Stablecoin Runs and the Centralization of Arbitrage

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USD Stablecoins

1. Blockchain assets with decentralized ledgers and access

2. Price stability: market price claimed to be stable at \$1
   - When trading other blockchain assets and with real purchases
   - The 6 largest USD stablecoins: \$5.6 billion in 2020 $\rightarrow$ \$130 billion in 2022 with a trading volume of \$7.4 trillion

3. Backed by a pool of USD reserve assets
   - Deposits, Treasuries, corp bonds, loans, repos, ABCPs, etc.
   - $\rightarrow$ Bridge between crptyo and the real financial system

4. No dividends paid out to investors
   - Stablecoin issuers receive all income from reserve assets

Implications for Financial Stability

- Heated debate about stablecoin run risk

- Some say: USD stablecoins resemble banks/MMFs; panic runs could lead to asset fire sales and strain key funding markets
- Others say: runs are unlikely because stablecoins are tradable like ETF shares; we are just observing fluctuating prices

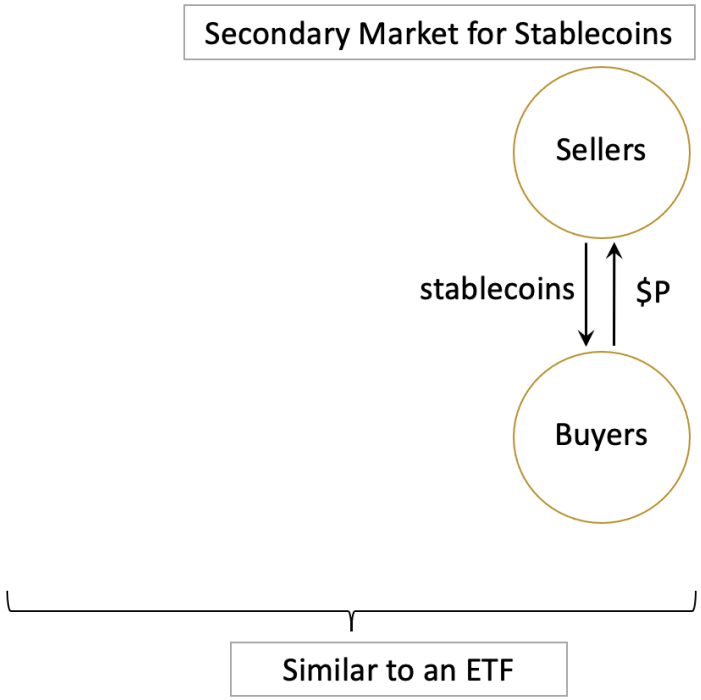
This Paper

1. How do USD stablecoins work? What is their market structure?

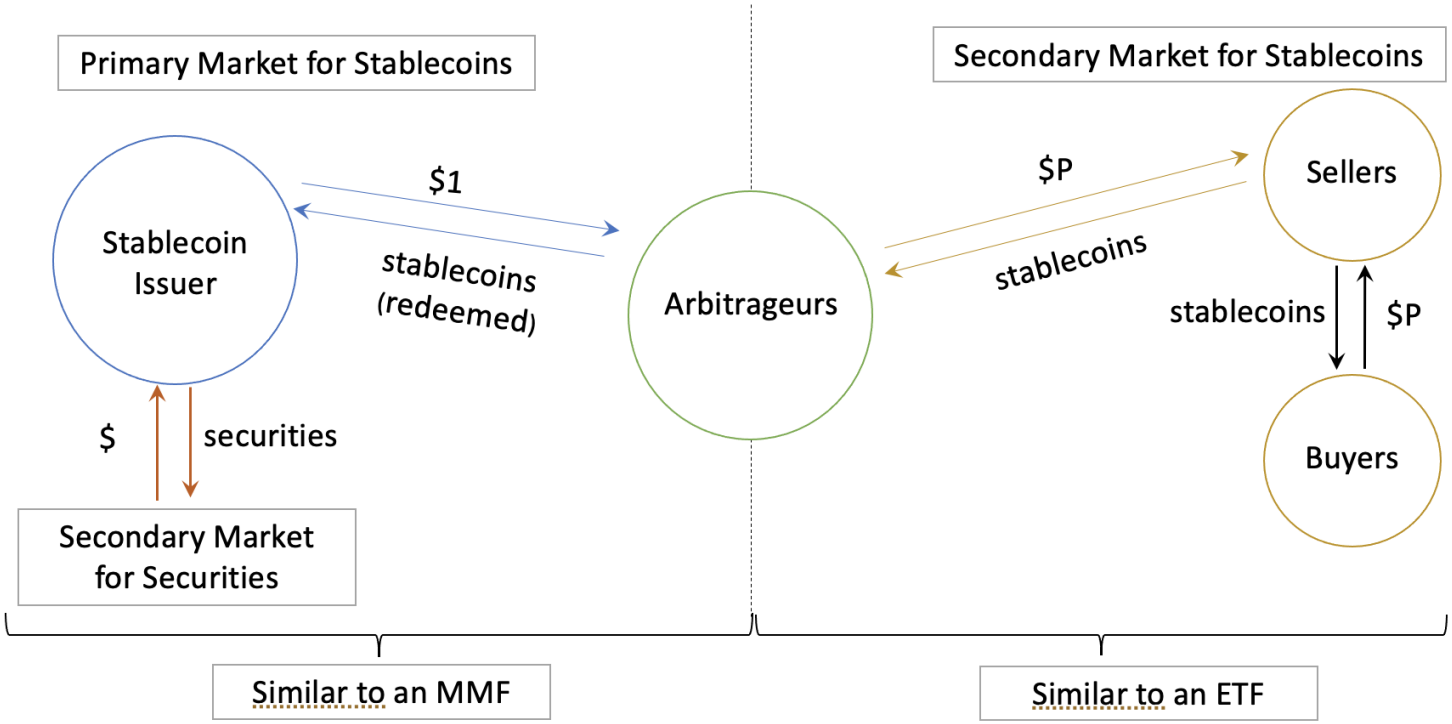
2. Can there be stablecoin runs among investors? How does market structure affect run risk?

