

# MAKING MONEY

Gary B. Gorton<sup>1</sup> Chase P. Ross<sup>2</sup> Sharon Y. Ross<sup>3</sup>

<sup>1</sup>Yale & NBER

<sup>2</sup>Federal Reserve Board

<sup>3</sup>Office of Financial Research, U.S. Treasury

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The views of this paper do not necessarily reflect the views of the Office of Financial Research, the Board of Governors of the Federal Reserve System, or their staffs.

## OVERVIEW

- It is difficult for private agents to make money

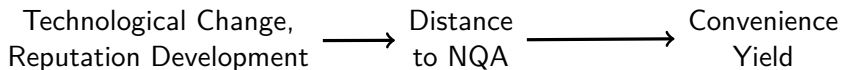
Minsky (1986): “Everyone can create money; the problem is to get it accepted.”

- Private debt can become money if agents accept the debt **no-questions-asked (NQA)** at par and without reservation or costly due diligence—it must be **information-insensitive**
- We study how private agents produce money
- We study two types of private debt:
  - ① Pre-Civil War private banknotes
  - ② Currently-issued digital stablecoins
- We show private banknotes and stablecoins have similar properties, dynamics, and challenges in getting their debt accepted as money NQA

- Money must satisfy the *no-questions-asked* (NQA) principle (Holmström 2015)
- Money earns a non-pecuniary return called the convenience yield
- Money is created by the government and private issuers
  - Privately-produced money is introduced when there are no better alternatives
  - But it rarely achieves NQA status (and only within a limited geographical area)
- The birth of new privately-produced money requires two ingredients: a lack of alternatives and a design that makes the money NQA

## RESULTS

- ① We estimate each new money's distance to NQA and convenience yield
  - At inception, new money often carries an *inconvenience* yield
- ② If a new money becomes closer to achieving NQA, its convenience yield increases
- ③ Technological change and reputation development decrease a new money's distance to NQA



- ④ Stablecoins have not developed individual reputations, which makes them more vulnerable to runs

# DISTANCE TO NQA

## MODEL INTUITION BASED ON GORTON (1999, JME)

- Banks at various distances from the agent's home issue debt called banknotes (or stablecoins)
- A banknote is a perpetual zero-coupon bond with an embedded put option to redeem at par
- Key variable: distance to no-questions-asked,  $d$ 
  - $d$  is a latent variable reflecting the frictions of using something as money
  - When  $d = 0$ , there are no frictions to redemption at face value, so it is accepted no questions asked
  - Distance implied by bank quotes and stablecoin prices using Black-Scholes,  $\hat{d}$
- The convenience yield is decreasing in  $d$

# PRE-CIVIL WAR PRIVATE BANKNOTES

STABLECOINS

CONCLUSION

# PRE-CIVIL WAR PRIVATE BANKNOTES



# PRE-CIVIL WAR PRIVATE BANKNOTES

## CONTEXT

- Private banknotes were a physical currency issued by a specific bank redeemable into specie, at par, on demand
- The notes did not trade at par: they were discounted at distances away from the issuing bank
- Merchants and customers needed to know the discounts and feared counterfeits and notes issued by bad banks
- **Banknote reporters** reported each banknote's price in the form of **discounts** — everybody used the detectors to value the banknotes with which they transacted



Dec. 1858

## VIRGINIA—WISCONSIN.

|   |               |
|---|---------------|
| <b>Farmers Bank of Virginia</b> ..... Richmond 3/4    | (J. A. Smith) |
| Branch at Alexandria..... W. H. Marbury, Cashr.       | 5/8           |
| Branch at Charlotteville..... Wm. A. Robb, Cashr.     | 3/4           |
| Branch at Danville..... Geo. W. Johnson, Cashr.       | 3/4           |
| Branch at Farmville..... A. G. Gwynn, Cashr.          | 3/4           |
| Branch at Fredericksburg..... Thos. Matthews, Cashr.  | 3/4           |
| Branch at Lynchburg..... Alex. Tompkins, Cashr.       | 3/4           |
| Branch at Norfolk..... A. S. Stutts, Cashr.           | 3/4           |
| Branch at Petersburg..... Pleasant G. Osborne, Cashr. | 3/4           |
| Branch at Winchester..... Jas. H. Sheppard, Cashr.    | 3/4           |
| Branch at Wytheville..... W. W. Hanson, Cashr.        | 3/4           |

10c. Fig. 3 figures drawn by sea horses. Unlike genuine.  
 10c. spurious. Vignette, a female sitting on a rock, holding in left hand a pole. On the right is a sheaf of wheat.  
 10c. letter D, variously filled. The face on each side of the figure; D, left margin, scarcely perceptible. Some Jan. 1 & 2, 1841. Vignette coarse.

