value-weighted borrowing and supply rates. In contrast, devaluation risk accounts for only 3.5%, and money market rates explain no more than 1%, with the remaining variation unexplained. Some of this unexplained variation may stem from liquidity mining programs, which incentivize investors to supply and borrow stablecoins through governance token rewards (Park and Stinner 2023). These incentives can distort stablecoin rates, causing deviations from traditional money market dynamics.

Market sentiment, as proxied by the Crypto Fear and Greed Index, is positively associated with interest rates, consistent with traders borrowing stablecoins to finance speculative positions during periods of optimism (Barbon, Barthelemy, and Nguyen 2023; Chaudhary, Kozhan, and Viswanath-Natraj 2023; Cornelli et al. 2024; Gorton, Klee, et al. 2022). This behavior aligns with studies showing how lending protocols are used to borrow stablecoins for leveraged trading in financial markets. As traders increase borrowing to finance such positions during periods of optimism, borrowing demand rises, driving up stablecoin interest rates.[29]

Money market rates, however, exhibit a negative relationship with stablecoin interest rates in our sample, suggesting frictions in the integration between traditional money markets and DeFi platforms. While perfect integration would imply a one-for-one pass-through between USD risk-free rates and stablecoin interest rates,

Table 5. USDT interest rates and devaluation risk.

	i^{USDT}_{supply}				i^{USDT}_{borrow}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathcal{P}$ (baseline)	1.109∗∗∗	0.511∗			1.254∗∗∗	0.576∗		
	(0.427)	(0.301)			(0.482)	(0.347)		
$\mathcal{P}$ (linear interpolation)			0.643∗	0.745∗∗∗			0.752∗	0.836∗∗∗
			(0.370)	(0.237)			(0.412)	(0.270)
FG_{Index}		0.051∗∗∗		0.049∗∗∗		0.057∗∗∗		0.055∗∗∗
		(0.009)		(0.009)		(0.011)		(0.011)
i_{USD}		−0.817∗∗∗		−1.079∗∗∗		−0.802∗∗∗		−1.094∗∗∗
		(0.198)		(0.214)		(0.222)		(0.243)
Intercept	2.681∗∗∗	1.566∗∗∗	3.016∗∗∗	1.508∗∗∗	3.849∗∗∗	2.558∗∗∗	4.204∗∗∗	2.494∗∗∗
	(0.305)	(0.411)	(0.295)	(0.384)	(0.342)	(0.465)	(0.326)	(0.435)
R-squared	0.036	0.279	0.015	0.289	0.035	0.259	0.016	0.269
Nr. obs.	317	317	317	317	317	317	317	317
Controls	✗	✓	✗	✓	✗	✓	✗	✓

Note: This table presents a regression analysis of the determinants of USDT interest rates. Columns (1)–(4) report results for supply rates, and (5)–(8) for borrow rates. Rates are value-weighted averages from Aavev2 and Compound. $\mathcal{P}$ measures devaluation risk. Standard errors are Newey-West robust. $***\ p < 0.01$, $**\ p < 0.05$, $*\ p < 0.1$.

our results suggest otherwise. Stablecoin rates appear to operate in a segmented market, disconnected from conventional financial markets.[30]

Appendix D provides protocol-specific results for Compound and Aave v2, which confirm that devaluation risk is a key driver of stablecoin interest rates on both platforms. The effects are generally stronger for Compound, reflecting differences in liquidity conditions and investor behavior across the two protocols.

3.4. Deviations from CIP

Our analysis so far documents the disconnect between interest rates and futures prices in the stablecoin market on the one hand, and conditions in conventional financial markets on the other. To test integration between markets more concretely, we can measure deviations from CIP.

We use borrowing and lending rates for Tether, on DeFi lending protocols such as Compound and Aave, together with futures contracts to investigate the existence of such deviations. Equivalently, we can use them to construct the risk premium of holding Tether instead of the USD after hedging the exchange rate risk. The deviation from CIP is computed as in Equation (9). It is the difference between a synthetic dollar rate $i_{\$,t}^{synthetic}$ and a direct dollar rate $i_{\$,t}$. The synthetic dollar rate can be constructed by converting dollars to Tether at spot rate s_t, lending Tether at $i_{usdt,t}$, and then re-converting Tether to dollars at maturity at the forward rate f_t. The horizon h is set at 90 days (3 months) for our analysis.