3. What is the effect of issuing dividends to investors?
   - Should stablecoins be regulated as securities?

1. Facts: The Secondary Market



1. Facts: The Primary Market and Arbitrageurs



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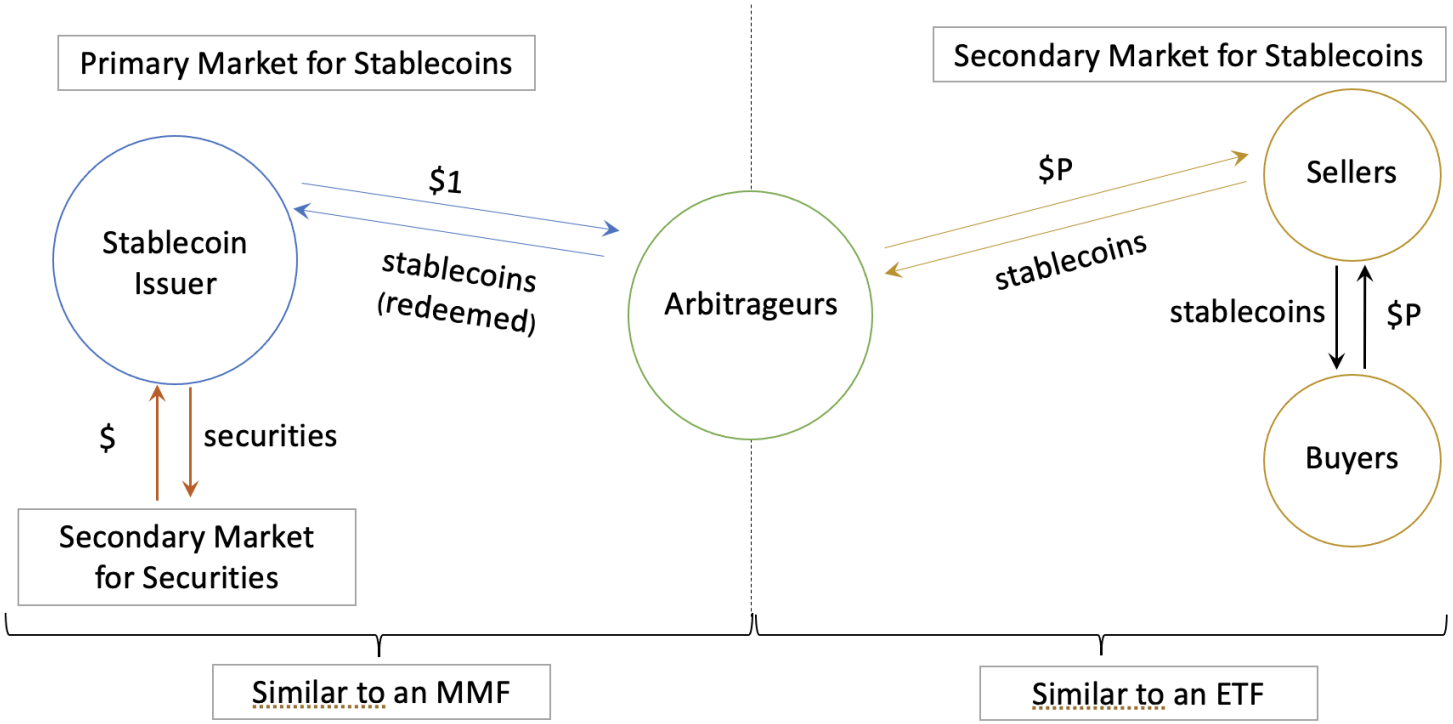
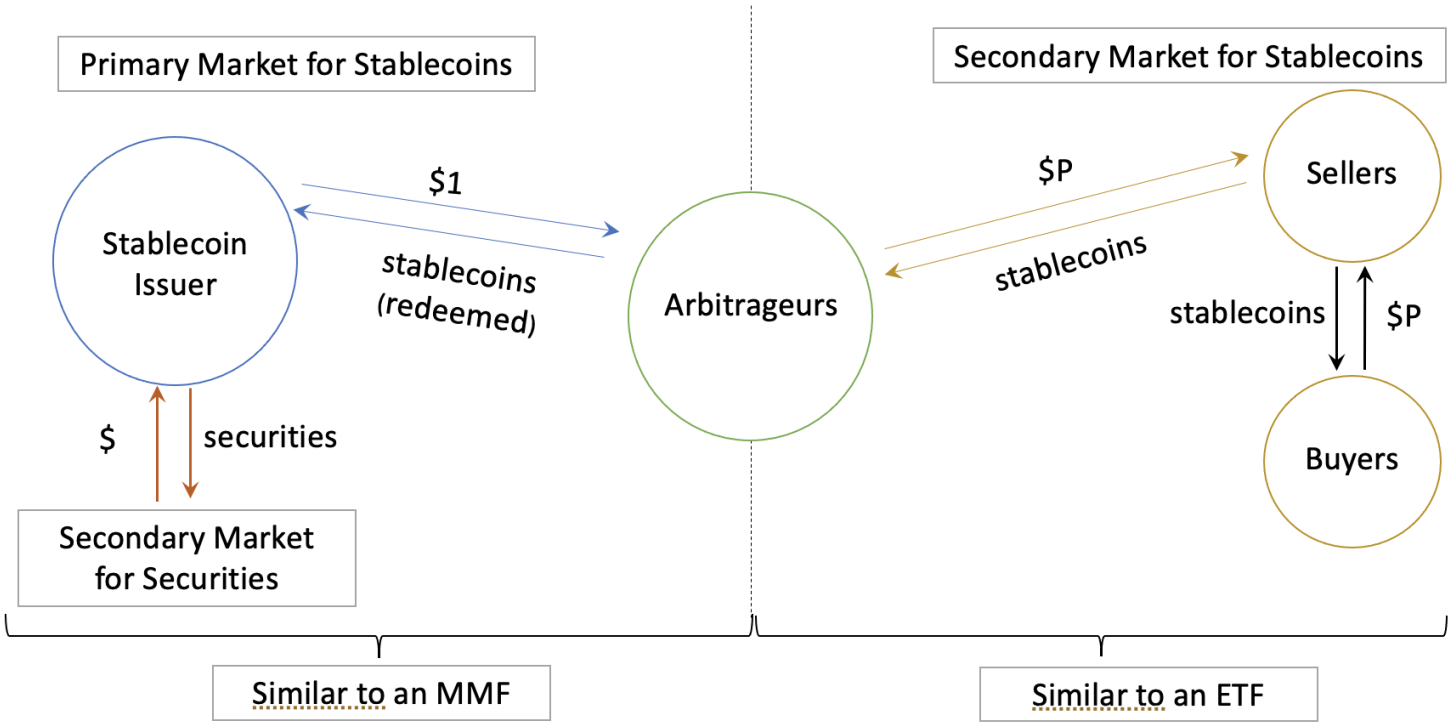