10c. Vignette, reaper lying under a stack of grain.

10c. spurious. Vig. two females, &c., building left corner.

20c. Pay to A. Walker, dated Richmond, Oct. 2, 1843. Vignette, female and sheaf of grain. Engraving coarse.

30c. let. B, pay at Lynchburg, to Wm. Radford, dated June 4, 1841, J. C. Blair, cash. Very good imitation. Fingers defective on the left hand of the female in the vignette, and the right foot looks as if it was bandaged.

30c. 1 altered from 5c. Vignette, a female sitting on a

50c. 1. rock, holding in her hand a stalk of tobacco.

60c. spurious. Vig. a farmer reaping near a sheaf.

50c. "50" on it six times—not so the genuine.

50c. spurious. Vignette, a man under a tree.

100c. spurious. Vignette, two females, &c.

100c. altered from an old plate. Vig. mercury, scales, &c.

**Manuf. & Farmers Bk** [J. R. Dickey, J.] Wheeling 3/4

5c. Vignette, men at work in a building; portrait on the left end; well done.

**Merchants' Bank** [Robt. C. Mitchell] Lynchburg 3/4

5c. spurious. Vignette, two females, ships in the distance.

5c. spurious. Vignette, steamship; female on right end.

**Bank of Eau Claire** [C. M. Seley] Eau Claire 1/2  
 10c. altered from 1c. No genuine 10c. on this bank.

**Bank of Fond-du-Lac** [Chas. W. Winfield] 1/2  
 10c. altered from 1c. Vignette, cattle and sheep.

**Bank of Fox Lake** [W. J. Dexter] Fox Lake 1/2  
 5c. altered by putting Washington and Lady, right end.  
 10c. altered from 1c. No genuine 10c.

**Bank of the Interior** [Geo. L. Field] Warsaw 1/2

**Bank of Jefferson** [A. H. Van Ostrand] Jefferson 1/2

**Bank of La Pointe**..... La Pointe 1/2

**Bank of Milwaukee** [T. E. B. Eldridge] Milwaukee 1/2

5c. spurious. Vignette, 3 females, plough, &c.

5c. altered from 1c. Vig. three sea nymphs and a cupid.

5c. spurious. Vig. sailor holding a flag, shipping, &c.

10c. spurious. Vignette, eagle, shield, &c.

20c. spurious. No Comptroller's die on it.

20c. altered. Vig. Indian & woman, horse, bee-hive, &c.

**Bank of Monroe**..... [J. B. Galusha]..... Monroe 1/2

**Bank of Manitowoc**..... Manitowoc 1/2

**Bank of Moneka**..... Gordon 1/2

**Bank of New London**..... New London 1/2

**Bank of Montello**..... [G. S. Kelsey]..... Montello 1/2

**Bank of North America**..... Superior 1/2

**Bank of the N. West** [A. G. Ruggles] Fond du Lac 1/2

**Bank of Oconto**..... [J. F. Woodruff]..... Oconto 1/2

**Bank of Oshkosh**..... [A. W. Kellogg]..... Oshkosh 1/2

**Bank of Portage**..... [H. L. Norton]..... Portage 1/2

**Bank of Racine**..... [Daniel Ullman]..... Racine 1/2

10c. altered from 1c. Vignette, a house, man, woman, and horse; on lower left corner, man on horse-back, cattle, &c.

20c. & 50c. altered. No 20c. or 50c. issued by this bank.

**Bank of Ripon**..... [E. F. Brockway]..... Ripon 1/2

## WISCONSIN—CANADA—N.

**Globe Bank**..... [W. E. Freeman]..... Milwaukee 1/2

**Green Bay Bank**..... [N. Ludington]..... Marinette 1/2

**Hall & Bro's Bank** [D. K. Moore] Eau Claire 1/2

**Hudson City Bank**..... [M. S. Johnson]..... Hudson 1/2

10c. altered from 1c. Vig. on lower left corner a glassboat landing, &c.

**Janesville City Bk.** [H. Richardson] Janesville 1/2

10c. altered from 1c. The bank has no 10c.

**Jefferson Co. Bank** [Daniel Jones] Watertown 1/2

2c. Vignette, Harrison and an Indian.

5c. 10c. & 20c. altered from 1c. Vig., Indian and woodman.

