

Harvard Kennedy School – Study Group
October 2023

Digital Monies

Sessions:

Tuesday October 10, 4:15 – 5: 30 PM: **Money and technology through the ages**

Tuesday October 17, 4:15 – 5: 30 PM: **The digital revolution in money and payments**

Tuesday October 24, 4:15 – 5: 30 PM: **Central Bank Digital Currencies**

Tuesday October 31, 4:15 – 5: 30 PM: **Monetary institutions for the digital age**

Ignazio Angeloni
(European University Institute)

Q: When did digital money first appear?

Understanding an abused term

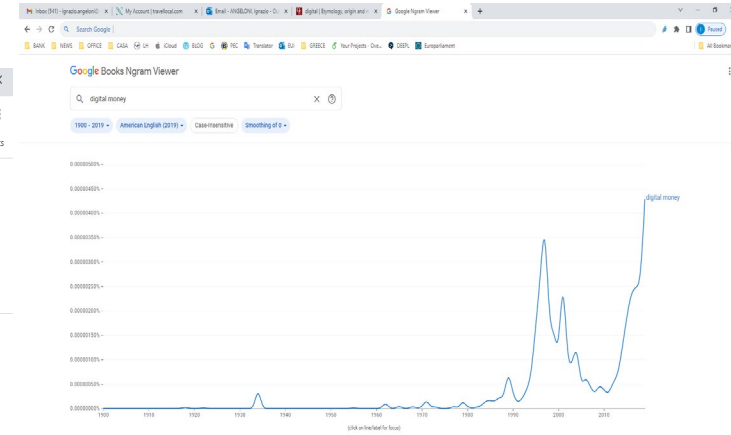
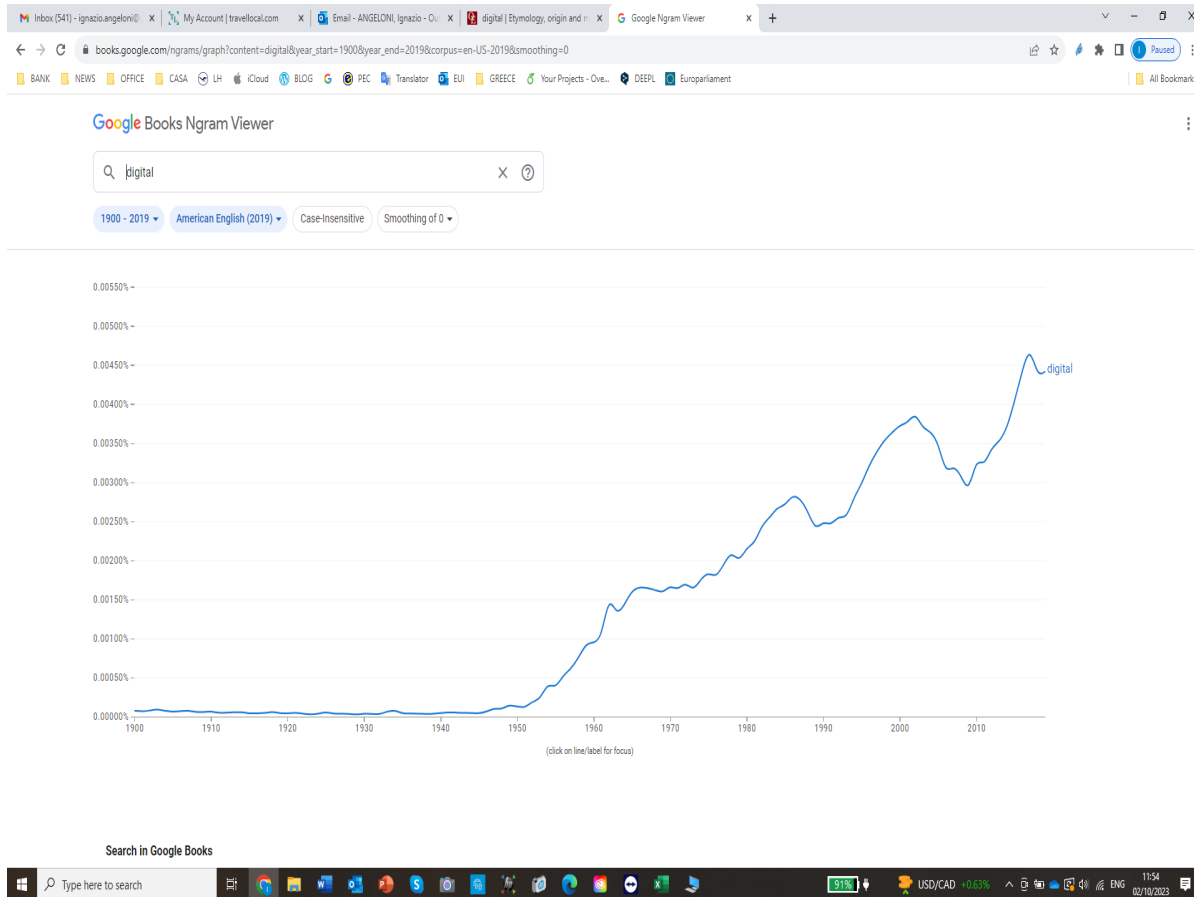
“Digital money” = money that is stored and transmitted by computers using binary (digital) language