- Finding: the set of arbitrageurs who can redeem stablecoins is surprisingly concentrated; not "decentralized" as claimed
  - E.g. Tether only authorizes 6 arbitrageurs in a given month

2. Model: Panic Runs and Centralization of Arbitrage

- Arbitrage enhances price stability
- But arbitrage subjects USD stablecoins to panic runs because of liquidity transformation and despite exchange-trading



- Fundamental trade-off between price stability and financial stability in designing a stablecoin

3. Quantifying Run Risk and the Effect of Issuing Dividends

- Calibrate model to estimate run risk of major stablecoins
- Estimated run-risk:
  - 3.9% for the largest USD stablecoin, Tether (USDT)
  - 3.3% for the second-largest USD stablecoin, Circle (USDC)
  - Circle also has significant run risk due to less concentrated arbitrage despite lower liquidity transformation
- If Tether and Circle were to issue dividends to investors:
  - Run risk would be reduced
  - Price stability would be improved

Related Literature

1. Liquidity transformation
   - Banks: e.g. Diamond and Dybvig 83, Goldstein and Pauzner 05
   - MMFs: e.g. Kacperczyk and Schnabl 13, Schmidt, Timmermann and Wermers 16
   - ETFs: e.g. Reilly 22, Koont, Ma, Pastor, and Zeng 22

2. Stablecoins
   - Fiat-backed stablecoins: Frost, Shin, and Wierts 20, Gorton and Zhang 21, Lyons and Viswanath-Natraj 21, Gorton, Ross and Ross 22, Gorton, Klee, Ross, Ross, and Vardoulakis 23
   - Financial stability: Li and Mayer 21, d'Avernas, Maurin, and Vandeweyer 22, Routledge and Zetlin-Jones 22, Barthelemy, Gardin and Nguyen 21, Liao and Caramichael 22, Kim 22
   - Algorithmic stablecoins: Adams and Ibert 22, Uhlig 22, Liu, Makarov and Schoar 23

3. Limits to Arbitrage
   - e.g. Shleifer and Vishny 97, Gromb and Vayanos 02, Oehmke 10, Du and Zhu 17, Davila, Graves and Parlatore 22

Roadmap

1. Data and Stylized Facts
2. Model
3. Estimation
4. Conclusion

Data

We construct a novel dataset for the six largest USD stablecoins:

1. Primary Market Data
   - Blockchain records "mints" and "burns" of stablecoins
   - Transaction-level data with time-stamp, volume, wallet address
2. Secondary Market Data
   - Obtain stablecoin trading prices from main exchanges
   - Daily price: volume-weighted average hourly closing price across exchanges by trading volume
3. Reserves
   - Reported breakdowns of reserve assets (Circle and Tether)
     - Self-reported, likely an optimistic estimate
   - Asset haircuts and CDS spreads by asset category

Secondary Market Price

Fact 1. The trading price of stablecoins in the secondary market constantly deviates from \$1. This price deviation per se does not constitute a panic run per se by investors.

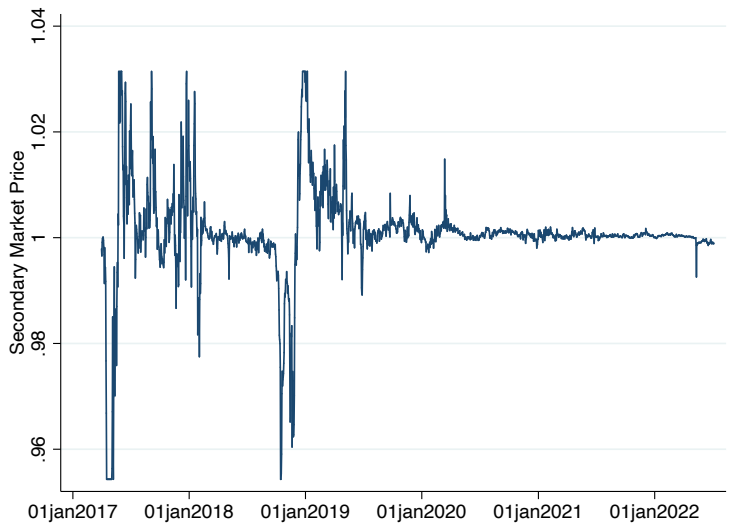


Figure: Tether (USDT)

