SUPRA ORACLES

The Ultimate Guide to Stablecoins

Table of Contents

Introduction

Money is traditionally required to demonstrate a reliable store of value, so most cryptocurrencies are too volatile to act as media of exchange. The first modern digital stablecoin, Tether (USDT), was designed to resolve these volatility issues. Stablecoins are digital currencies pegged to the price of a specific asset. They are meant to hold relatively stable values equal to major fiat currencies or commodities.

Since USDT's 2014 launch, hundreds of stablecoins have been introduced into the market. According to CoinMarketCap, around 200 stablecoins still exist in the market today. The total stablecoin market is valued at over $150 billion at the date of this publication.[1] Stablecoins' rapid growth can be attributed to critical use cases inside and outside of the decentralized finance (DeFi) industry. For example, stablecoins:

- Facilitate cash flows more easily across international borders.
- Empower freelancers and small and medium enterprises (SMEs) with more financial autonomy without using legacy payment systems.
- Enable ordinary people to earn high yields on DeFi protocols that offer high savings or interest rates on their stablecoin "savings."

However, the Stablecoin Trilemma limits stablecoins' potential. The trilemma describes a trade-off between decentralization, price stability, and capital efficiency. Stablecoins often have to choose a trade-off between three objectives: decentralization, price stability, and capital efficiency. Each stablecoin design is equipped with a different mechanism that prioritizes one or two out of the three objectives but often fails to address all three equally.

This research paper will offer a survey on the following stablecoin designs: **asset-backed**, **seignorage**, **over-collateralized**, and **delta-neutral**. For each design, we will describe its mechanisms and disadvantages. Following an analysis of different stablecoin designs, this paper will present the results from a cross-sectional linear regression with averaged-out variables across all stablecoin designs. The paper will conclude with final remarks and propose deeper research on stablecoins designs.

[1] See The Block, available at https://www.theblockcrypto.com/data/decentralized-finance/stablecoins

Stablecoin Designs Assessment

Asset-Backed Stablecoins

The three most popular stablecoins, Tether (USDT), USD Coin (USDC), and Binance USD (BUSD) are asset-backed. These stablecoins directly are tied to the US dollar through reserves held by their creators. In other words, their teams theoretically hold $1 for every single token, allowing arbitrageurs to take advantage of price deviations and maintain the 1:1 peg with the USD. Other types of asset-backed stablecoins hold reserves in commodities, commercial paper, and other cryptocurrencies. The asset-backed stablecoin model encompasses all stablecoins that hold their price constant to the asset they have in reserves.

Variables Contributing to Asset-Backed Stablecoin Volatility

The variables that contribute to a price divergence between the actual US dollar and a USD reserve-backed stablecoin is comparable to that of price divergences between financial derivatives and their underlying assets. Reserve asset-backed stablecoins are intended to be priced the same as US dollars but they are not US dollars. These stablecoins are traded in financial markets, which means their prices reflect supply & demand, counterparty risk, and convenience premiums.

Supply & Demand

Popular asset-backed stablecoins like USDT or USDC will slightly deviate above or below $1. This is because while asset-backed stablecoins are backed by real USD reserves, their value is not held constant to the $1 in reserves. These asset-backed stablecoins resemble financial derivatives of the US dollar, meaning they are traded separately in the markets and are subject to supply and demand:

- In Figure 1.1, when **demand increases**, the **asset price increases**
- In Figure 1.2, when **demand decreases**, the **asset price decreases**
- In Figure 1.3, when **supply increases**, the **asset price decreases**
- In Figure 1.4, when **supply decreases**, the **asset price increases**

Please note that the nature of of the demand shock determines whether there is a shift along the demand curve or a shift in the demand curves. Let’s assume that the cryptocurrency market is moving into a “bear” market. Investors quickly move to trade their speculative cryptocurrencies for asset-backed stablecoins and then farm these stablecoins. The demand for stablecoins increases, and their prices increase. Theoretically, when a user purchases X amount of an asset-backed stablecoin, they are also depositing X amount into the reserves. But settlement delays and other processes could cause a buy-side liquidity deficit, which would increase the price of the asset-backed stablecoin.