By this definition:

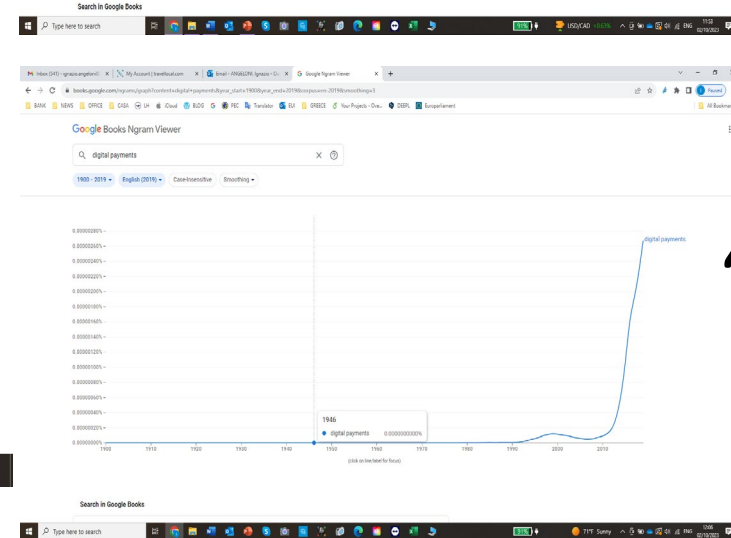
- 1. Money started being “digital” in the 1950s*
- 2. By the end of the century, about 90% of money was digital*

Google Ngram Viewer

“digital”



“digital money”



“digital payments”

The origin of digital money

1. *Post-WWII consumer and payments boom; explosion of personal checks*
2. *Manual handling of personal checks became increasingly unfeasible; it required*
 - a. authenticity controls
 - b. identification of the parties involved (payee, payer) and the bank(s) involved
 - c. rejecting blank or faulted checks
 - d. digital recording of transactions
 - e. updating client ledgers
3. *Bank of America commissioned ERMA^(*) to Stanford Research Inst.*
4. *Completed in 1955, ERMA automatically performed all the above functions...*
5. *... except for the physical transmission of checks*

() **Electronic Recording Machine Accounting** - a mainframe computer weighing 25 tons, with 300 km of wire and thousands of diodes and “vacuum tubes” (semiconductors)*

Next steps (all digital)

- 1. Credit & debit card 1970s*
- 2. Internet banking 1990s*
- 3. Check truncation 2004*
- 4. Online platforms 2014 (after the PayPal spinoff from eBay)*
- 5. Smartphone applications 2014 onwards*

Next steps (non-digital)

1. ATM (1976)

Paul Volcker (2008): “ATMs are the only useful innovation in banking for the past 20 years”