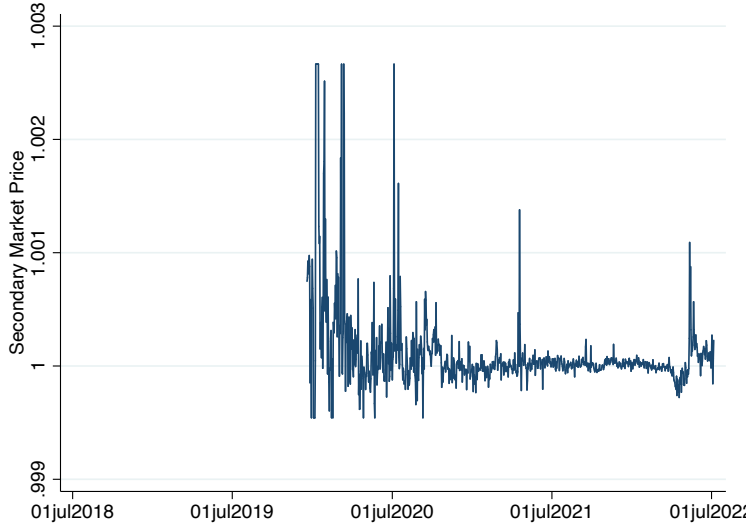


Figure: Circle (USDC)

- Consistent with existing empirical literature, e.g., Gorton and Zhang 21 and Lyons and Viswanath-Natraj 21

Primary Market Concentration

Fact 2. The redemption of stablecoins in the primary market is performed by a concentrated set of arbitrageurs

Table: Primary Market Monthly Redemption Activity

	USDT	USDC	BUSD	USDP	TUSD	GUSD
No. of Arbitrageurs	6	521	214	178	66	1
Top 1 Share (%)	66	45	48	41	50	100
Top 5 Share (%)	97	85	81	74	86	100
Vol (mil)	577	2976	1596	260	154	113

"To be approved by Tether [as an arbitrager], you have to go through due diligence, audits, and satisfy jurisdiction requirements...It's pretty hard. Before, there were only 6 [arbitrageurs], and now with FTX ['s Alameda] and 3AC gone, we are down to 4 or 3... ... Circle has much easier due diligence..."

Secondary Market Price and Primary Market Concentration

Fact 3. Stablecoins with more concentrated arbitrageurs experience more pronounced price deviations in the secondary market.