Figure 1.1

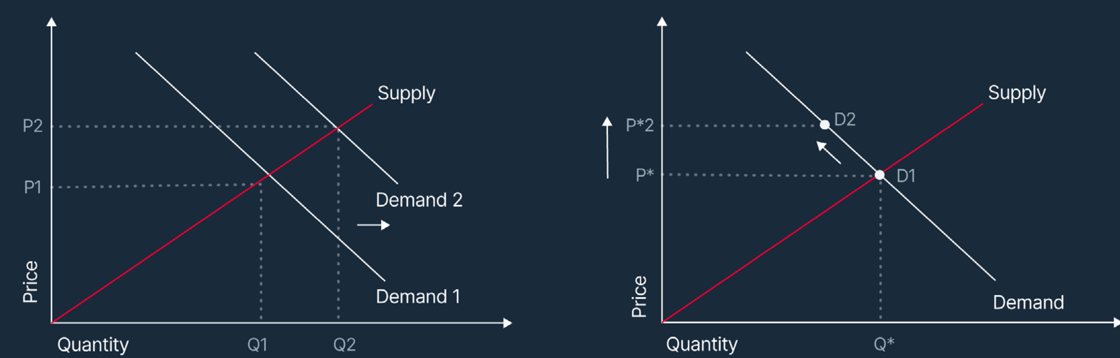
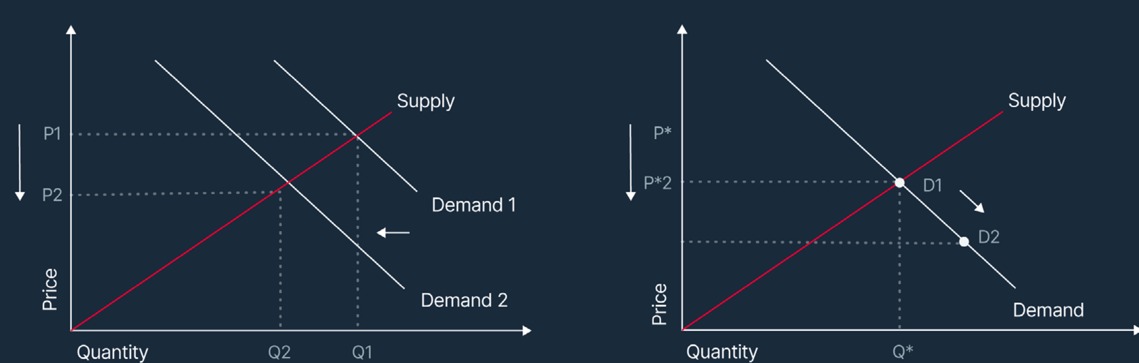
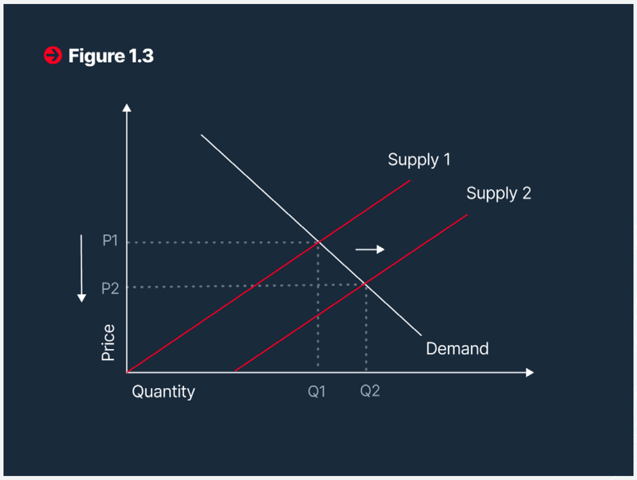
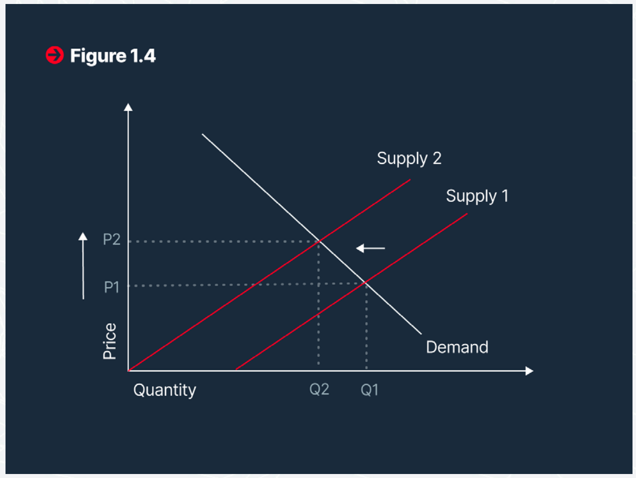


Figure 1.2







Counterparty Risk

Counterparty risk arises when users lose trust in the stablecoin issuer and are skeptical that the issuer can effectively meet its financial obligations. This risk also arises when there's a loss of trust in a collection of asset-backed stablecoins or the general stablecoin market.

Case Study: Contagion and Demand Spillover from the UST Collapse

The collapse of Terraform's algorithmic stablecoin TerraUST (UST) initiated a contagion-like trust deficit for USDT, pushing its prices down. Interestingly enough, UST's collapse increased demand for USDC and pushed its prices up. Figure 1.5 below illustrates the price divergences for USDT (shown in red) and UDSC (shown in white).

One possible explanation for this phenomenon addresses the composition of reserves backing each asset. USDC publicly holds more cash and cash equivalents in their reserves than USDT, and cash reserves could be seen as more reliable than other reserve assets. However, while the reserve backing is public information, it is unclear how many community members would be aware of specific reserve breakdowns or how strongly they view breakdowns as a sign of trust. Figures 1.6 and 1.7 break down the percentage of reserves that are held for USDT and USDC, respectively.