**Juncon Bank**..... [Saml. B. Scott]..... Milwaukee 1/2

**Kankakee Bk** [H. W. Harwood] Black River Falls 1/2

**Kewaunee Bank**..... [Geo. A. Beck]..... La Crosse 1/2

**Kenosha Co. Bank** [J. H. Kimball] Kenosha 1/2

**Kokomo Bank**..... Hillsdale 1/2

**Laborers' Bank**..... [E. C. Hall]..... Ellipse 1/2

**La Crosse Co. Bank** [W. W. Webb] La Crosse 1/2

**Lumbermen's Bank** [J. B. Kemere] Conterelle 1/2

10c. Engraving poor and paper light.

**Manitoue Co. Bk** [L. Kemper] Two Rivers 1/2

**Marathon City Bank**..... Gemekon 1/2

**Marathon Co. Bank** [C. Wheeler] Eagle River 1/2

**Marine Bank**..... [J. H. Skidmore]..... Milwaukee 1/2

**Mechanics' Bank**..... [E. G. Martin]..... Superior 1/2

**Memomonee Bank**..... Memomonee 1/2

**Merchants' Bank**..... [H. R. Church]..... Madison 1/2

2c. Vignette, sheaf, cars, bridge, canal locks, &c.

5c. spurious. Vignette, Indian viewing train of cars.

**Mercantile Bk** [W. B. Huntington] Beaver Dam 1/2

10c. altered from 2c. Vignette, doves, cattle, pigs, &c.

**Merch. & Mech. Bk** [J. S. Partridge] Whitewater 1/2

**Monroe Co. Bank**..... [J. E. Myers]..... Sparta 1/2

**Northern Bank** [Robert Chappell] Green Bay 1/2

**Northern Wisconsin Bank** [E. Wood] Aurora 1/2

Dec. 1858

44

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Branch at Charlotte... H. H. Cook, Cashr. 3/4  
Branch at Charlottesville... Wm. A. Robb, Cashr. 7/8  
Branch at Danville... Gen. W. Johnson, Cashr. 7/8  
Branch at Farmville... A. G. Vaughan, Cashr. 7/8  
Branch at Fredericksburg... A. Goodwin, Cashr. 7/8  
Branch at Lynchburg... Thos. Matthews, Cashr. 7/8  
Branch at Norfolk... Alex. Tompkins, Cashr. 7/8  
Branch at Petersburg... Pleasant G. Osborne, Cashr. 7/8  
Branch at Winchester... Jas. H. Sheppard, Cashr. 7/8  
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10s. Vig. 3 figures drawn by sea horses. Unlike genuine.  
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10s. letter D, vignettes filled. The face on each side of the figure is Jan. 1 & 8, 1858.

10s. Vignette.  
10s. spurious V.  
20s. Pay to A. Vignette, female  
30s. let. B, pay 4, 1841, J. C. defective on the right  
30s. Altered 6  
50s. 1. rock, boat  
60s. spurious  
50s. "50" on it  
50s. spurious V.  
100s. spurious Vignette, two females, &c.  
100s. altered from an old plate. Vig., mercury, scales, &c.

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## DISTANCE TO NO-QUESTIONS-ASKED WITH BLACK-SCHOLES

- Find  $\hat{d}$  that solves

$$P_t(\hat{d}) = \frac{V_t - [V_t N(d_1) - D_t^R \exp\{-r_f \hat{d}\} N(d_2)]}{D_t^R}$$

where

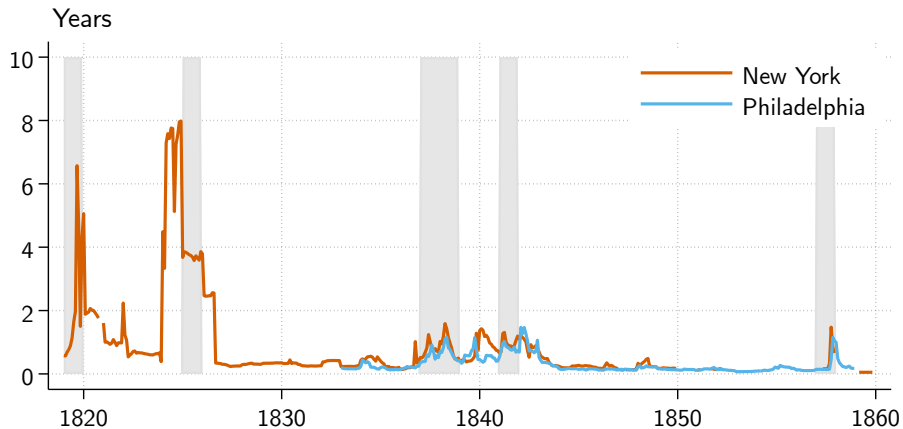
$$d_1 = \frac{\ln(V_t/D_t^R) + (r_f + \frac{\sigma^2}{2})\hat{d}}{\sigma\sqrt{\hat{d}}} \text{ and } d_2 = d_1 - \sigma\sqrt{\hat{d}}$$