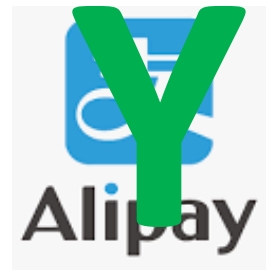
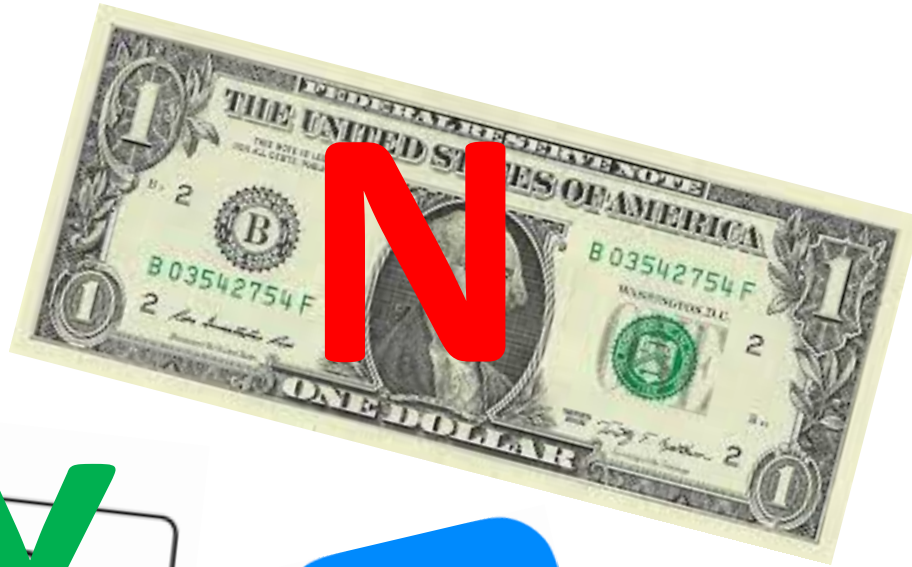
The long journey of credit cards

1. *Diners (1950)*
2. *Bank Americard (1958)*
3. *85.6 mm by 53.98 mm (corner radius 3.18 mm)*
4. *Click-clack machine*
5. *Debit card (1966)*
6. *Magnetic stripe 1970s*
7. *Chip with PIN (a French invention in 1974, implanted in all cards starting from the 1990s)*