In a frictionless setting, we would expect interest rates to be equalized after hedging exchange risk using a futures contract. Therefore, the benchmark for efficient interest rate markets suggests that CIP deviations should be zero or within bounds governed by transaction costs such as gas fees (fees users pay to process transactions or use smart contracts) on the Ethereum blockchain.

$$CIP_t = i_{\$,t}^{synthetic} - i_{\$,t} \tag{9}$$

$$= \left(\left(\frac{f_t}{s_t}\left(1 + i_{usdt,t}\frac{h}{360}\right) - 1\right) \times \frac{360}{h} - i_{\$,t}\right) \times 100 \tag{10}$$

Figure 6 plots the CIP deviation (along with the synthetic dollar interest rate and direct dollar rates). Deviations are persistently positive. The average CIP deviations based on borrowing and supply rates are 4.43 and 3.14 percentage points respectively. These indicate the existence of a risk premium embedded in stablecoin rates even after controlling for exchange risk using a futures contract. Note that the deviation narrows somewhat in the second half of the sample period, and is negative for CIP deviations based on supply rates towards the end of our sample.

3.4.1. Limits to arbitrage in CIP trade

Our explanation for the weak integration between stablecoin and traditional interest rates has primarily focused on market segmentation and the influence of leveraged trading on lending protocols. We now consider a second source of friction: limits to arbitrage in these markets. In a classic CIP arbitrage trade, money market rates in two currencies must share the same maturity. However, while money market rates are fixed for specific maturities, interest rates on lending protocols lack a term structure; interest accrues approximately every 15 seconds in block time on the Ethereum blockchain.

Because Tether interest rates are not fixed at a 3-month term like USD money market rates, there is no risk-free arbitrage profit in a standard CIP trade. To construct a synthetic dollar interest rate, an investor would need to lock funds in Tether for 3 months before reconverting to dollars at a forward rate, relying on the expected interest rate over that period. The positive premium on stablecoin rates over money market rates may partly reflect this interest rate risk.

Arbitrage between stablecoin interest rates and money market rates entails transaction costs, given the need to move capital from financial intermediaries to DeFi platforms. These costs include gas fees, as noted above, analogous to commissions paid on exchanges. In this case these costs are paid to validators authenticating transactions on the Ethereum blockchain. Other costs of providing liquidity to stablecoin markets can include costs of liquidating debt. In addition there is the cost of supporting an off-ramp from Tether to USD in order to conduct