- **Assume:**

- $P = 100$ –Quote
- $\sigma$  = volatility of asset growth over previous year
- $r_f$  from 10-Year Treasury yield from Global Financial Data
- $V_t$  = Market value of equity and debt = total assets
- $D_t^R$  = banknotes to redeem = 1 by hypothesis

# BANKNOTE DISTANCE TO NO-QUESTIONS-ASKED

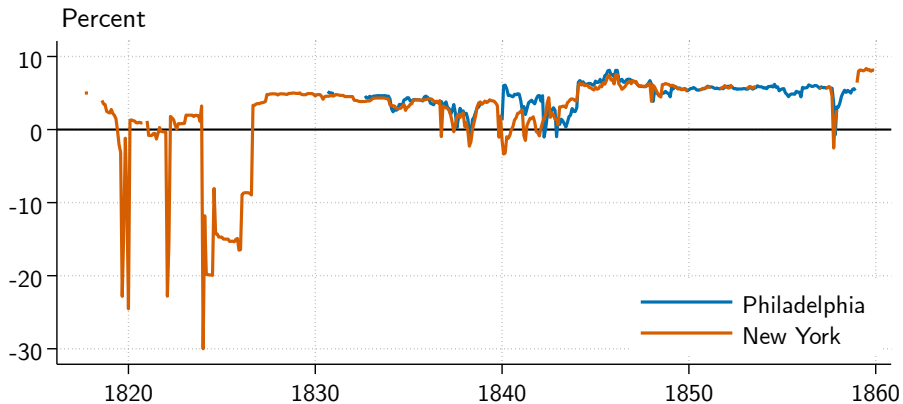
## VALUE-WEIGHTED AVERAGE



# BANKNOTE CONVENIENCE YIELD

VALUE-WEIGHTED AVERAGE

$$\text{Convenience Yield}_{it} = \text{Benchmark Yield}_{it} - \text{Money-like Debt Yield}_{it}$$



[Banknote Yields](#)

[Details](#)

## ① Distance to No-Questions-Asked

- Distance implied by bank quotes and stablecoin prices using Black-Scholes,  $\hat{d}$

## ② Convenience Yield

$$\text{Convenience Yield}_{it} = \text{Benchmark Yield}_{it} - \text{Money-like Debt Yield}_{it}$$

## ③ Technology, Reputation $\rightarrow$ Distance to NQA $\rightarrow$ Convenience Yield

PRE-CIVIL WAR PRIVATE BANKNOTES

STABLECOINS

CONCLUSION

- Stablecoins are privately-issued digital tokens residing on a blockchain
- Issuers back their stablecoins one-for-one with reserves
- Many lend their stablecoins to borrowers who want leverage for crypto trading
  - People borrow stablecoins to finance buying Bitcoin, just like borrowing dollars to finance a stock purchase
  - We use lending data from a large exchange which allows direct lending of many currencies