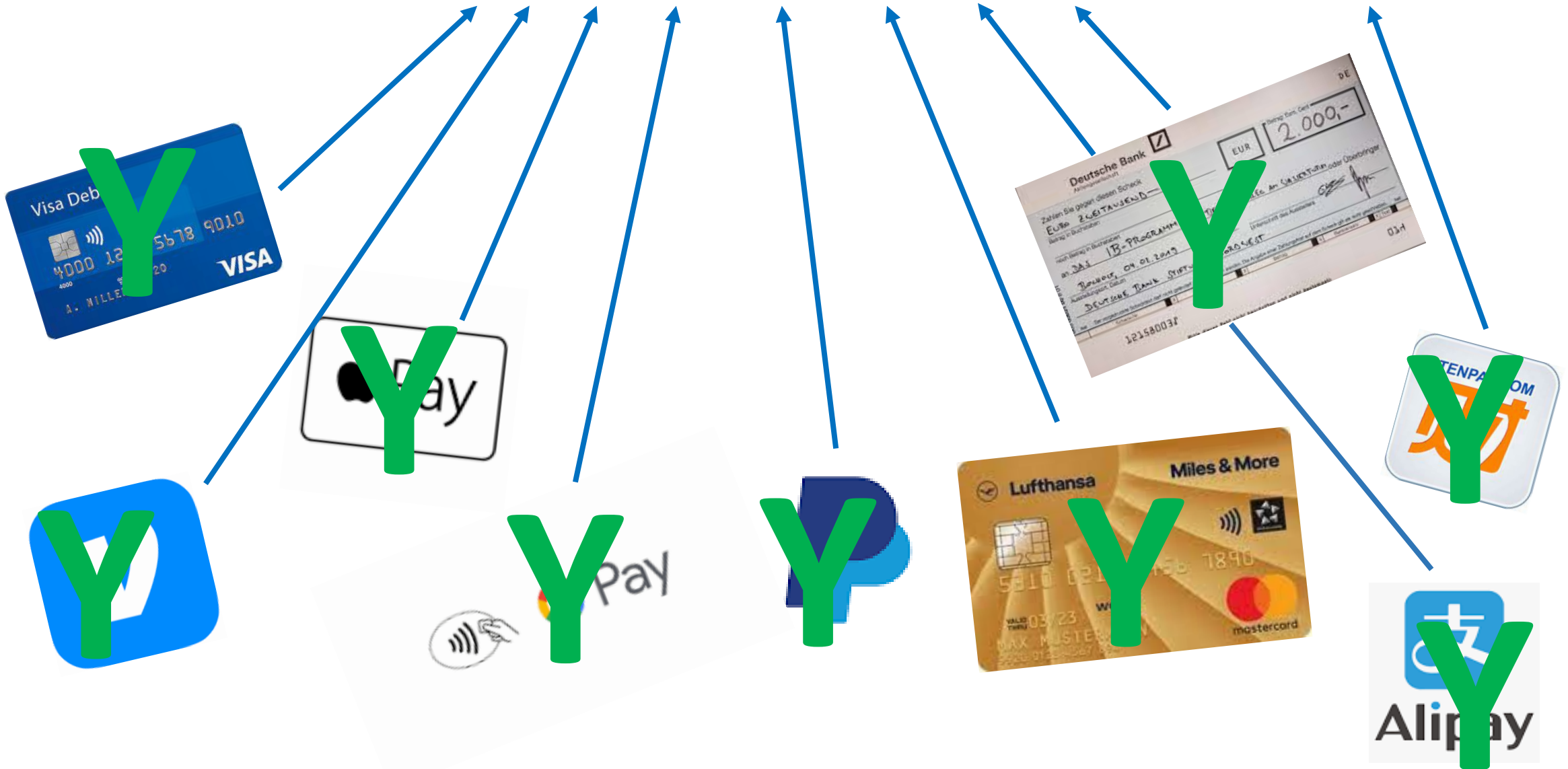
How people pay today



Which ones are digital?



All recorded in bank and central bank ledgers



SEPA – Single European Payment Area

- 1. All banks in 20+ countries*
- 2. Domestic = Cross border*
- 3. 1-2 day settlement finality*
- 4. Zero charges for the user*
- 5. Instant settlement available at a small cost*