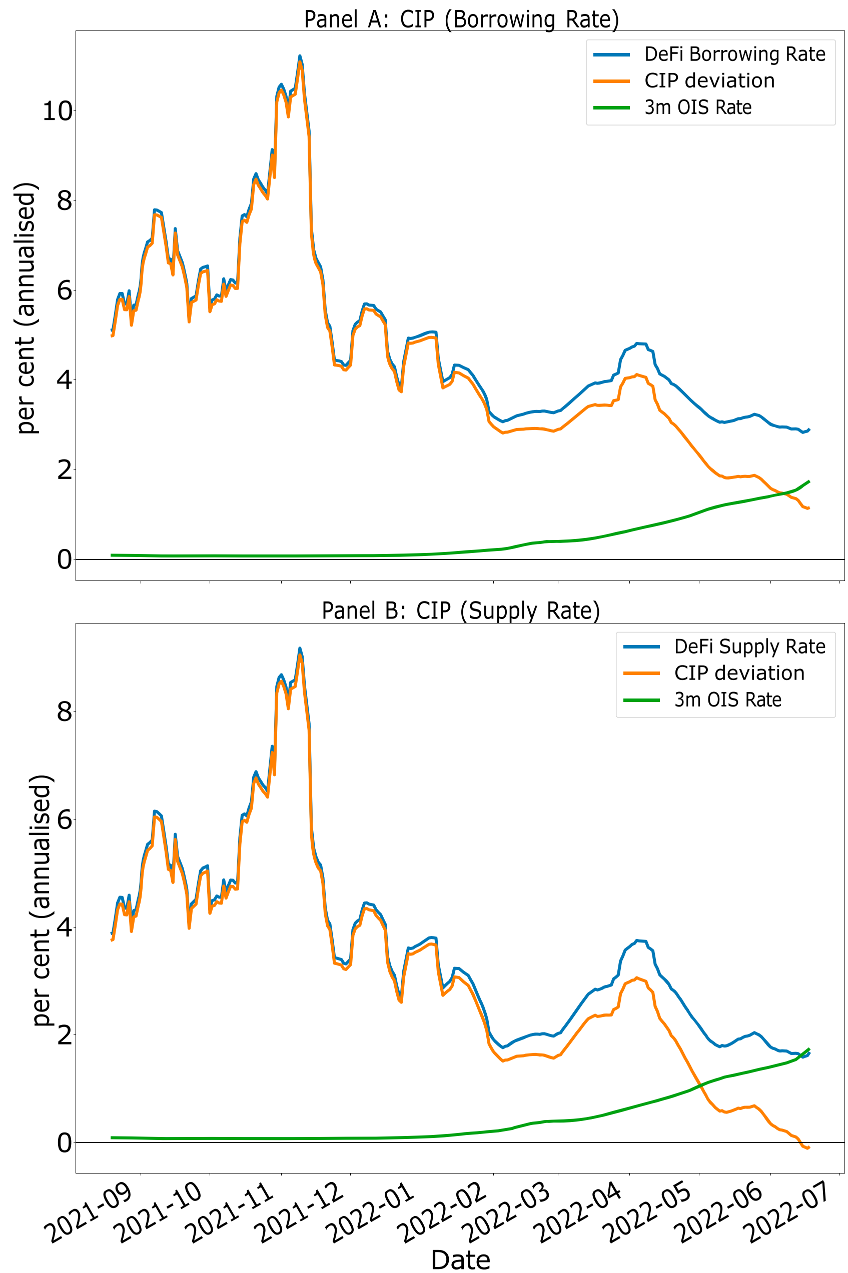

Figure 6. Money market, stablecoin rates and deviations of CIP.

Note: Figure plots USDT supply and borrow rates, USD money market (3m OIS) and CIP deviations. Panel A measures CIP deviations based on borrow rates, and Panel B measures CIP deviations based on supply rates. CIP deviations are equal to the difference between stablecoin and USD rates after hedging exchange rate risk with a futures contract. All rates are a 14 day rolling average, and annualized. The sample runs from August 5th 2021 to June 18th, 2022.

a round-trip arbitrage trade. Retail investors need to access spot markets in USDT/USD on centralized cryptocurrency exchanges like Bitfinex. Processing lags for withdrawals of dollars on these exchanges are substantial, and fees are imposed when dollar withdrawals are frequent or large.[31] Finally, counterparty risk on a futures exchange, including the risk of liquidations due to not posting sufficient margin, can also be a limit to arbitrage. This has been documented specifically for the BTC/USD pair (Schmeling, Schrimpf, and Todorov 2023).

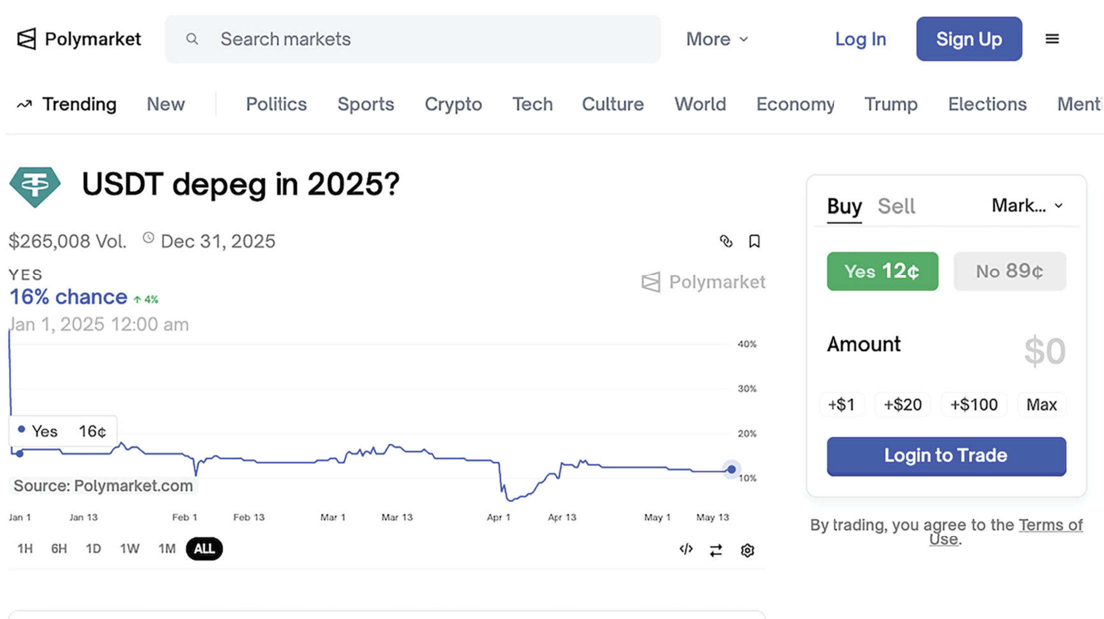

Figure 7. Polymarket-implied probabilities of USDT de-pegging in 2025.

