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Stablecoins and Peg Risk

Introduction

Main purpose in this notebook:

- Explain why stablecoins depeg.
- Measure depeg behavior in market data.
- Connect peg deviations to arbitrage frictions and run-risk dynamics.

Three Economic Designs

The notebook compares three designs:

- Fiat-backed (custodial reserves).
- Crypto-collateralized (on-chain overcollateralization).
- Algorithmic (incentive/mechanism-based stabilization).

A reduced-form pricing identity used for interpretation is:

$$P_t = 1 - \lambda_t,$$

where λ_t is the market-implied redemption/liquidity-risk discount (Gorton et al. 2026).

Data: Measuring Peg Deviations

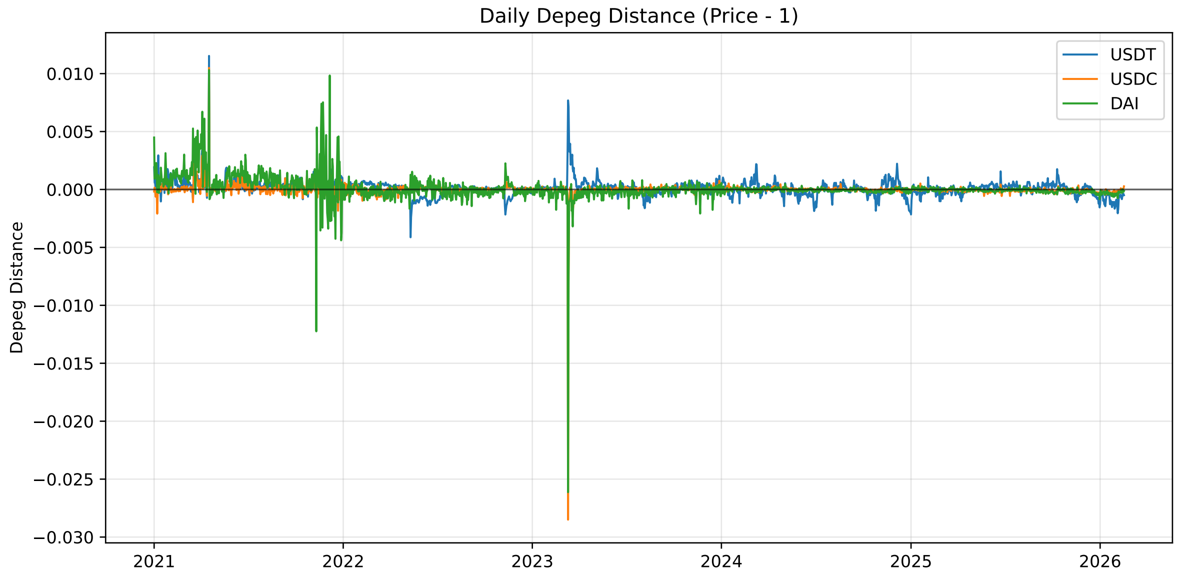
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import yfinance as yf
import warnings
warnings.simplefilter(action="ignore", category=FutureWarning)

tickers = ["USDT-USD", "USDC-USD", "DAI-USD", "BTC-USD", "ETH-USD"]
px = yf.download(tickers, start="2021-01-01", progress=False)["Close"].dropna(how="all")