Figure 1.6: Tether (USDT) as of September 14, 2021[2]

Reserve Asset	**Percentage of Total Holdings**
Commercial Paper	65.39%
Fiduciary Deposits	24.20%
Cash	3.87%
Reserve Repo Notes	3.6%
Treasury Bills	2.94%
Secured Loans	12.55%
Corporate Bonds, Funds, and Precious Notes	9.96%
Other investments (including digital assets)	1.64%

[2] De, Nikhilesh. And Hochstein, Marc. “Tether’s First Reserve Breakdown Shows Token 49% Backed by Unspecified Commercial Paper” Updated: September 14, 2021. Coindesk. https://www.coindesk.com/markets/2021/05/13/tethers-first-reserve-breakdown-shows-token-49-backed-by-unspecified-commercial-paper/

Figure 1.7: USD Coin (USDC) as of April 2022[3]

Reserve Asset	Percentage of Total Holdings
Cash & Cash Equivalents	100%

Convenience Premium

The Convenience Premium refers to the additional "premium" investors are willing to pay in addition to the $1 value of a token. This premium comes from the convenience of using stablecoins, either to hedge risk in their cryptocurrency portfolios or to earn passive income in yield farming activities. Staking, yield farming, and other passive means of earning income with asset-backed stablecoins make these assets more intrinsically valuable than the reserves backing them. Stablecoins holders would earn more farming on Curve than depositing actual US dollars in a Certificate of Deposit (CD). Currently, those who open CD accounts or savings accounts would earn on average 1-2% on their assets. Meanwhile, staking and yield farming opportunities offer around 6-8% APY on stablecoins. The additional 6-8% earning potential would make asset-backed stablecoins more intrinsically valuable than US dollars, which could increase their prices above the $1 peg.

Disadvantages of Asset-Backed Stablecoins

The primary disadvantage of asset-backed stablecoins is their centralized nature. Default risk arises when the stablecoin issuer is unreliable or untrustworthy. However, asset-backed stablecoins that hold reserves in trustworthy, regulated third-party institutions are unlikely to default even if the stablecoin creator failed. In the event that Coinbase and Circle both went bankrupt, USDC is unlikely to go to zero because the coin's reserves are held at BNY Mellon. The risk of simply holding an asset-backed stablecoin like USDT or USDC is low because de-pegging is generally minimal and temporary. However, when investors are using these stablecoins to stake, farm, or leverage riskier trades, minimal and temporary de-pegging could lead to heavier losses. Assume that a liquidity provider is using the Curve protocol as a savings account. He or she believes that there is a low risk of slippage and impermanent loss because Curve only offers pools where assets have similar volatilities.

[3] Grant Thorton. April 2022. Available at: https://www.centre.io/hubfs/PDF/2022%20Circle%20Examination%20Report%20April%202022.pdf?hsLang=en

If one stablecoin dramatically de-pegs, then the liquidity provider would temporarily experience impermanent losses until the stablecoin's price recovers to its original peg. Therefore, the financial risks from asset-backed stablecoins are predominantly from leveraging the assets to earn yield or participate in other market activities.

Over-Collateralized Stablecoins

Over-collateralized stablecoins hold cryptocurrency reserves that are valued greater than the stablecoins' value. For example, MakerDAO's DAI is an over-collateralized stablecoin backed by cryptocurrencies worth 150% of its value. These large price differentials act as a "buffer" in the event the cryptocurrencies backing the stablecoin depreciate dramatically. So theoretically, let's say Ether was used as reserves for DAI. Then, Ether could lose ⅓ of its value and the DAI would still be fully collateralized. Over-collateralized stablecoins like DAI work by allowing users to lock their cryptocurrencies as collateral in exchange for minting and receiving DAI. Because the user is technically "borrowing" DAI, they would have to pay interest for borrowing DAI when they unlock their collateral. This interest rate is called the stability fee. MakerDAO's algorithm decreases the stability fee when DAI is above the $1 peg to encourage borrowing/minting new DAI, increasing the supply of the token and bringing down its price. If reserve assets start to depreciate, then the protocol will trigger a liquidation of the stablecoin to ensure that the stablecoin is fully collateralized.

Variables Contributing to Over-Collateralized Stablecoin Volatility

Like asset-backed stablecoins, over-collateralized stablecoins are backed by other assets and traded in the market. Over-collateralized stablecoins are also subject to the same volatility factors as asset-backed stablecoins, including supply & demand, counterparty risk, and the convenience premium. However, the volatility of over-collateralized stablecoins also depends on overall cryptocurrency market conditions and the diversity of the collateral.

Cryptocurrency Market Conditions

Over-collateralized stablecoins are collateralized by cryptocurrency assets. When market conditions are favorable, the collateral backing the stablecoins is often more than sufficient. When market conditions are unfavorable, there is a higher possibility that the collateral will drop below the intended valuation of the stablecoin, causing the stablecoin to depreciate below its peg.

The Diversity of Cryptocurrencies Held in Reserves

The diversity of an over-collateralized stablecoin's "reserve portfolio" would determine the amount of risk the stablecoin is hedging when collateralizing its valuation. For example, a significant price drop in Bitcoin would seriously weaken the collateral for a stablecoin backed mostly by Bitcoin. Meanwhile, a stablecoin with a more diversified portfolio may have better hedged against the risk of Bitcoin price drops. MakerDAO's DAI is backed by WBTC, USDC, YFI, LINK TUSDT PAX USD, AAVE, UNI, renBTC, MANA, 0X, GUSD, and more. The stablecoin is also backed by Uniswap V2 liquidity pool pairs like DAI/ETH, DAI/USDC, and ETH/USDT. sUSD reserves include ETH alongside LINK/USD trading pairs.

Case Study: Adding More Collateral to DAI

MakerDAO experienced a demand surge that de-pegged their DAI during the 2020 Rise of Yield Farming. As the demand to acquire DAI for yield farming activities increased, the price of the stablecoin also increased. By the end of 2020, around 75% of DAI was held in liquidity pools on protocols like Curve, Compound, Uniswap, Sushiswap, balancer, and Yearn Finance. When MakerDAO failed to bring down the price of DAI, which had appreciated to as high as $1.10, the organization started to consider solutions that would alter DAI's original composition. Originally, in an attempt to bring down DAI's price, the algorithm governing DAI set the stability fee to zero. Borrowers minting DAI offer other crypto assets as collateral and they also pay a "stability fee", which is similar to the interest rates paid on a loan.