Banks, central banks provide “roots” to money

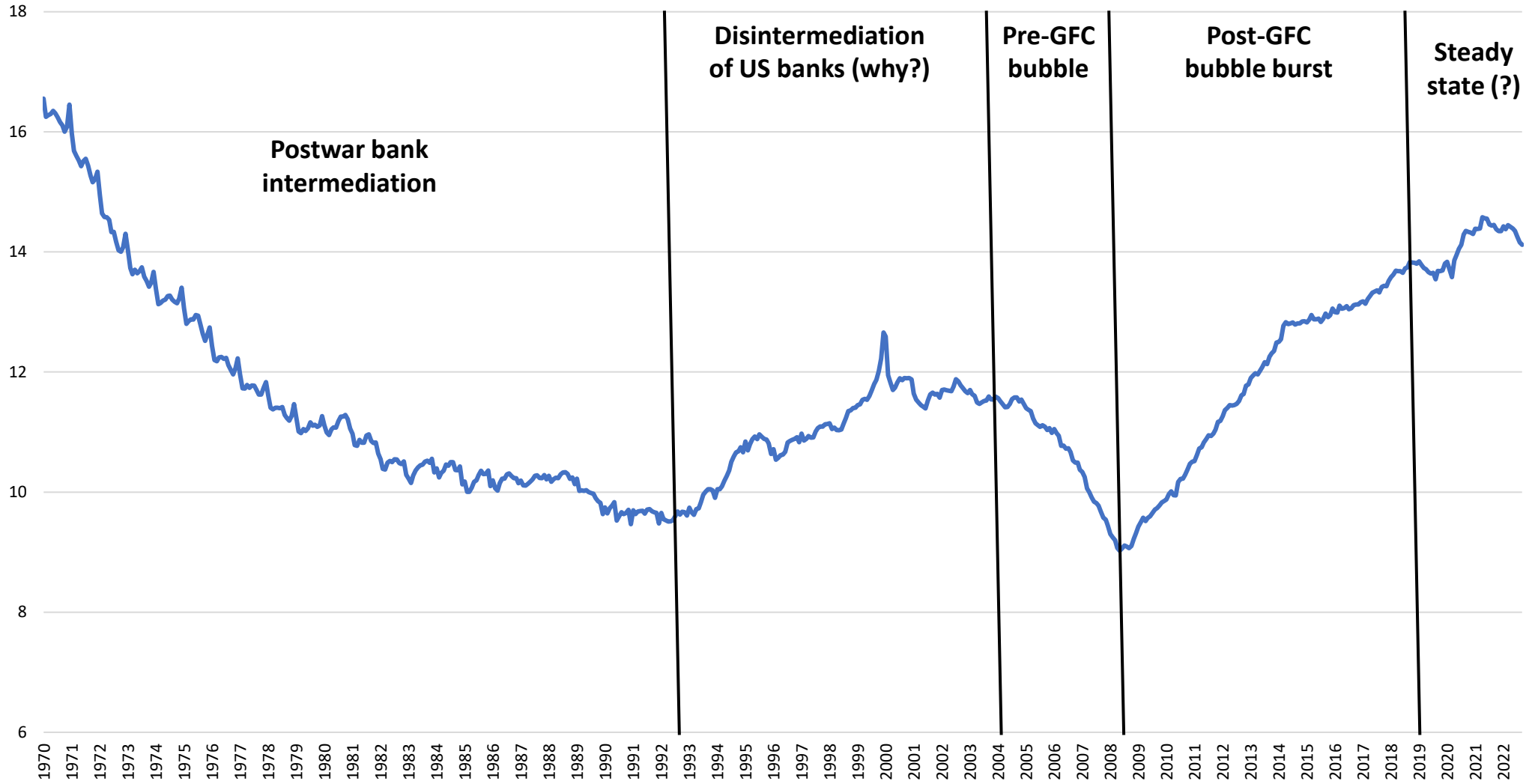
- 1. Central banks preserve its value (“price stability”)*
- 2. Central banks supervise the stability of banks*
- 3. Banks manage a large part of the payment systems*
- 4. Bank deposits are insured (up to 100.000€ in eurozone or 250,000\$ in US)*