stables = ["USDT-USD", "USDC-USD", "DAI-USD"]
d = px[stables] - 1.0

summary = pd.DataFrame({
    "mean_depeg": d.mean(),
    "std_depeg": d.std(),
    "min_depeg": d.min(),
    "max_depeg": d.max(),
    "mean_abs_depeg": d.abs().mean(),
})
summary
```

	mean_depeg	std_depeg	min_depeg	max_depeg	mean_abs_depeg
Ticker					
USDT-USD	0.000123	0.000723	-0.004128	0.011530	0.000454
USDC-USD	-0.000004	0.000787	-0.028500	0.010496	0.000198
DAI-USD	0.000077	0.001136	-0.026131	0.010310	0.000485



Key result:

- Depeg distance is usually small but not zero; stress episodes generate larger deviations.

Arbitrage Logic Around the Peg

No-arbitrage friction band used in the notebook:

$$|P_t - 1| \leq \kappa.$$

If observed depegs exceed this band frequently, markets are pricing meaningful redemption or liquidity frictions (Gorton et al. 2026).

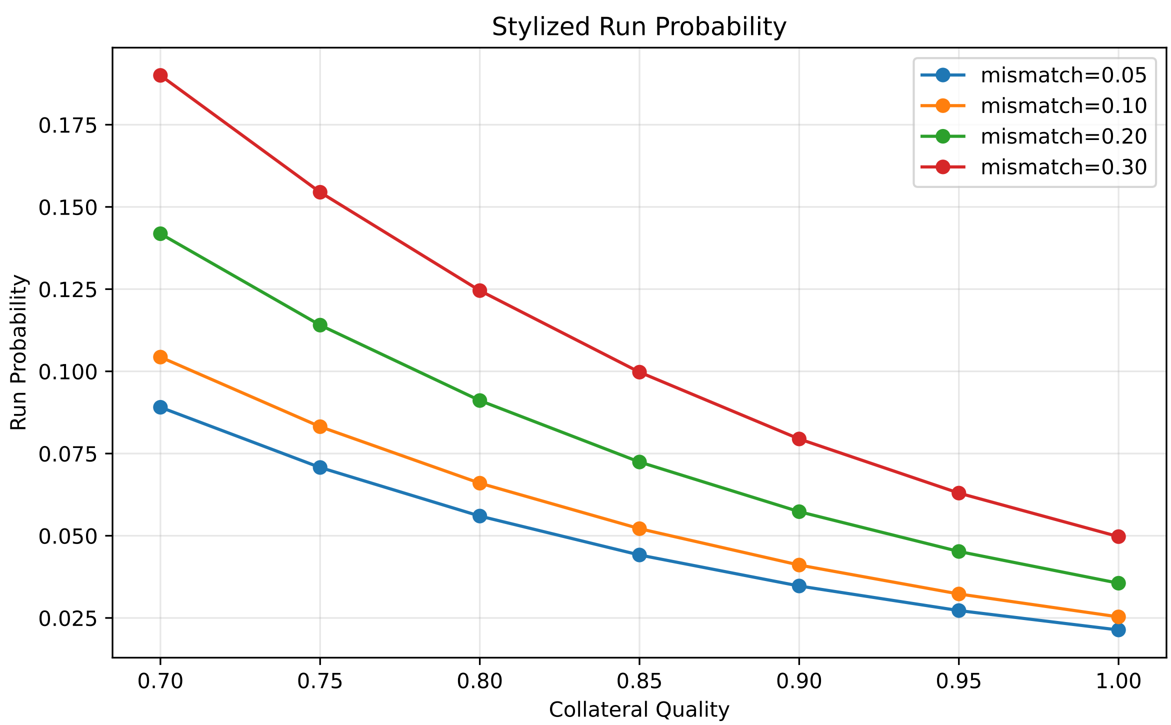
```
Ticker
USDT-USD    0.014949
USDC-USD    0.005873
DAI-USD     0.034170
Name: share_outside_band, dtype: float64
```

Run Risk as a Coordination Problem

Stylized run-probability mapping:

$$\Pr(\text{run}) = \sigma(a + b(1 - c) + \gamma\ell),$$

where c is collateral quality and ℓ is liquidity mismatch (Gorton et al. 2026).

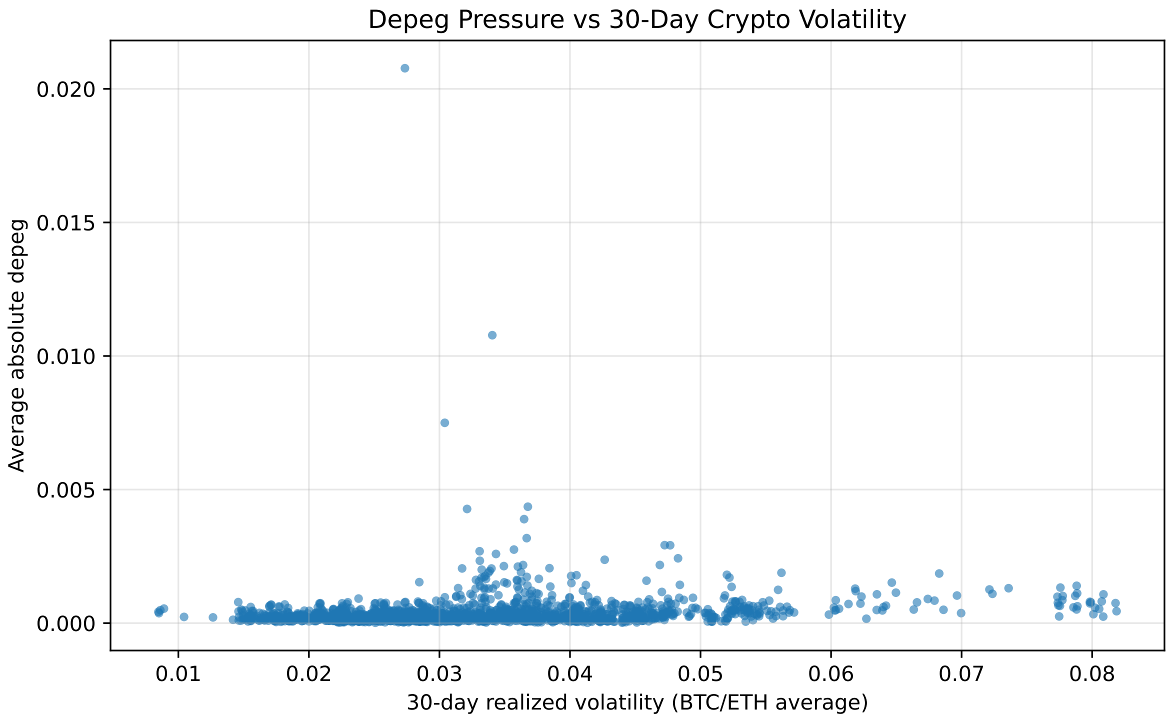


Key result:

- Run probability rises nonlinearly as collateral quality falls and liquidity mismatch rises.

Stablecoins and Market Stress