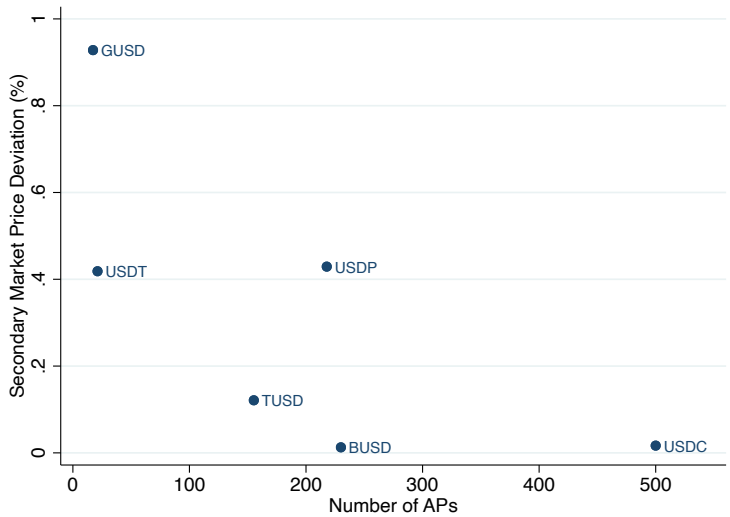


Figure: Number of Arbitrageurs

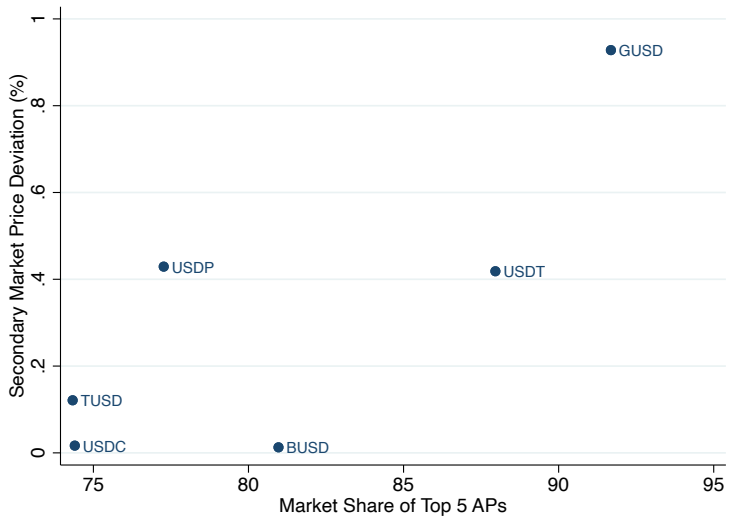


Figure: Top 5 Arbitrageurs Share

- Why centralized arbitrage if it makes stablecoins less stable and at the same time violates their goal of being decentralized?

Reserve Assets

Fact 4. Stablecoins engage in varying degrees of liquidity transformation by investing in illiquid assets.

Table: Tether (USDT)

	Deposits	Treas	Muni	MM	Corp	Loans	Others
2021/06	10.0	24.3	0.0	50.7	7.7	4.0	3.3
2021/09	10.5	28.1	0.0	45.7	5.2	5.0	5.5
2021/12	5.3	43.9	0.0	34.5	4.6	5.3	6.4
2022/03	5.0	47.6	0.0	32.8	4.5	3.8	6.4

Table: Circle (USDC)

	Deposits	Treas	Muni	MM	Corp	Loans	Others
2021/05	60.4	12.2	0.5	22.1	5.0	0.0	0.0
2021/06	46.4	13.1	0.4	24.2	15.9	0.0	0.0
2021/07	47.4	12.4	0.7	23.0	16.4	0.0	0.0
2021/08	92.0	0.0	0.0	6.5	1.5	0.0	0.0
2021/09	100.0	0.0	0.0	0.0	0.0	0.0	0.0
2021/10	100.0	0.0	0.0	0.0	0.0	0.0	0.0

Model (A Sketch)

Model Setup

- $t = 0, 1, 2, 3$
- A unit measure of infinitesimal investors
  - Choose to buy a stablecoin at $t = 0$ at a cost
  - Derive convenience from price stability at $t = 1$
  - Decide to sell at $t = 2$ or stay until $t = 3$
- Noise traders' trading hurts price stability at $t = 1$
- n identical arbitrageurs each with balance sheet capacity χ
- A representative stablecoin issuer
  - Holds a productive but illiquid reserve asset
    - Premature liquidation incurs discount ϕ
    - $R \geq 1$ at $t = 3$ with ex-ante unknown probability $\pi(\theta)$
  - Chooses arbitrage concentration n at $t = 0$

Price Stability and Arbitrage Concentration

- At $t = 1$, noise traders either buy or sell δ stablecoins from arbitrageurs with equal probability
- The stablecoin's secondary-market price at $t = 1$ is given by

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

  where $K = \frac{1}{\chi} \frac{n-1}{n(n-2)}$

- Price stability improves with more efficient arbitrage ($\downarrow K$)
  - When arbitrageurs are less concentrated ($\uparrow n$)
  - With better balance sheet capacity ($\uparrow \chi$)
- Investors suffer cost of price variance: $\alpha\delta^2 K^2$