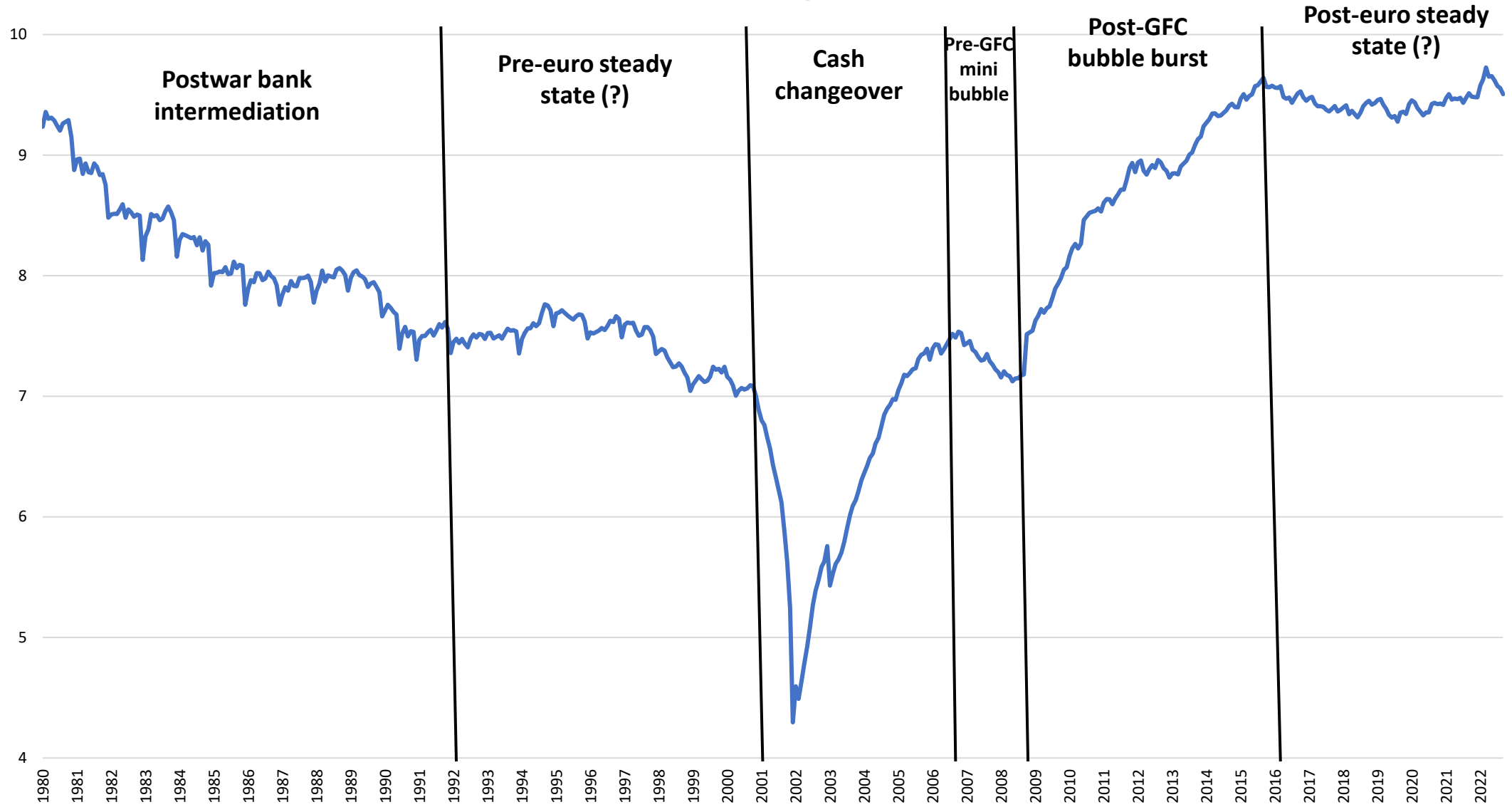


Q: Is paper currency disappearing?

United States: Currency/M3 % ratio



Euro area: Currency/M3 % ratio



Federal Reserve Payments Study (FRPS; 2022)

Trends in noncash payments, by value, 2000–21 (Trillions of dollars)

Period	Checks	ACH debit transfers	ACH credit transfers	Credit cards	Non-prepaid debit cards	Prepaid debit cards
2000	40.30	9.24	8.62	1.28	0.35	ND
2003	40.86	11.87	12.23	1.68	0.63	ND
2006	41.47	13.32	17.70	2.12	0.97	0.08
2009	34.07	15.03	22.14	1.92	1.46	0.14
2012	27.21	18.65	27.51	2.55	1.87	0.23
2015	29.18	19.60	32.48	3.05	2.18	0.29
2018	26.77	23.28	40.87	3.98	2.75	0.35
2021	27.23	33.19	58.66	4.88	3.94	0.61

<https://www.federalreserve.gov/paymentsystems/2022-The-Federal-Reserve-Payments-Study-Initial-Data-accessible.htm#Figure1>

Note: All estimates are on a triennial basis. Card payments were also estimated for 2016, 2017, 2019, and 2020. Credit card payments include general-purpose and private-label versions. Prepaid debit card payments include general-purpose, private-label, and electronic benefits transfer (EBT) versions. Estimates for prepaid debit card payments are not displayed for 2000 and 2003 because only EBT was collected. ND indicates where no data are available.

Federal Reserve Payments Study (2002)

Trends in noncash payments, by **number**, 2000–21 (Billions)

Period	Checks	ACH debit transfers	ACH credit transfers	Credit cards	Non-prepaid debit cards	Prepaid debit cards
2000	42.6	2.1	3.9	15.6	8.3	ND
2003	38.6	4.2	4.6	19.0	15.6	ND
2006	32.2	8.7	6.0	21.7	25.0	3.3
2009	25.8	11.4	7.7	21.6	37.9	6.0
2012	19.7	12.1	8.6	26.8	47.3	9.3
2015	18.1	13.9	10.0	33.7	56.6	11.2
2018	14.0	16.6	11.9	44.7	72.7	13.8
2021	11.2	20.3	15.9	51.1	87.8	18.1