# SUMMARY STATISTICS

## 10 LARGEST STABLECOINS

| <i>Ticker</i> | July 2021 Characteristics |                       |                  | Price |        |          |      |      | Price Relative to \$1 (% of <i>N</i> ) |        |           |
|---------------|---------------------------|-----------------------|------------------|-------|--------|----------|------|------|--|--------|-----------|
|               | <i>N</i><br>days          | Market Cap.<br>\$ mln | Volume<br>\$ mln | Mean  | Median | St. Dev. | Min  | Max  | Below \$1                              | At \$1 | Above \$1 |
| 1 USDT        | 1,661                     | 62,390                | 1,095,432        | 1.00  | 1.00   | 0.02     | 0.57 | 1.32 | 0.06                                   | 0.87   | 0.08      |
| 2 USDC        | 729                       | 26,450                | 47,553           | 1.00  | 1.00   | 0.01     | 0.98 | 1.04 | 0.03                                   | 0.83   | 0.14      |
| 3 BUSD        | 485                       | 11,131                | 77,409           | 1.00  | 1.00   | 0.00     | 0.98 | 1.01 | 0.03                                   | 0.94   | 0.03      |
| 4 DAI         | 444                       | 5,260                 | 11,838           | 1.00  | 1.00   | 0.01     | 0.93 | 1.06 | 0.08                                   | 0.53   | 0.39      |
| 5 USTERRA     | 177                       | 1,981                 | 983              | 1.00  | 1.00   | 0.01     | 0.96 | 1.04 | 0.10                                   | 0.61   | 0.29      |
| 6 TUSD        | 876                       | 1,402                 | 1,500            | 1.00  | 1.00   | 0.01     | 0.94 | 1.07 | 0.06                                   | 0.79   | 0.15      |
| 7 PAX         | 743                       | 906                   | 1,308            | 1.00  | 1.00   | 0.01     | 0.98 | 1.04 | 0.06                                   | 0.82   | 0.13      |
| 8 LUSD        | 85                        | 629                   | 127              | 1.01  | 1.01   | 0.01     | 0.97 | 1.07 | 0.06                                   | 0.15   | 0.79      |
| 9 HUSD        | 486                       | 561                   | 1,551            | 1.00  | 1.00   | 0.00     | 0.97 | 1.05 | 0.04                                   | 0.90   | 0.06      |
| 10 USDN       | 390                       | 407                   | 596              | 1.00  | 1.00   | 0.01     | 0.95 | 1.02 | 0.27                                   | 0.65   | 0.09      |

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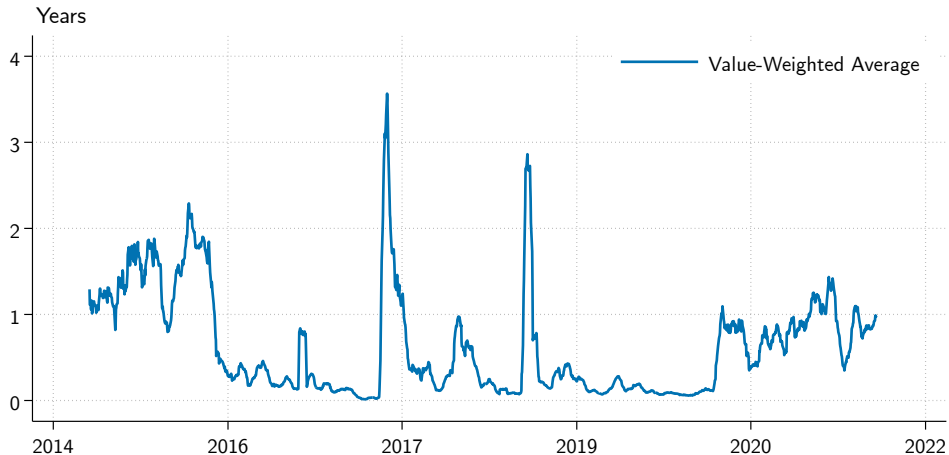
# SUMMARY STATISTICS

## SELECTED FUNDING RATES

|                    | Ticker | Name         | Avg. Rate<br>(%) | $\sigma$<br>(%) | Avg. Term<br>(Days) | Avg. Funding<br>(\$ mil) | $N$<br>(Days) |
|--------------------|--------|--------------|------------------|-----------------|---------------------|--------------------------|---------------|
| <i>Fiat</i>        | BTC    | Bitcoin      | 8.8              | 10.8            | 18.3                | 226.3                    | 2,186         |
|                    | ETH    | Ether        | 6.9              | 9.0             | 8.9                 | 84.9                     | 900           |
|                    | BTCN   | Bitcoin Cash | 2.1              | 10.4            | 8.2                 | 3.2                      | 112           |
|                    | LTC    | Litecoin     | 6.7              | 11.3            | 15.9                | 9.1                      | 900           |
| <i>Stablecoins</i> | USDT   | Tether       | 12.4             | 9.9             | 13.4                | 33.1                     | 674           |
|                    | DAI    | Dai          | 17.0             | 38.8            | 40.4                | 0.1                      | 260           |
| <i>Sovereign</i>   | USD    | Dollars      | 26.7             | 27.1            | 20.2                | 283.3                    | 2,186         |
|                    | EUR    | Euro         | 14.6             | 16.0            | 13.3                | 7.2                      | 975           |
|                    | GBP    | Pounds       | 14.8             | 26.3            | 15.8                | 0.2                      | 863           |
|                    | JPY    | Yen          | 17.1             | 19.5            | 14.7                | 0.2                      | 865           |