Note: Figure plots the daily price of the Polymarket prediction contract on whether Tether (USDT) will de-peg from the U.S. dollar in 2025. The contract resolves to 'Yes' if, at any time in 2025, all 1-minute Coinbase USDT-USD candles within a 24-hour period close below 98 cents. Prices are interpreted as market-implied probabilities. Data accessed from Polymarket: https://polymarket.com/event/usdt-depeg-in-2025.

3.5. Robustness tests

3.5.1. Market-based measure of partial default: comparison with polymarket

While our baseline estimates focus on the probability of full default ($\underline{s} = 0$), our framework also yields materially higher probabilities of partial default. As shown in Panel D of Figure 3, the estimated probability of a 5% devaluation–that is, Tether trading at or below 95 cents–is 12.4 percentage points on an annualized basis.

These estimates are broadly comparable to other market-based indicators of partial default risk. For example, Polymarket has recently launched a prediction market on the likelihood of Tether de-pegging in 2025.[32] The contract pays out if USDT trades below 98 cents for an entire 24-hour period on Coinbase at any point during 2025.[33]

When the market opened on January 1, 2025, the implied probability of de-pegging was 16% (Figure 7). By the end of March 2025, the price of a 'YES' token had declined to 14 cents, implying an annualized probability of approximately 18%. By comparison, our model yields an estimated devaluation probability of 31.1% annually when the threshold is set to $\underline{s} = 0.98$. While this suggests that Polymarket may be underpricing the risk of partial default, we caution that the resolution criteria used by Polymarket are relatively strict: the payout condition requires all trading intervals within a 24-hour period to remain below the 98 cent threshold. This restriction implies that transient deviations below parity–followed by quick reversion–would not trigger a payout. Our estimate, by contrast, captures the average pricing of devaluation risk over time and is sensitive to any observed discount, regardless of its persistence. This helps explain the differences between our estimates and those implied by the Polymarket trading platform.

3.5.2. USDT perpetual futures and devaluation risk

While the analysis so far has focused on the USDT/USD three-month futures contract to measure devaluation risk, another contract traded on the FTX exchange during this period is the USDT/USD perpetual futures contract. Perpetual futures provide a novel framework for evaluating devaluation risk, leveraging their absence of expiry dates and the use of funding rates to align futures prices with spot prices. These unique features make perpetual futures a valuable tool for gauging market sentiment in cryptocurrency markets (Chaudhary, Kozhan, and Viswanath-Natraj 2023; Gorton, Klee, et al. 2022).

Appendix F utilizes the funding rate as an alternative proxy for measuring devaluation risk. Compared to three-month futures contracts, perpetual futures exhibit closer alignment with spot prices and significantly higher average daily trading volumes of 11.24 million USD. During periods of market stress, such as the Terra-Luna crash in May 2022, perpetual futures markets displayed heightened trading activity, more pronounced negative funding rates, and a decline in the futures-spot basis. These negative funding rates reflect increased market pessimism about the stability of the USDT peg, contributing to heightened devaluation risk.

A robust negative correlation is identified between funding rates and devaluation risk derived from three-month futures contracts. Higher funding rates, indicative of greater confidence in the USDT/USD peg, correspond to lower devaluation risk. Additionally, we find the correlates of the funding rate include USDT velocity, Bitcoin volatility, and redemption activity, which are identified as determinants driving devaluation risk observed in the analysis of three-month futures contracts in Section 3.2.

3.5.3. USDC perpetual futures and devaluation risk

A similar robustness test is performed using USDC/USD perpetual futures, introduced on the Kraken exchange in late 2023. Perpetual futures for USDC share the same structural features as USDT perpetual futures, with funding rates serving as a mechanism to align futures prices with spot prices and as an indicator of market sentiment.