The idea was that setting the stability fee to zero would incentivize borrowers and increase the liquidity of the collateral. This method failed, and MakerDAO's creator, Rune Christensen, proposed diversifying the collateral portfolio backing DAI. He believed that collateral diversification was the only long-term solution to maintaining DAI's peg.[4] Figure 2.1 shows that the price of DAI fluctuated

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[4] Harper, Colin. "No Other Option but More Collateral: The Short and Long Term Fixes for DAI's Broken Peg". Updated: September 14, 2021. Coindesk. https://www.coindesk.com/tech/2020/09/11/no-other-option-but-more-collateral-the-short-and-long-term-fixes-for-dais-broken-peg/

less severely around its peg after Christensen opted to diversify collateral towards the end of 2020.

Source: Messari.io

Disadvantages of Over-Collateralized Stablecoins

Over-collateralized stablecoins face three major drawbacks. While these stablecoins are usually well collateralized during favorable market conditions, their collateral reserves can and have quickly depreciated below the value necessary to fully collateralize a stablecoin.

Diversifying collateral can help mitigate these risks, but is not a fool-proof strategy during widespread negative market conditions or black swan events.

Second, over-collateralized stablecoins can be incredibly capital inefficient for inexperienced traders. During favorable market conditions, the extra collateral above the full collateral valuation could be under-allocated. However, a more advanced DeFi trader may realize that the extra collateral could support margin trading and increased exposure. Finally, over-collateralized stablecoins resemble regulated securities under the Howey test, meaning they could be subject to U.S. regulations.

Seigniorage-Based Stablecoins

Seigniorage-based stablecoins are not collateralized or backed by reserves. Instead, these stablecoins rely on an algorithm that controls supply and demand to peg its price to an asset. When the stablecoin's price is above the peg, the algorithm mints new tokens to increase supply. When the stablecoin's price is below the peg, the algorithm burns tokens to decrease supply. Various seigniorage-based stablecoins are designed within a more complex ecosystem, but the foundation for their design is derived from basic supply and demand procedures. The complex ecosystem generally consists of two tokens: the stablecoin and the value accruing seigniorage utility/investment/governance token.

Stablecoin holders can convert the stablecoin to the value-accruing token at the stablecoin's implied peg. When the stablecoin's price is too low, there is an arbitrage opportunity to mint the value accruing token. Arbitraguers profit from the price difference between the underpriced stablecoin and the value accruing token. As more seigniorage tokens are minted and stablecoins are burned, the stablecoin's circulating supply contracts and its price increases. When a stablecoin's price is too high, there would be an arbitrage opportunity to mint the stablecoin and burn the seigniorage token. In this case, the stablecoin's circulating supply expands and its price decreases.

Variables Contributing to Seigniorage-Based Stablecoin Volatility

Seigniorage-based stablecoins exhibit various structures and typically exist as one component in larger ecosystems. As a result, the variables that contribute to seigniorage-based stablecoin volatility differ across stablecoin issuers and ecosystems. Generally, the supply and demand variables that affect asset-backed and over-collateralized stablecoins also contribute to seigniorage-based stablecoin volatility. Beyond simple supply and demand, the volatility of seigniorage-based stablecoins also depends on future demand, community, and token distribution.

Ecosystem: Future Demand, Community, and Token Distribution

Like asset-backed and over-collateralized stablecoins, seigniorage-based stablecoin prices fluctuate on supply and demand. However, seigniorage-based stablecoin prices rely on current and future market demand. Credibility and trust are important for asset-backed and over-collateralized stablecoins, but even more so for seigniorage-based stablecoins. Seigniorage-based stablecoins are heavily dependent on future demand. A stablecoin's community is often driving demand through individual and, oftentimes, free marketing campaigns. Equally as important is the distribution of tokens among diverse token holders. When the distribution of tokens is unevenly skewed towards a select few wallets, there's a greater chance of significant price drops following an exit from one or two token holders.

Arbitrage Opportunities

Seigniorage models only work when the barriers of arbitrage are low and enough people can spot arbitrage opportunities. Because Seigniorage-backed stablecoins do not hold collateral, arbitrage opportunities may be less obvious for lesser experienced traders. However, most arbitrage traders will recognize opportunities given that the speculative coin holds true value. The arbitrageur's risk comes from the uncertainty of being able to exit their position on the speculative coin at their target price after trading in the stablecoin for the speculative token. A lack of arbitrageurs to mint (burn) the stablecoin, when the price is under (above) the peg, would mean that the stablecoin cannot adequately expand (contract) its supply and adjust its price. Thankfully, the risk that the public wouldn't take advantage of arbitrage opportunities is low, particularly when considering the number of trading bots designed to just perform this very specific task.

Disadvantages of Seigniorage-Based Stablecoins and a Possible Solution

The most prevalent disadvantage to purely seigniorage-based stablecoins is the reliance on organic traction. Luna's TerraUSD ($UST) collapsed because the project lacked organic traction. Other projects, like Frax, started with 1-to-1 collateralization with another stablecoin or asset (USDC in this case), and then lowered their collateral as they gained more traction.