```
/tmp/ipykernel_1996198/307199599.py:4: Pandas4Warning: Sorting by default when concatenating
  joined = pd.concat([rv, depeg_pressure], axis=1).dropna()
```



	crypto_risk_30d	avg_abs_depeg
crypto_risk_30d	1.000000	0.150746
avg_abs_depeg	0.150746	1.000000

Interpretation:

- Depeg pressure and market volatility often co-move during stress (Griffin and Shams 2020).
- This is descriptive evidence, not a causal estimate.

Takeaways

- Stablecoins are peg mechanisms with balance-sheet and liquidity risk.
- Persistent depegs should be interpreted as risk premia, not pure noise.
- Arbitrage frictions and run dynamics are central for understanding peg breaks.
- This notebook is an in-sample diagnostic exercise, not a trading strategy backtest.

Gorton, Gary B., Elizabeth C. Klee, Chase P. Ross, Sharon Y. Ross, and Alexandros P. Vardoulakis. 2026. "Leverage and Stablecoin Pegs." *Journal of Financial and Quantitative Analysis* 61 (1): 99–136. https://doi.org/10.1017/S0022109025000134.

Griffin, John M., and Amin Shams. 2020. "Is Bitcoin Really Untethered?" *Journal of Finance* 75 (4): 1913–64. https://doi.org/10.1111/jofi.12903.