Appendix G provides a detailed analysis of USDC perpetual futures. These markets exhibit significantly lower liquidity, with average daily trading volumes of just 3920 USD compared to USDT's 11.24 million USD. Additionally, USDC funding rates are more volatile, averaging −0.15%.

The determinants of USDC funding rates are less robust. Velocity remains a significant factor, but Bitcoin volatility shows weak significance, and redemption activity does not meaningfully affect funding rates. These differences arise due to several factors. First, USDC markets are far less liquid, limiting price discovery and market efficiency. Second, USDC maintained a stable peg throughout the sample period (December 2023 to December 2024), with minimal redemption activity or market stress. Third, the asset composition of USDC reserves is substantially different. USDC reserves are fully backed by highly liquid assets such as U.S. Treasury securities, repurchase agreements, and segregated cash, ensuring stronger market confidence.[34]

In contrast to USDT, the absence of significant market stress events for USDC reduces the explanatory power of funding rate determinants. This suggests that, for USDC, our measure of devaluation risk is less informative under the relatively stable market conditions observed during the sample period.

4. Conclusion

4.1. Summary

Stablecoins are integral to the cryptocurrency ecosystem, facilitating the purchase and sale of cryptoassets at lower cost than national currencies and serving as vehicles for remittances and cross-border transactions. Popular stablecoins depend on centralized custodians holding assets off-chain. When collateralization is partial and less liquid, this can prompt mass withdrawals, risking suspension of convertibility and collapse of the peg.

This paper presents a market-based measure of devaluation probabilities using futures for Tether, the dominant stablecoin. On average, the probability of full default, defined as a complete collapse of the peg, is priced at 60 basis points annually, with significant time variation that can spike during periods of stress. We also quantify partial default risk, estimating an annualized probability of 12.4 percentage points for a 5% devaluation (i.e. trading at or below 95 cents).

Several factors contribute to devaluation risk, including market risks like BTC volatility and network characteristics such as transaction velocity and investor redemptions, which can lead to run-like behavior on stablecoins.

Stablecoin interest rates price devaluation risk. However, we identify a disconnect between stablecoin markets and traditional financial markets. Stablecoin rates are more influenced by market sentiment and devaluation risk than by conventional money market rates. Even after hedging exchange rate risk using futures contracts, stablecoin rates remain systematically higher, violating CIP. Factors contributing to the weak integration of stablecoin and traditional markets include market segmentation, lack of term structure in DeFi interest rates, and transaction costs of arbitrage.

Our findings are robust to alternative specifications, including the use of perpetual futures and comparison with market-based probabilities from Polymarket.

4.2. *Policy implications*

While stablecoins primarily facilitate leveraged trading within cryptocurrency markets, their broader adoption for cross-border and financial transactions could significantly impact traditional financial markets, raising concerns for investors, regulators, and policymakers.

For investors, our work highlights the importance of understanding run-risk determinants and addressing frictions in segmented money markets that contribute to stablecoin vulnerabilities. Enhancing redemption processes and integrating stablecoin interest rate markets more effectively would attract arbitrage capital, helping to maintain the peg. Tracking devaluation risk offers a practical way to assess stablecoin stability and guide investment decisions.

For regulators, our findings emphasize the need for a robust framework to address systemic risks.[35] Europe's MiCA, introduced in December 2024, takes steps toward this goal by imposing strict reserve management requirements, enhancing transparency, and mandating operational and prudential standards for issuers. By clarifying the treatment of crypto-assets and custodial risk, it aims to reduce vulnerabilities in the stablecoin ecosystem.

While MiCA provides a strong regulatory foundation, private-sector innovations can enhance stability and trust. For example, TrueUSD's real-time reserve audits via Chainlink, implemented in February 2023, ensure that new tokens are issued only when reserves are verified. Such initiatives provide practical models for improving governance in the stablecoin ecosystem.

Further measures could include capital requirements, central bank support, or insurance mechanisms to protect users. Policymakers might also encourage alternative stablecoin designs, such as tokenized deposits or reserve-backed tokens, which combine central bank-backed stability with private digital currency features, addressing liquidity and redemption risks (Garratt and Shin 2023; Goel 2024).