Case Study: The Collapse of UST and LUNA

When algorithmic stablecoins are designed carelessly, they pose significant threats to the decentralized financial ecosystem. The most prominent example in recent history is $UST's infamous depegging. The UST peg mechanism resembles the typical seigniorage stablecoin model. The ecosystem drives demand with its lending protocol Anchor. Anchor is high-yield savings account for UST, and at one point offered yields as high as 20%[5]. But when Anchor lowered its yield, demand for UST declined and yield farmers left the protocol. Unfortunately for UST, most of the stablecoin's demand was driven by the Anchor protocol. In fact, over 67% of UST's circulating supply was on the Anchor protocol[6].

In his paper published in October 2021, Wake Forest professor Ryan Clements argued that $UST was dangerously reliant on two largely untested assumptions: 1) traders will always recognize arbitrage opportunities, and 2) that UST will always present attractive use cases (Clements, 2021)[7]. The assumption that failed was 2) that UST will always present attractive use cases. Anchor protocol's declining yield traffered $UST's collapse (although some believe that a coordinated attack was also involved).

When UST's demand and the price fell, the re-pegging mechanism kicked in and arbitrageurs recognized the opportunity to mint LUNA and burn UST. However, this mechanism did not sufficiently restabilize UST's peg and its price kept falling, less some temporary price recoveries. In the end, the price of UST dropped to as low as 30 cents. Meanwhile, LUNA's circulating supply skyrocketed as arbitrageurs continued to mint LUNA, sending LUNA's price in free fall. Figure 3.1 charts the price pairing UST/USD, which was steadily pegged around $1 until the steep price drop in mid-May. Figure 3.2 illustrates the price of LUNA, which also dropped off the map as the number of tokens in its circulating supply skyrocketed from around 725 million to 7 trillion during the UST de-pegging.

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[5] Kahan, Dan. "Anchor Targets 20% Fixed Stablecoin Yield". The Defiant. https://thedefiant.io/anchor-targets-20-fixed-stablecoin-yield/

[6] Haqshanas, Ruholamin. "67% of UST's Demand Comes from Anchor Protocol: Stablecoin Now 3rd Largest". The Tokenist. https://tokenist.com/67-of-usts-demand-comes-from-anchor-protocol-stablecoin-now-3rd-largest/

[7] Clements, Ryan. "Built to Fail: The Inherent Fragility of Algorithmic Stablecoins". Updated: October 25, 2021. Wake Forest Law Review. http://www.wakeforestlawreview.com/2021/10/built-to-fail-the-inherent-fragility-of-algorithmic-stablecoins/

Figure 3.1: UST drops from its $1 peg to a few cents in mid-May 2022. Source: TradingView.

Figure 3.2: LUNA loses around 99.99% of its value as its circulating supply increases from 725 million to 7 trillion. Source: Messari.io.

Case Study: Frax and Partially-Collateralized Seigniorage-based Stablecoins

UST began as a purely seigniorage-based model with zero collateral, but its creators intended to introduce collateral if it was ever needed. The seignorage model requires community adoption, so Terra developed the Anchor protocol to incentivize $UST adoption. The model is the equivalent of “fake it until you make it”. Frax flipped that narrative by introducing a stablecoin that was fully collateralized with USD when it launched.

As Frax gained traction, the stablecoin would gradually lower its collateral. If the demand for Frax is high enough to increase the stablecoin’s price over $1, then the protocol lowers its collateral. If the demand for Frax contracts and the stablecoin’s price falls under $1, then the protocol increases its collateral. In other words, Frax moves towards a seigniorage model when the market can afford it. When the market demand cannot sufficiently support the seigniorage model, Frax adopts a design that more closely resembles an asset-backed model. Other partially-collateralized seigniorage stablecoins include ESD V2, but its USDC-collateralized reserve ratio is fixed at 20-30% and doesn’t adjust to market demand[8].

Delta-Neutral Stablecoins

Delta-neutral stablecoins derive their designs from a prevalent trading strategy in TradFi derivatives markets. Delta neutral refers to a position where the investor incurs neither a gain nor loss regardless of the assets’ price fluctuations within the portfolio. To achieve this, the investor takes equivalent long and short positions that essentially ‘cancel’ each other out, creating a ‘stable’ asset portfolio. Delta-neutral stablecoins are fully collateralized by other cryptocurrencies.

Delta-neural stablecoins employ delta-neutral trading strategies to engineer a stablecoin that does not gain or lose value as the asset prices backing the token fluctuate. The user would deposit other cryptocurrencies in the protocol as collateral, and then take a short position on a Perpetual Future offered on a decentralized derivatives exchange. UXD is currently the most popular delta-neutral stablecoin in the market, but there are likely many more delta-neutral stablecoins in development. Users create delta-neutral positions on UXD when their short position on the derivatives protocol is equivalent to the collateral deposited on UXD.

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[8] Simon, Benjamin. “Stability, Elasticity, and Reflexivity: A Deep Dive inot Algorithmic Stablecoins”. Mechanism Capital. https://www.mechanism.capital/algorithmic-stablecoins/

Variable Contributing to the Delta-Neutral Stablecoin Volatility

Settlement Speed and Other Technical Difficulties

Transactions on decentralized exchanges can experience time lags, so a delta-neutral stablecoin may not have a short position to cover its collateral at any given time. Furthermore, Delta-neutral stablecoins are heavily reliant on decentralized derivatives exchanges, which are in turn heavily reliant on oracles. Unreliable price roalces may also cause price volatility.