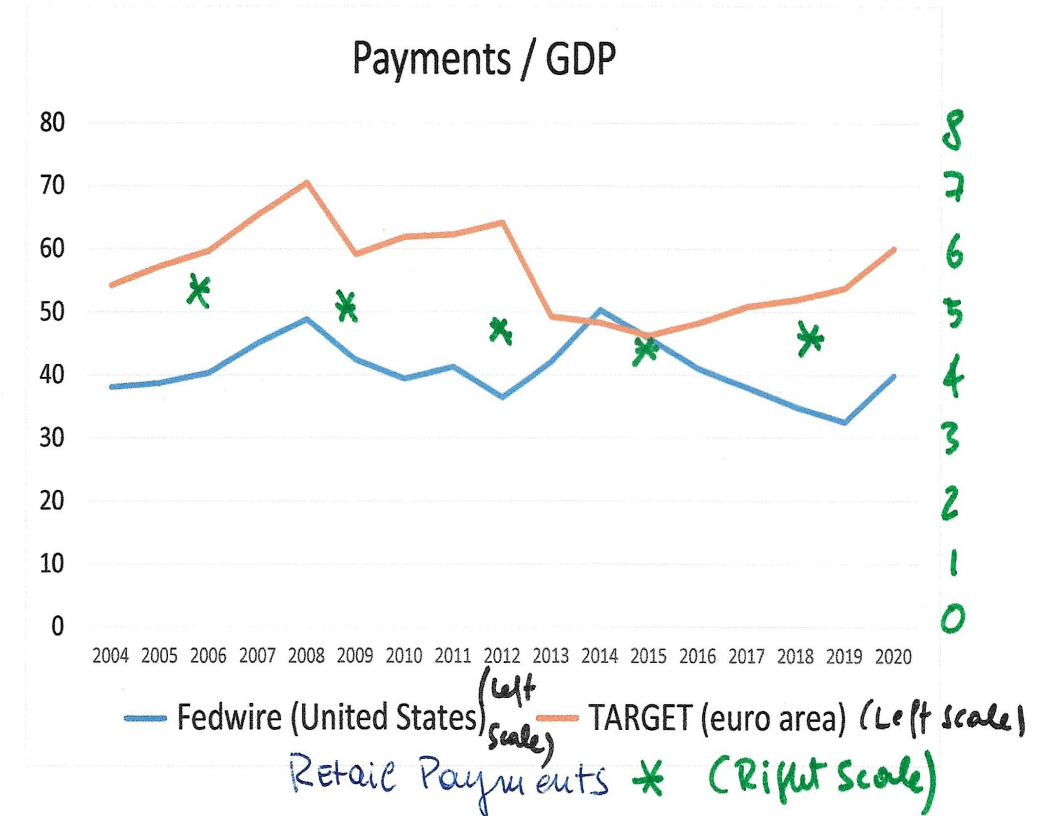
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RETAIL PAYMENTS AND CENTRAL BANK SETTLEMENTS

Date	United States				Euro area (TARGET)	
	Retail payments		Fedwire settlements		bn euro	ratio to GDP
	bn \$	ratio to GDP	bn \$	ratio to GDP		
2000	60	5,8			263	37,3
2001					330	44,7
2002					395	51,8
2003	67	5,9			421	53,6
2004			465	38,1	444	54,2
2005			505	38,7	486	57,2
2006	76	5,5	558	40,4	534	59,7
2007			652	45,0	617	65,4
2008			722	48,9	682	70,5
2009	75	5,2	614	42,4	551	59,1
2010			594	39,5	593	61,9
2011			644	41,3	613	62,3
2012	78	4,8	592	36,4	634	64,2
2013			709	42,1	492	49,2
2014			883	50,3	494	48,3
2015	87	4,8	834	45,8	489	46,3
2016			767	41,0	524	48,2
2017			740	38,0	573	50,8
2018	98	4,8	716	34,9	605	51,9
2019			695	32,5	647	53,8
2020			840	39,9	691	60,0
2021	129	5,5			722	58,3

Source of the data: see main text.



Rootless trees



Cryptocurrencies



Stablecoins

What are they?

