Stablecoins and Centralization of Arbitrage, Ma, Zeng, Zhang (2023)

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Summary

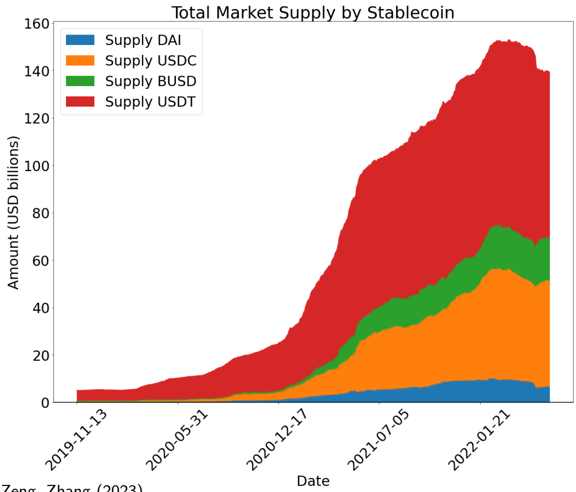
- Stablecoins operate on the blockchain and are pegged at parity to the US dollar.
- They serve as vehicle currencies for trading crypto assets, are used in DeFi applications, and are used for alternative payments, such as remittances and cross-border transactions.
- Paper investigates two important topics in stablecoins: run risk and arbitrage design.
- **Run risk**: Stablecoins on the issuer side are like a MMF: hold risky assets (asset illiquidity), with a small fraction of liquid reserves to meet redemptions.
- **Arbitrage design**: Arbitrageurs carry out deposits/redemptions in the primary market to stabilize the peg at 1 USD, similar to authorized participants pegging a ETF to its net asset value.

Contributions

- Paper combines run-risk and arbitrage design in an elegant model framework with supporting empirical evidence, and makes the following contributions:
  1. **Concentrated arbitrage and peg stability**: In cross-section, stablecoins with more concentrated arbitrage, (low number of arbitrageurs n), have larger deviations from the peg.
  2. **Tradeoff between price stability and financial stability**: Increasing n reduces limits to arbitrage and increases peg stability. However, it increases payoff of a coordinated sell-off by investors, increasing run-risk.
  3. **Stablecoin risk management**: A dividend on stablecoins can redistribute income to stablecoin investors, reduce run-risk and increase peg stability.

Stablecoin Market

Most common type are centralized stablecoins lead by Tether and USDC. Typically backed by dollar reserves and interest-bearing assets like Treasury bonds.



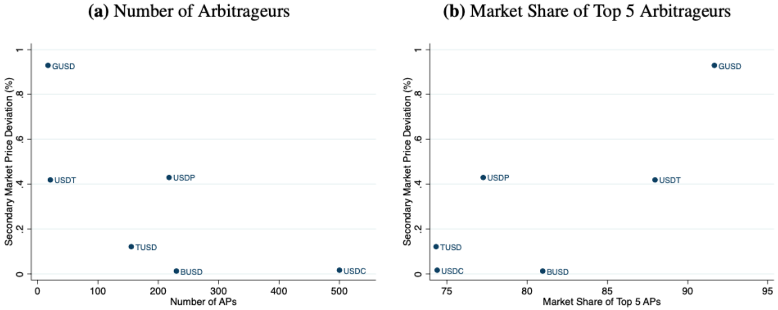
Tether Balance Sheet

- Tether started to provide breakdown of reserves since May 2021, but they consist of less liquid assets and are not fully backed by cash or cash equivalents.
- Asset illiquidity is a source of run-risk!
- Reserve breakdown Quarter 1 2023

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%

Peg efficiency in cross-section

- Convincing evidence that access to arbitrage trades matters for peg efficiency in cross-section.
- **Tether**: More concentrated than other coins (small n). Tether can limit n through higher costs of redemptions, limits on minimum size of withdrawal and high compliance costs.
- **USDC**: Lower compliance costs and easier access to Treasury (large n).



Model summary

Periods $t = 0, 1, 2, 3$ and 4 types of agents.:

1. Noise traders that use stablecoins for remittances in period $t = 1, 2$
2. Arbitrageurs (n) that deposit/redeem stablecoins based on peg-prices that deviate from par value.
3. Informed investors that decide to participate in stablecoin market. Their participation is based on the stability of the peg in period 1. In period 2, they decide whether to sell stablecoin (Diamond and Dybvig type run),or wait until period 3 to liquidate their assets.
4. Issuer earns revenue based on participating investors and invest in assets with return R and share of illiquid assets ϕ. Investor chooses level of arbitrage n at $t = 0$ to optimize revenue.