# STABLECOIN $\hat{d}$

## 30-DAY MOVING AVERAGE



Stablecoin Count

Top 3  $\hat{d}$

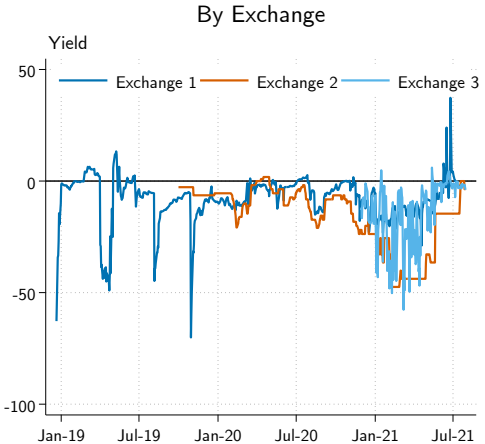
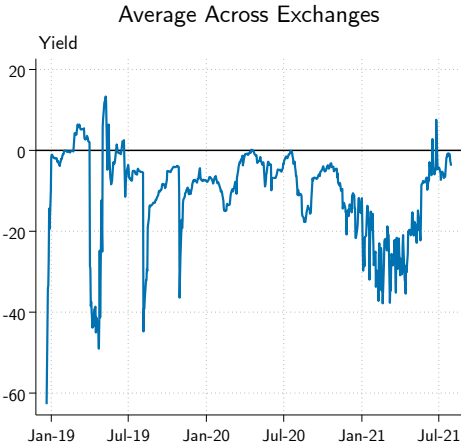
## STABLECOIN CONVENIENCE YIELD

$$\text{Stablecoin Convenience Yield} = \underbrace{\text{Benchmark Yield}}_{(1)} - \underbrace{\text{Stablecoin Yield}}_{(2)}$$

- ① We use three measures as the non-money benchmark yield
  - Bitcoin's lending rate
  - CME's Bitcoin futures implied repo rate
  - 1-month overnight-indexed swaps
- ② The stablecoin yield is the stablecoin lending rate

# STABLECOIN CONVENIENCE YIELD

## BITCOIN LENDING RATE VS. TETHER LENDING RATE



Summary Statistics

## STABLECOIN DISTANCE TO NQA AND CONVENIENCE YIELD

- Issuers deliberately try to affect  $d$ , and  $d$  is endogenously determined [details](#)
- We identify the effect of  $\hat{d}$  on the convenience yield using exogenous shocks to  $d$
- We treat **launches of new Nvidia GPUs** as exogenous shocks to  $d$ 
  - Nvidia designs graphics processing units (GPUs) for video games
  - But blockchain miners also use Nvidia GPUs to mine Ether
- We regress the convenience yield on  $\hat{d}$  for the 3 days after new Nvidia GPU releases



PRE-CIVIL WAR PRIVATE BANKNOTES

STABLECOINS

CONCLUSION

## CONCLUSION

- It is difficult for private agents to make money
- We studied two forms of privately-produced money: pre-Civil War banknotes and current stablecoins
- Stablecoins remain a ways away from being accepted as money, no-questions-asked
- As a result, stablecoins do not yet earn a positive convenience yield—just like early private banknotes
- Stablecoins have not established independent reputations and are vulnerable to runs



# Appendix

## BLACK-SCHOLES DETAILS: PRIVATE BANKNOTES

- Find  $\hat{d}$  that solves

$$P_t(\hat{d}) = \frac{V_t - [V_t N(d_1) - D_t^R \exp\{-r_f \hat{d}\} N(d_2)]}{D_t^R}$$

where

$$d_1 = \frac{\ln(V_t/D_t^R) + (r_f + \frac{\sigma^2}{2})\hat{d}}{\sigma\sqrt{\hat{d}}} \text{ and } d_2 = d_1 - \sigma\sqrt{\hat{d}}$$

- **Assume:**

- $P = 100$ —Quote
- $\sigma$  = volatility of asset growth over previous year
- $r_f$  from 10-Year Treasury yield from Global Financial Data
- $V_t$  = Market value of equity and debt = total assets
- $D_t^R$  = banknotes to redeem = 1 by hypothesis