Notes

1. https://www.chainalysis.com/blog/stablecoins-most-popular-asset/
2. https://www.theblock.co/post/329947/stablecoin-market-cap-200-billion-usd
3. We discuss these different types of stablecoin risks in Section 2 more thoroughly. These include custodial risk, where centralized issuers may mismanage or abscond with reserve funds; devaluation risk, arising from insufficient or illiquid reserves backing the stablecoin; systemic risk, where stablecoin usage increases risk exposures of financial intermediaries, potentially leading to fire sales of collateral; and payment risk, where entities with stablecoin-denominated receivables are exposed to devaluation in much the same way firms are exposed to exchange rate risk when liabilities are denominated in foreign currencies (Eichengreen, Hausmann, and Panizza 2007).
4. For the full press release, see https://www.esma.europa.eu/press-news/esma-news/esma-releases-last-policy-documents-get-ready-mica. MiCA includes measures to enhance transparency, prevent market abuse, and regulate custodial risks associated with stablecoins, thereby reducing their potential systemic impact.
5. In late 2023, USDC perpetual futures began trading, and we discuss our findings in a robustness test in Appendix F.
6. Large deposit outflows have similarly been implicated in the run on Silicon Valley Bank (Van Vo and Le 2023).
7. A smart contract is a self-executing set of instructions, written in computer code, that defines contractual conditions for each counterparty under different scenarios. As it is managed by code and recorded on the blockchain, it can be publicly verified by all network participants.
8. Stablecoins are widely used in the cryptocurrency market due to the added intermediation costs when trading cryptocurrencies against dollars and their usability across a greater cross-section of crypto exchanges. For example, total trading volume between Bitcoin and Tether surpassed the trading volume of BTC/USD in 2019.
9. The contract liquidates underlying Ethereum collateral if the value of that collateral is less than 150% of the corresponding DAI-borrowing value. Agents therefore have an incentive to scale back borrowing by redeeming DAI when Ethereum prices fall in order to prevent their collateral from breaching the 150% level.

10. For more information on AMOs, see https://docs.frax.finance/amo/overview.
11. Other use cases for stablecoin payments are in cross-border flows or as a hedge against macroeconomic risk (Adams et al. 2023).
12. Quarterly statement released by Tether Ltd on breakdown of reserves. Statement issued on May 13th,2021 on Tether's twitter account. Available at https://twitter.com/Tether_to/status/1392811872810934276
13. USDC reserve details are available at https://www.circle.com/transparency.
14. The oracle problem refers to the challenge of integrating reliable and secure real-world data into blockchain applications, as blockchains themselves cannot access external data directly. This limitation creates a reliance on oracles-entities or systems that act as intermediaries to fetch and deliver this data. Oracle risk arises when these intermediaries are compromised, leading to potential manipulation, inaccurate data, or a single point of failure. Decentralized Oracle Networks, such as Chainlink, mitigate these risks by employing independent and incentivized node operators to provide data in a secure, reliable, and decentralized manner. We provide supplementary detail on Chainlink in Appendix A.
15. ERC20 and TRX are standards which provide features including the transfer of tokens from one account to another, measuring the current token balance of an account, and measuring the total supply of the token available on the network. It deploys smart contracts, auto-executing code on the blockchain, to perform these various functions.
16. Huobi exchange statement on the migration to the Tether blockchain, https://prn.to/2ZkPzw0
17. Data available at https://www.coinapi.io/.
18. Our sample closes with the June 2022 futures contract and does not include the collapse of FTX in November 2022, which introduced counterparty and settlement risks. As of June 2022, FTX appeared financially stable, with plans to acquire BlockFi and Voyager (Sigalos 2022). However, we recognize the systemic role of Alameda Research, a firm closely tied to FTX, in Tether markets. Between 2014 and 2021, Alameda accounted for 37% of all USDT distribution, highlighting the interdependence of major market participants (Protos Staff 2023). The interconnected risks between FTX, Alameda Research, and Tether only surfaced after our sample period, as highlighted by media reports on Alameda's reliance on FTX's proprietary token for its balance sheet (Allison 2022) in November 2022.
19. API available at https://docs.kaiko.com/v/kaiko-rest-api/defi-and-blockchain/lending-and-borrowing-data/lending-rates.
20. For example, the interest rate model for borrowing rates on the Compound protocol is given by the piece-wise Equation (11). a_0 is the base rate, and is the rate corresponding to zero utilization. The slope parameter b_0 measures the sensitivity of interest rates to utilization. Typically the threshold $\bar{u}$ is set at 0.8.

$$i_{USDT}^{borrow} = \begin{cases} a_0 + b_0 u, & u \leq \bar{u} \\ a_0 + b_0 \bar{u} + b_1(u - \bar{u}), & u > \bar{u} \end{cases} \tag{1}$$