Stablecoin Runs and Arbitrage Concentration

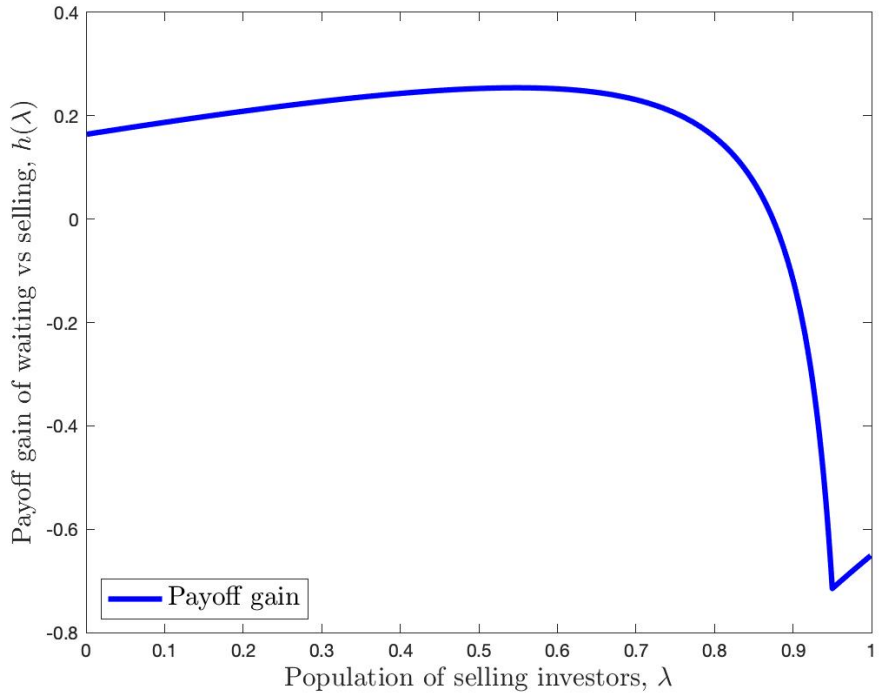
- At $t = 2$
  - Investors receive a private noisy signal about θ, where $1 - \pi(\theta)$ is the default prob of the reserve asset
  - λ investors sell stablecoins to arbitrageurs at the secondary market price q
  - Given λ, q is higher with more efficient arbitrage ($\downarrow K$)
- If investors wait until $t = 3$, they receive

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

  - η long term benefit

Stablecoin Runs and Arbitrage Concentration

- Payoff gains from waiting until $t = 3$ vs selling at $t = 2$



- There exists a unique run threshold $\pi(\theta^*)$
- The run threshold (risk) increases with arbitrage efficiency $K \downarrow$
  - $\rightarrow$ Tradeoff between financial stability and price stability

Issuer Optimization and the Effect of Dividends

- The stablecoin issuer chooses n to maximize expected profits:

$$\underbrace{G(E[W])}_{\text{participating investors}} \times \text{Revenue per investor if solvent}$$

- When the stablecoin issuer holds more illiquid assets, it optimally chooses a more concentrated set of arbitrageurs
  - In practice, Tether has more illiquid assets and more concentrated arbitrage than Circle

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- If the issuer distributes dividends to investors at $t = 3$
  - Investors incentives to stay to $t = 3 \uparrow \rightarrow$ issuer can allow for more arbitrage $\rightarrow$ price stability improves
  - The issuer's revenue, i.e., skin in the game, to prevent runs $\downarrow$ $\rightarrow$ effect on run risk depends

Model Calibration

Model Calibration for Tether and Circle

- Step 1: Solve for run threshold and probability for a given K
  1. Asset illiquidity ϕ
     - Repo haircuts from the NYFed
     - Similar to Bai, Krisnhamurthy, and Weymueller 12
  2. Long term benefit η
     - Stablecoin lending rates from Aave
     - Similar to Gorton, Klee, Ross, Ross, and Varoulakis 23
  3. Distribution of fundamentals $\pi(\theta)$
     - Distribution of recovery rates using CDS spreads

Model Calibration for Tether and Circle

- Step 2: Estimate variance cost $\alpha\delta^2$ and investors' demand $G(\cdot)$ to jointly match
  1. Slope of arbitrage demand w.r.t. sec. market price, i.e., K
  2. Slope of investor demand G w.r.t. long term benefit η

- Identification intuition:
  1. If issuer chooses low K, variance cost $\alpha\delta^2$ must be high
  2. Empirical $\frac{dG}{d\eta}$ pins down investors' demand slope $\frac{dG}{dE(W)}$

Slope of Arbitrage Demand and Slope of Investor Demand

- To obtain the slope of arbitrage demand K

$$\text{Max Price Deviations}_t = \beta \text{Redemption/Creation}_t + FE_y + \varepsilon_t$$

- For a 10 ppts $\uparrow$ in relative redemptions/creations
  - a 2.1 cent larger price deviation at USDT
  - a 1.6 cent larger price deviation at USDC

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- To obtain the slope of investor demand G w.r.t η

$$\text{Market Size}_t = \gamma \text{Lending Rate}_{t-1} + FE_y + \varepsilon_t$$