## BLACK-SCHOLES DETAILS: STABLECOINS

- Find  $\hat{d}$  that solves

$$P_t(\hat{d}) = \frac{V_t - \left[ V_t N(d_1) - D_t^R \exp\{-r_f \hat{d}\} N(d_2) \right]}{D_t^R}$$

where

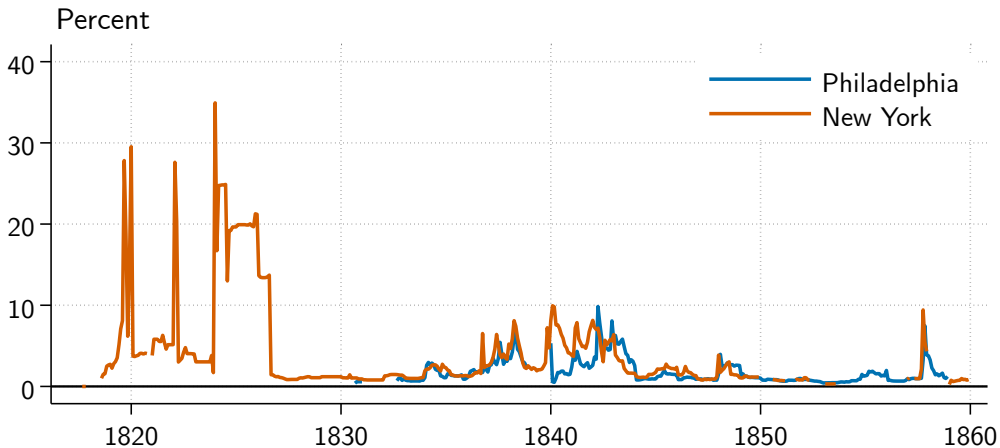
$$d_1 = \frac{\ln(V_t/D_t^R) + (r_f + \frac{\sigma^2}{2})\hat{d}}{\sigma\sqrt{\hat{d}}} \text{ and } d_2 = d_1 - \sigma\sqrt{\hat{d}}$$

- **Assume:**

- $\sigma$  = volatility of historical stablecoin price over past quarter
- $r_f$  for an arbitrary maturity estimated from Treasury curve each day
- $V_t$  = market value of equity and debt = 100 by hypothesis
- $D_t^R$  = stablecoins to redeem = 1 by hypothesis

# BANKNOTE YIELD

VALUE-WEIGHTED AVERAGE



## BANKNOTE CONVENIENCE YIELD

$$\text{Convenience Yield}_{it} = \underbrace{\text{Benchmark Yield}_{it}}_{(1)} - \underbrace{\text{Money-like Debt Yield}_{it}}_{(2)}$$

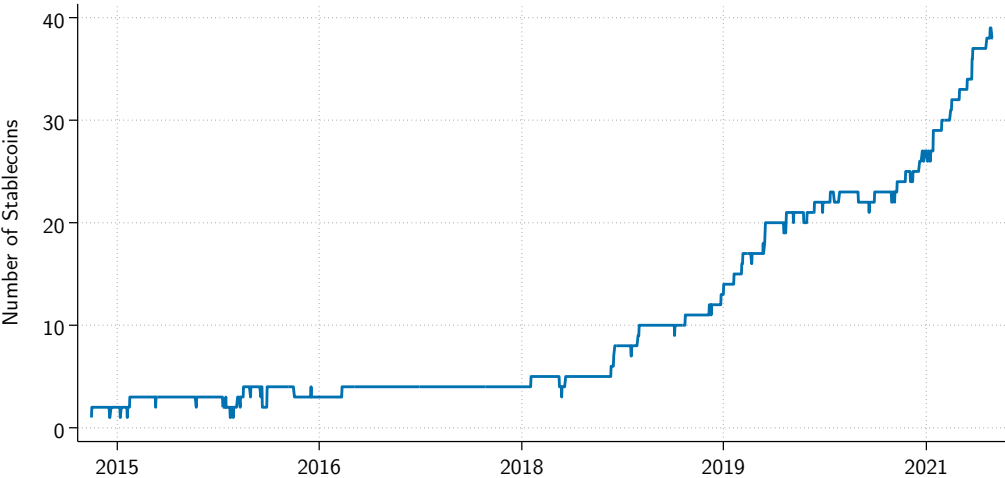
- ① We use two non-money benchmarks as a counterfactual for if there were such a form of AAA-rated money
  - Moody's AAA corporate bond yield
  - Moody's municipal bond yield
- ② We calculate the banknote's implied yield using the note's discount:

$$\text{Money-like Debt Yield}_{it} = \left( \frac{\text{Banknote Quote}_{it}}{100 - \text{Banknote Quote}_{it}} \right)$$

- Estimates what a note broker would earn by taking the note back to issuing bank and asking for par in specie