Disadvantages of Delta-Neutral Stablecoins

Insurance Fund Asset Management Risk

When funding rates are negative, the insurance fund acts as a buffer to restore the peg. However, there is a risk that the insurance fund runs dry before the stablecoin's peg can be restored. This may be considered a worst case scenario or black swan event, and would most likely be triggered by a complete lost of trust in the stablecoin.

Insufficient Liquidity Risk

Decentralized derivative protocols may not have enough liquidity in their perpetual futures markets to meet a delta-neutral stablecoin's demand for perpetual futures. When this happens, the stablecoin protocol has the option to integrate with centralized derivatives markets or start backing their stablecoin with more collateral. Neither of these options would preserve the decentralized nature of the protocol, but it could theoretically avoid steep price decreases.

Analyzing Volatility Across Stablecoin Designs

Summary Statistics for 30-day and 1-year Volatility

Figure 4.1 below shows that there has been more volatility within the last 30-day period in May 2022 than in the past year from May 2021 - to May 2022 among a sample of 13 - 18 distinct stablecoins. This sample includes BinanceUSD ($BUSD), Celo Dollar ($CUSD), Dai ($DAI), Float Protocol ($BANK), FRAX ($FRAX), Frax Share ($FXS), Gemini Dollar ($GUSD), HUSD ($HUSD), Pax Dollar ($USDP), Stasis Euro ($EURS), Tether ($USDT), TrueUSD ($TUSD), and USD Coin ($USD). The increased volatility may partly be attributed to overall market sentiment shifts and contagion shocks from UST's demise. The positive mean values for the percentage change in 30-day and 1-year prices relative to BTC and ETH indicate that, unsurprisingly, stablecoins are less volatile than BTC and ETH.

Figure 4.1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
currentMarketcap	17	9,184,901,919.000	21,119,008,506.000	0.000	73,183,685,373.000
marketcapDominance	17	0.729	1.676	0.000	5.807
percentageChange30dUsd	18	-17.512	29.190	-74.853	0.817
percentageChange30dBtc	18	10.952	39.262	-66.176	35.606
percentageChange30dEth	18	21.558	43.015	-62.942	48.569
percentageChange1yrUsd	13	7.585	67.552	-98.363	213.635
percentageChange1yrBtc	13	42.463	89.452	-97.832	315.312
percentageChange1YrEth	13	43.847	90.320	-97.811	319.346
athUsd	18	88.716	356.668	0.325	1,517.302
athTimestamp	18	1,610,421,950.000	54,091,096.000	1,455,265,800	1,652,587,200
cycleLowUsd	18	1.117	1.493	0.050	6.007
cycleLowTimestamp	18	1,645,587,800.000	19,639,764.000	1,570,127,400	1,653,206,400
volatility30d	18	2.364	6.797	0.011	29.355
volatility1yr	17	0.984	1.690	0.028	7.012
tokenType	18	0.722	0.461	0	1

ERC20 Versus Non-ERC20 Tokens

Figure 4.2 and 4.3 show the 30-day and 1-year volatility density charts for ERC-20 and non-ERC-20 tokens. The results indicate that ERC-20 stablecoins are not more or less volatile than other non-ERC-20 tokens in DeFi ecosystems. Separate t-tests in Figures 4.4 and 4.5 for 1-year and 30-day volatility confirm the visual arguments made by the density graphs. This result is important because it confirms that stablecoins are not more likely to hold their peg when they are native to the most popular Layer-1 technology, Ethereum.

Figure 4.2 illustrates a 30-day volatility density graph for ERC-20 tokens (1) and non-ERC-20 tokens (2).

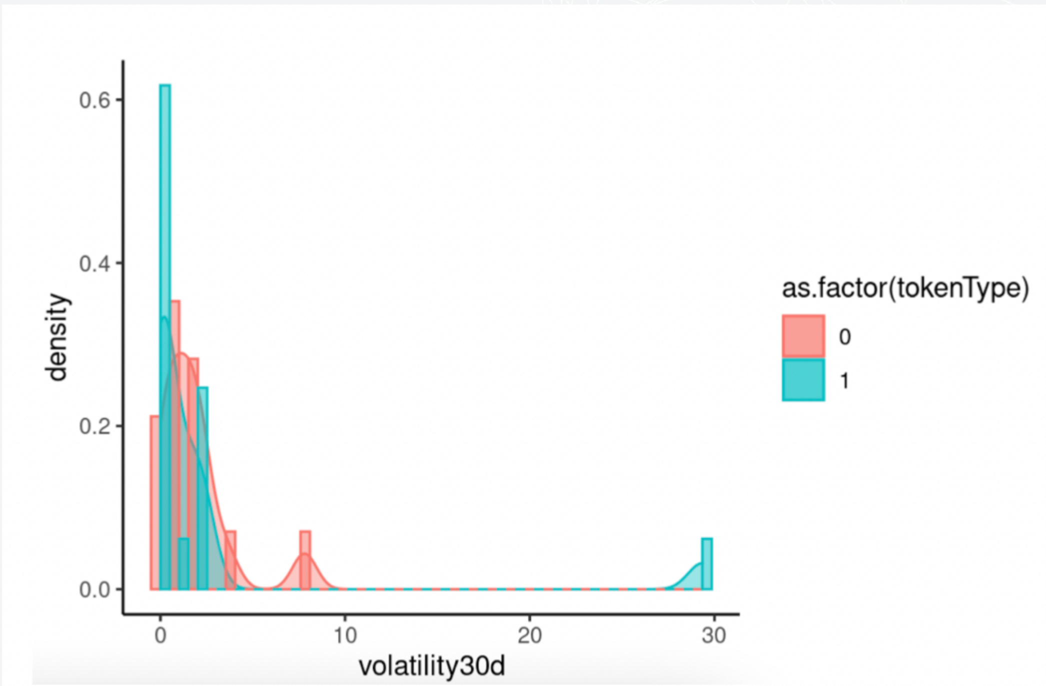

Figure 4.3 illustrates a 1-year volatility density graph for ERC-20 tokens (1) and non-ERC-20 tokens (2).