  - γ for USDT and USDC are 0.38 and 0.65, respectively

Estimated Run Probabilities

Coin	Month	ϕ	Run Prob
USDC	2021m5	0.0310	5.713%
USDC	2021m6	0.0343	7.459%
USDC	2021m7	0.0341	7.077%
USDC	2021m8	0.0270	3.372%
USDC	2021m9	0.0250	3.761%
USDC	2021m10	0.0250	3.336%
USDT	2021m6	0.0441	4.592%
USDT	2021m9	0.0447	4.711%
USDT	2021m12	0.0418	4.594%
USDT	2022m3	0.0400	3.927%

- Both Tether and Circle have significant run risk
- Tether has more illiquid assets but Circle has less concentrated arbitrage, which amplifies run risk

The Effect of Issuing Dividends

Figure: Price Variance Cost

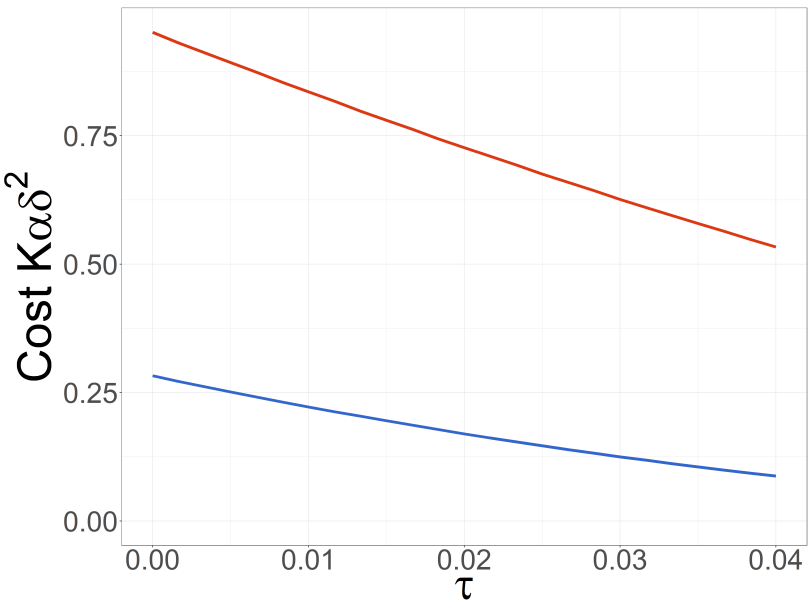
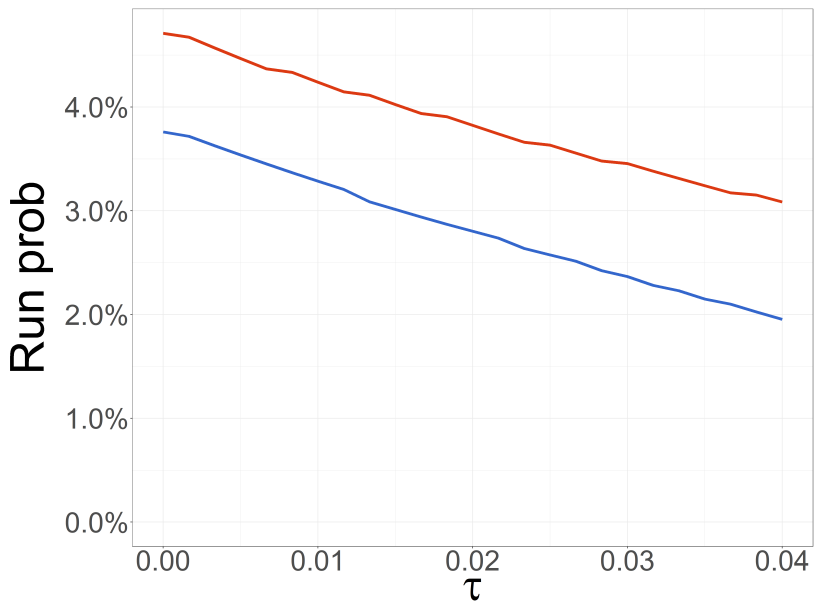


Figure: Run Probability



- If dividends were issued by Tether and Circle, their price stability would be improved and run risk would be reduced

Conclusion

1. USD stablecoins are subject to significant run risk from liquidity transformation
   - Despite exchange-trading
   - Despite concentrated arbitrage
2. Trade-off between price stability and financial stability
   - Arbitrage efficiency improves price stability
   - But arbitrage efficiency also amplifies run risk
3. Issuing dividends to investors could improve price stability and reduce run risk