Model: equilibrium prices

- In period 1, noise trading induces a symmetric peg with discounts and premiums given by $+-\delta K$, where $K = \frac{1}{\chi}\frac{n-1}{n(n-2)}$

$$p_1 = \begin{cases} 1-\delta K & \omega = \delta \\ 1+\delta K & \omega = -\delta \end{cases}$$

- In period 2, selling pressure by investors induces discounts, with liquidation occurring when share of selling investors is greater than share of liquid reserves $\lambda > 1-\phi$.

$$p_2(\lambda) = \begin{cases} 1-K\lambda & \lambda \leq 1-\phi \\ \frac{1-\phi}{\lambda} - K\lambda & \lambda > 1-\phi \end{cases}$$

- In both periods, increased arbitrage ($n\uparrow$) reduces K and makes peg more efficient.

Model: investor pay-off and issuer optimization

- The investor value in period 3, with probability of good state of fundamentals $\pi(\theta)$, illiquidity ϕ and investment return η.
- In a coordinated sell-off there is zero long-term value of investment.

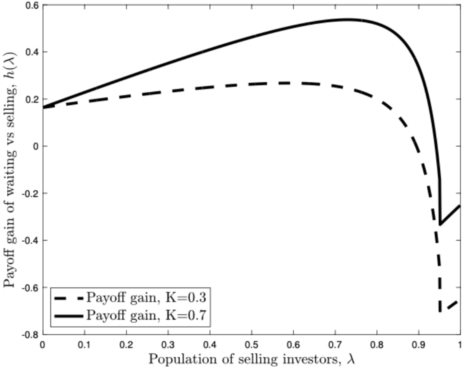
$$v_3(\lambda) = \begin{cases} \pi(\theta)\left(\frac{1-\phi-\lambda}{(1-\phi)(1-\lambda)} + \eta\right) & \lambda \leq 1-\phi, \\ 0 & \lambda > 1-\phi \end{cases}$$

- Issuer maximizes profits subject to the level of arbitrage n.

$$\max_n E[\Pi] = G(E[W]) \int_{\pi(\theta)\geq\pi(\theta^*)} \pi(\theta)(R(\phi)-1)dF(\theta)$$

Model: efficient arbitrage can increase run-risk

- The payoff of waiting until period $t = 3$ versus selling the stablecoin at p_2 is captured by $h(\lambda) = v_3(\lambda) - p_2(\lambda)$
- Increase in arbitrage efficiency is given by $K \downarrow$. More efficient arbitrage means p_2 is higher (trading at smaller discount).
- This increases pay-off of selling at $t = 2$, increasing run-risk.



Model: dividends to investors

- Issuer profits is redistributed to increase long-term benefit to investor. All else equal, less likely to run on the issuer.

$$v_3(\lambda;\tau) = \begin{cases} \pi(\theta)\left(\frac{1-\phi-\lambda}{(1-\phi)(1-\lambda)}(1+\tau)+\eta\right) & \lambda \leq 1-\phi, \\ 0 & \lambda > 1-\phi \end{cases}$$

- Issuer now receives a smaller profit per investor. However there is an increase in expected investor participation with less run-risk.

$$\max_n E[\Pi] = G(E[W]) \int_{\pi(\theta)\geq\pi(\theta^*)} \pi(\theta)(R(\phi)-1-\tau)dF(\theta)$$

- In model calibration, dividend increases arbitrage and peg stability, and reduces run-risk.

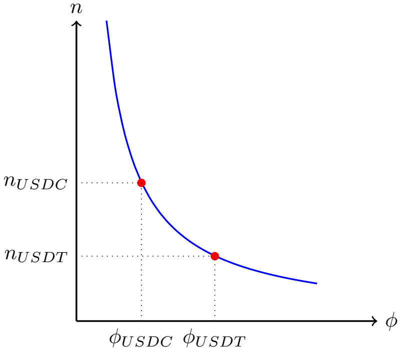
Comment #1: Endogenising ϕ: asset illiquidity