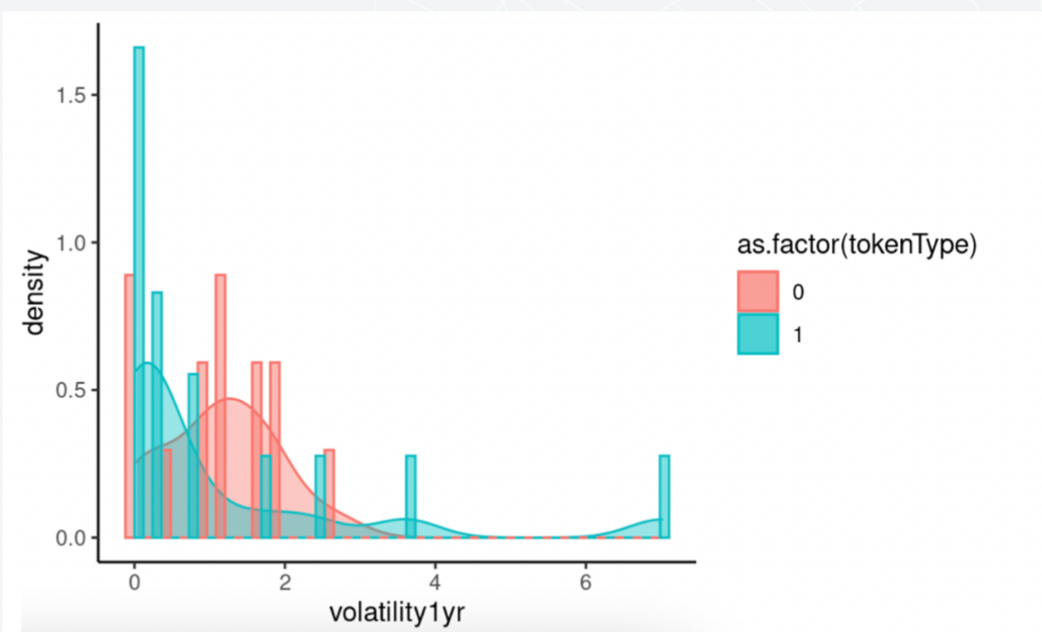

Figure 4.4 T-test results show that there are no significant differences in 1-year average volatility for ERC-20 tokens and non-ERC-20 tokens.

```
data:  volatility1yr by tokenType
t = 0.00055435, df = 18.457, p-value = 0.9996
alternative hypothesis: true difference in means between group 0 and group 1 is not equal to 0
95 percent confidence interval:
 -1.126467  1.127063
sample estimates:
mean in group 0 mean in group 1
       1.134748        1.134451
```

Figure 4.5 T-test results show that there are no significant differences in 30-day average volatility for ERC-20 tokens and non-ERC-20 tokens.

```
data:  volatility30d by tokenType
t = -0.36005, df = 17.575, p-value = 0.7231
alternative hypothesis: true difference in means between group 0 and group 1 is not equal to 0
95 percent confidence interval:
 -4.633910  3.279989
sample estimates:
mean in group 0 mean in group 1
       1.835510        2.512471
```

Cross-Sectional Linear Regression

The linear regression model is intended to measure the cross-sectional average 30-day and 1-year price volatility across a sample of 13 - 17 stablecoins. This data was imported from Messari.io as a CSV, and then cleansed and analyzed in the language R. The model for average 30-day and 1-year volatility will include the following independent variables: market dominance, 30-day or 1-year price changes relative to USD, Ether (ETH), and Bitcoin (BTC), the all-time high price, time since the all-time high price, all-time low price, cycle low price, and the time since the cycle low price.

The cycle low price refers to the lowest trading price since hitting the all-time high price. There were no statistically significant results for 30-day volatility. There were statistically significant results for 1-year percentage change relative to USD, all-time high price, and cycle low price. The linear regression indicated a positive correlation between average 1-year volatility and the all-time high price in USD. Specifically, an $0.026 increase in the all-time high price is correlated with one standard deviation of volatility.

The analysis also indicated a negative correlation between average 1-year volatility and the cycle low price. Intuitively, this result is confusing as a significant cycle low should theoretically be positively correlated with volatility. However, this could indicate that there is a negative relationship between low cycle prices with significant price increases. If there is a relationship between the low cycle prices and significant price increases, the relationship is likely non-linear due to the complex mechanisms that change stablecoin prices based on supply and demand. The adjusted R-squared suggests that this linear model can explain around 40% of stablecoin volatility variations.