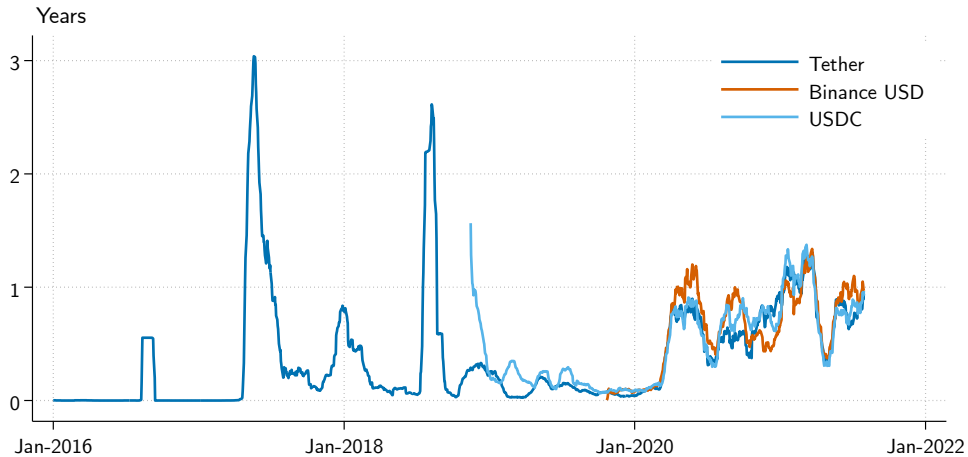


# STABLECOIN COUNT



# STABLECOIN $\hat{d}$ DYNAMICS

## SELECT STABLECOINS



## STABLECOIN CONVENIENCE YIELD SUMMARY STATISTICS

| Stablecoin | Exchange   | Bitcoin Lending CY |         | Implied Repo Rate CY |         | Overnight-Indexed Swap CY |         |
|------------|------------|--------------------|---------|----------------------|---------|---------------------------|---------|
|            |            | Mean               | St. Dev | Mean                 | St. Dev | Mean                      | St. Dev |
| USDT       | Average    | -10.2              | 10.8    | -15.9                | 10.7    | -15.0                     | 11.0    |
|            | Exchange 1 | -8.0               | 10.3    | -12.3                | 9.9     | -11.4                     | 9.9     |
|            | Exchange 2 | -15.5              | 13.9    | -25.2                | 15.6    | -24.9                     | 15.9    |
|            | Exchange 3 | -13.4              | 14.1    | -15.4                | 13.7    | -15.4                     | 13.9    |
| DAI        | Average    | -14.6              | 37.2    | -18.6                | 37.9    | -18.6                     | 37.8    |
|            | Exchange 1 | -12.4              | 38.3    | -16.8                | 38.8    | -16.9                     | 38.8    |
|            | Exchange 3 | -12.8              | 16.3    | -14.5                | 15.8    | -14.4                     | 15.8    |
| USDC       | Exchange 2 | -15.1              | 14.1    | -24.9                | 16.1    | -24.6                     | 16.5    |
| BUSD       | Exchange 2 | -13.4              | 13.2    | -23.2                | 15.3    | -23.0                     | 15.6    |

# STABLECOIN EVENT STUDIES

## 3 DAY WINDOW FOR LARGEST STABLECOINS

|   | NYAG<br>Lawsuit   | Attestations      | New Stablecoin<br>Announced | New Stablecoin<br>Starts Trading | Bitcoin<br>Crashes |
|---|-------------------|-------------------|-----------------------------|----------------------------------|--------------------|
| $\mathbb{I}(\text{Post})$                                 | 0.66***<br>(4.54) | -0.10*<br>(-1.69) | -0.07<br>(-0.76)            | 0.08<br>(1.44)                   | 0.81***<br>(3.67)  |
| $\mathbb{I}(\text{Treat})$                                | -0.04<br>(-0.13)  | -0.05<br>(-0.74)  |                             |                                  |                    |
| $\mathbb{I}(\text{Post}) \times \mathbb{I}(\text{Treat})$ | -0.11<br>(-0.37)  | 0.08<br>(0.99)    |                             |                                  |                    |
| $N$   | 70                | 1,450             | 91                          | 1,350                            | 70                 |
| $R^2$   | 0.61              | 0.41              | 0.89                        | 0.37                             | 0.70               |
| Events  | 2                 | 41                | 6                           | 42                               | 5                  |
| Coin Fixed Effects  | Yes               | Yes               | Yes                         | Yes                              | Yes                |