- A key trade-off in paper is between peg stability and financial stability:
- **Peg stability**: Increased arbitrage ($n \uparrow$) increases peg stability.
- **Financial stability**: Increased arbitrage ($n \uparrow$) increases pay-off of a coordinated sell-off, increasing run-risk.
- However, the analysis is assuming the issuer's asset illiquidity, ϕ is constant.
- It would be interesting to model, jointly, the asset illiquidity ϕ and access to arbitrage n.

$$\max_{n,\phi} E[\Pi] = G(E[W]) \int_{\pi(\theta) \geq \pi(\theta^*)} \pi(\theta)(R(\phi) - 1) dF(\theta)$$

Comment #1: Endogenising ϕ: asset illiquidity

- Optimal $[\phi, n]$ for stablecoin issuers can be rationalized.
- What are model parameters that can affect optimal choice of $[\phi, n]$? Different fundamentals, noise of private signal of investors, different interest rate schedule $R(\phi)$, transaction costs of arbitrage, different long-term benefits to investor.



Comment #2: Welfare and optimal regime

- Welfare of USDC and USDT can be compared to other regimes such as a narrow bank [$\phi \to 0, n \to \infty$].
- The model framework can show that it is not optimal for an issuer to be like a narrow bank: some amount of asset illiquidity is needed to make profits, however being more capital efficient comes at the cost of peg stability as it results in more concentrated arbitrage.
- As a regulator and social planner, would you want issuers to be closer to a narrow bank? For example, if the objective function is a weighted function of run-risk, peg stability and issuer profits?
- Social planner function:
  Welfare=f(issuer profits,run-risk,peg stability)

Comment #3: Competition between USDC and Tether

- An interesting trend is the de-risking of both Tether and USDC balance sheets since 2021.
- Tether (Oct 2022) and USDC (July 2022) have reduced their exposures to commercial paper to zero.
- As a potential exercise and discussion, it is interesting to think about how competition can be introduced in model setup.
- For example, competition will erode issuer profits, as investors switch to a competitor.
- Competition should cause the stablecoin issuer to de-risk and increase peg stability to maintain market share $\phi \downarrow$, and $n \uparrow$.

Comment #4: Stablecoin risk management and policy

- In response to redistributing profits via dividends, If ϕ becomes endogenous, will issuer have incentive to take more risk to maintain profits, increasing ϕ in equilibrium (assuming $R'(\phi) > 0$)?
- Model framework can be used to assess the welfare of additional policies:

1. **Real-time auditing**: Auditing of reserves on-chain using Chainlink's proof of reserve. It will reduce noise of signal about fundamentals, $\theta_i = \theta + \epsilon_i$ and reduce run-risk, all else equal.
2. **Capital requirements and CBDC-backed stablecoin**: These solutions aim to make stablecoins closer to a narrow bank, by limiting $\phi < \bar{\phi}$. in equilibrium, $\phi \downarrow$ and $n \uparrow$, increasing peg stability and reducing run-risk.

Minor comments-Empirics

- Similar to n and peg stability, can you look at ϕ and peg stability in cross-section. Might be difficult to measure ϕ for all coins but useful in stylized facts.
- In addition to taking a cross-sectional average, can include panel regressions of peg stability on concentration, including time series of the number of arbitrageurs and market share of top 5% for individual stablecoins.
- Interesting to examine liquidity of exchanges trading Stablecoin/USD. In general USDT/USD much more liquid than USDC/USD in secondary market. Does this mean more noise trading (remittances) for USDT?

Minor comments-Model

- Would results change if arbitrageurs have information on the fundamentals, similar to investors?
- Should investors use the level of p_2 to form their prior on fundamentals, and therefore help form the ex ante level of run-risk? How would results change?
- Instead of making n a choice variable of issuer, an alternative is to impose costs of arbitrage access (i.e. fixed cost of withdrawals, compliance costs etc). In this setup the amount of arbitrage is optimized by balance sheet constrained arbitrageurs. Will this setup be equivalent?

Conclusion

- This is the first paper to think deeply about both the run-risk and arbitrage design of stablecoins in an integrated framework.
- I learnt a lot from reading this paper, and it is a must read in this emerging literature.
- Cross-sectional evidence shows that peg stability is a function of arbitrage concentration in the market. More arbitrage means more peg stability!
- An interesting trade-off in the model framework is between peg stability and financial stability. In particular, this rationalizes why an issuer with asset illiquidity ($\phi > 0$) may want to limit arbitrage to reduce run-risk.
- Important policy implications from this model framework, such as the relative welfare of dividends, private auditing of reserves, and increased capital requirements.
- Thank you!