	Dependent variable:
	volatility30d
percentageChange30dUsd	-0.00870
	(0.09408)
percentageChange30dBtc	
percentageChange30dEth	
marketcapDominance	-1.86807
	(2.18467)
athUsd	-0.000001
	(0.00698)
athTimestamp	-0.0000001
	(0.0000001)
cycleLowUsd	-0.51232
	(1.74830)
cycleLowTimestamp	0.00000
	(0.0000001)
Constant	70.54064
	(245.15720)
Observations	17
R^2	0.10627
Adjusted R^2	-0.42997
Residual Std. Error	8.34892 (df = 10)
F Statistic	0.19818 (df = 6; 10)
Note:	*p**p***p<0.01

	Dependent variable:
	volatility1yr
percentageChange1yrUsd	0.16148**
	(0.04686)
percentageChange1yrBtc	
percentageChange1YrEth	
marketcapDominance	-0.04972
	(0.40671)
athUsd	0.02564**
	(0.00743)
athTimestamp	0.00000
	(0.00000)
cycleLowUsd	-6.73829**
	(1.98606)
cycleLowTimestamp	-0.00000
	(0.0000000)
Constant	-1.05317
	(44.42244)
Observations	13
R^2	0.70342
Adjusted R^2	0.40685
Residual Std. Error	1.47264 (df = 6)
F Statistic	2.37181 (df = 6; 6)
Note:	*p**p***p<0.01

Figure 4.6 shows the linear regression results for 30-day volatility on the left and 1-year volatility on the right. There were no statistically significant results for 30-day volatility. For 1-year volatility, the all-time high price is positively correlated with volatility while the cycle low price is negatively correlated with volatility.

Conclusion: Future Research Should Be Design-Specific

The academic literature generally agrees that asset-backed stablecoins experience the least volatility relative to other stablecoin designs. For example, Jarno and Kolodziejcky (2021) concluded that asset-backed stablecoins are less volatile than collateralized stablecoins. While the study also included algorithmic stablecoins, the authors did not believe that the sample size for algorithmic stablecoins was large enough to produce statistically significant results.

One of the most difficult challenges to analyzing stablecoin volatility is the lack of data. There are simply not enough large cap or respected stablecoins in the market to compose a sample large enough to support statistically significant results. Most disciplines, including financial econometrics, request a minimum sample size of 20 data points to produce sound statistically significant results. Ideally, researchers would have a sample size large enough to study 20 asset-backed stablecoins, 20 seigniorage style stablecoins, and so on. Due to limited data availability, current research on stablecoin volatility may be better suited for time-series or panel-data methodologies.

Future Research for Asset-Backed Stablecoins

A cross-sectional linear regression could test correlations between volatility and variables that indicate supply, demand, counterparty risk, and convenience. The linear model could have 30-day volatility and 1-year volatility as dependent variables. 30-day trading volume, 1-year trading volume, max supply, circulating supply, and the percentage of cash equivalents held as collateral could make up the independent variables. Unfortunately, the current asset-backed stablecoin market cannot provide a large enough sample size of relevant asset-backed stablecoins. Therefore, the most statistically sound research methodologies may compare time-series models for the most prominent asset-backed stablecoins.

Future Research for the Volatility of Over-Collateralized Stablecoins

The volatility of over-collateralized stablecoins is hypothesized to be dependent on: 1) the volatility of the cryptocurrencies that are held in its reserves, 2) the diversity of cryptocurrencies held in its reserves, 3) the percentage of non-cryptocurrency assets held in its reserves (if any), and 4) the size and engagement of the stablecoin's community. There may be other aspects that also come into play based on the ecosystem built around specific over-collateralized stablecoins. Again, small sample sizes are a hurdle to statistically significant results. Studies including over-collateralized stablecoins could be designed quite similarly to single asset-backed stablecoins. In addition to time series analysis, the research could also include event-study analyses or Granger causality models to study how market conditions affect over-collateralized stablecoins.

Future Research for the Volatility of Seigniorage-based Stablecoins

Seigniorage-based stablecoins have unique incentive structures and ecosystem designs, so there are many possible research directions. An interesting research topic would be to investigate any relationships between seigniorage-based stablecoin volatility and the distribution of seignorage share tokens/investment tokens on yield farming and staking protocols. Because seigniorage-based stablecoin ecosystems can be complex, any relationships may require semi or non-parametric modeling.

Future Research for Delta-Neutral Stablecoins

The delta-neutral stablecoin design is relatively new. Researchers can model various scenarios and conduct stress tests to simulate how a delta-netural stablecoin could perform in the market. However, if the goal is to study delta-neutral stablecoins that are already on the market, the researcher could conduct a time series analysis on UXD. Even then, UXD has not been on the market for long and data could still be quite limited.

Why Should Research Be Design-Specific?

These suggested research directions concentrated on analyzing volatility triggers within specific stablecoin designs as opposed to comparing stablecoin designs. While the comparison between stablecoin designs may be interesting for industry leaders and regulators alike, any results would fail to capture the holistic understanding of why stablecoins exist. Asset-backed stablecoins may very well be the most "stable", but they are decentralized. Over-collateralized stablecoins may be more trustworthy than most seigniorage-backed stablecoins, but they are capital inefficient. Seigniorage-style stablecoins may be the most decentralized, but when they fail, they do so phenomenally. Stablecoin designs hold their own purposes and advantages, and co-existing stablecoin designs allow people to choose what they believe best fit their needs and philosophies.

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