21. Available through an API at https://alternative.me/crypto/fear-and-greed-index/.
22. Alternatives such as a VAR model augmented with a Markov regime switching method have been used in Blagov and Funke (2016) and Zhang and Drapeau (2022).
23. To measure the half-life, we run an auto-regressive process of order 1 on the deviations, $\Delta = \rho\Delta_{t-1} + u_t$. The half-life, or the time it takes for a shock to dissipate by 50%, is $T = \frac{\log(0.5)}{\log(\rho)}$.
24. In unreported results, we find three pieces of evidence supporting the sufficiency of an AR(1) model for evaluating the expected future spot price. First, the ACF and PACF plots show significant partial autocorrelations up to lag 5, suggesting that higher-order AR models (e.g. AR(5)) may fit better. Second, AIC and BIC results indicate that the optimal lag length is 9 for AIC and 5 for BIC, consistent with the PACF findings. Third, regression results show that the partial R-squared increases from 0.447 in AR(1) to 0.514 in AR(5), highlighting diminishing returns from including additional lags. Together, these findings suggest that while AR(5) may marginally improve fit, AR(1) remains a tractable and sufficiently accurate representation of spot price dynamics.
25. To compute the default probability, we first estimate the auto regressive parameter ρ in Equation (1). and use an average estimate of $\rho = 0.67$ over the full sample. In calculating the annualized probability, we use the estimate of ρ and assume a horizon $h = 90$ of the futures contract. We assume $\underline{s} = 0$ for the baseline specification.
26. In addition to the sensitivity analysis to $\underline{s}$, we conducted sensitivity analyses to evaluate the impact of varying h (horizon) and ρ (persistence) on devaluation risk. For h, the default probability (annualized) ranges from 8.11% at $h = 7$ to approximately 0.16% at $h = 360$, confirming that shorter horizons amplify perceived devaluation risk. For ρ, devaluation risk increases moderately, rising from 0.62% at $\rho = 0.01$ to 0.69% at $\rho = 0.99$. These results indicate that lower persistence and shorter horizons elevate the likelihood of perceived devaluation, while longer horizons and higher persistence mitigate this risk.
27. The minimum fees for withdrawals on Tether are \$1000 for fiat withdrawals or up to 10 basis points of the transaction, whichever is greater, and vary for blockchain transfers depending on the network used. For more details, we refer readers to https://tether.to/en/fees/.
28. For a full account of USDC's reserve composition and the de-pegging event, we refer readers to https://www.circle.com/blog/an-update-on-usdc-and-silicon-valley-bank
29. Stablecoin borrowing rates are algorithmically determined on lending protocols as a positive function of utilization. Increased borrowing raises utilization, which subsequently increases both borrowing and supply rates.
30. Appendix D explores this further by examining the impact of Federal Reserve policy rate announcements on stablecoin interest rates, prices, and issuance. We find no significant response of borrowing or supply rates to Federal Open Market Committee

(FOMC) announcements, consistent with segmented markets. However, higher interest rates are associated with declines in stablecoin prices and issuance, reflecting reduced demand for stablecoins as investors rebalance toward higher-yielding assets.

31. For more information, refer to the following announcements by Bitfinex: https://bit.ly/2NEzITW and https://www.bitfinex.com/posts/311. Bitfinex states that it takes investors 7 to 15 days to make dollar withdrawals from their platform in order to comply with intermediation procedures. Bitfinex has also introduced a transaction cost of 3% for investors who make more than two dollar withdrawals a month, or for withdrawals of more than $1 million in a given month.
32. https://polymarket.com/event/usdt-depeg-in-2025
33. Specifically, the market resolves to 'Yes' if *all* one-minute candles for USDT-USD on Coinbase are below 0.98000 (i.e. a high of 0.97999 or lower) for any 24-hour window between 01 Jan 2025 and 31 Dec 2025 (Eastern Time). A 24-hour period that begins on 31 December 2025 is also eligible.
34. USDC reserves are composed of highly liquid assets, including U.S. Treasury securities, repurchase agreements, and cash held in Circle Reserve Funds and segregated accounts at regulated financial institutions. As of November 2024, total reserves were $39.48 billion (November 27) and $39.80 billion (November 29), exceeding USDC in circulation and ensuring 1:1 backing. See https://www.circle.com/transparency for more details.
35. For more details, see Appendix A.

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