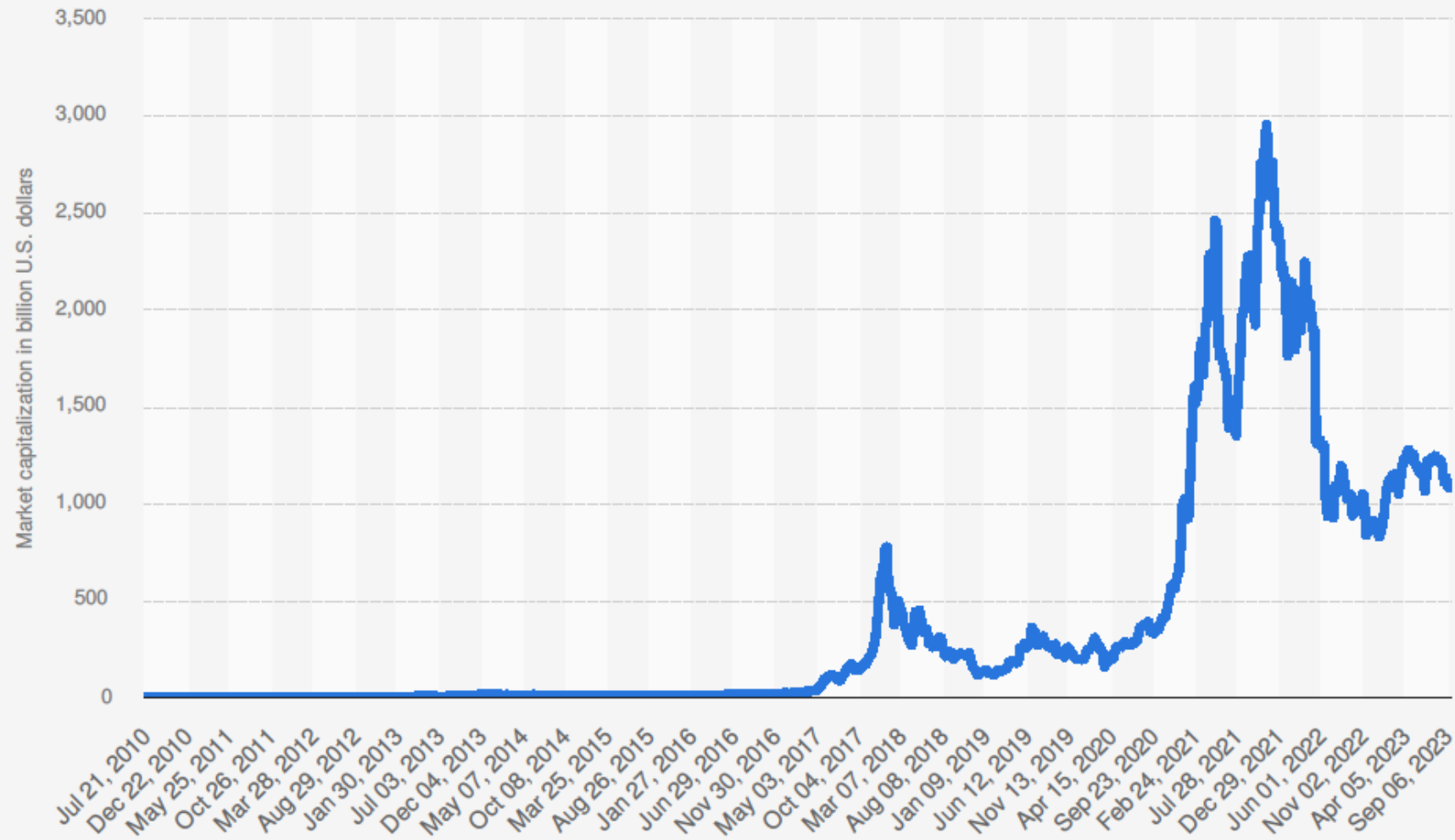
Cryptocurrencies: assets exchanged on a distributed ledger and generated by peer-to-peer arrangements where “miners” create new crypto units and validate transactions by solving a computer algorithm (“outside” assets)

Stablecoins: diversified investment pools offering payment services (“inside” assets) on a distributed ledger

Origin in the post-GFC mood

1. *Lack of trust in banks*
2. *Lack of trust in central banks, regulators*
3. *Quest for “peer-to-peer” alternatives, independent on traditional institutions*

Overall cryptocurrency market capitalization per week from July 2010 to September 2023 (in billion U.S. dollars)



Sources

CoinGecko; BitInfoCharts
© Statista 2023

Additional Information:

Worldwide; July 2010 to September 2023; Note that due to changing exchange rates, the USD values as reported can change. This also applies in retrospect.

Crypto-rankings

Rank	Name	Type	Cap. bn. US\$	Cap. %
1	Bitcoin	Cryptoc.	518	47,1
2	Ethereum	Cryptoc.	184	16,7
3	Tether	Stablec.	83	7,5
4	Binance	Cryptoc.	31	2,8
5	XRP	Cryptoc.	26	2,4
6	USD Coin	Stablec.	25	2,3
...
20	Dai	Stablec.	4	0,4
...
22	True USD	Stablec.	3	0,3

Crypto-currencies

Collateralized
stablecoins

Bitcoin objectives (*Satoshi 2008*)

1. *Cash equivalent*
2. *No need for central authority*
3. *Irreversibility (finality)*
4. *Privacy (100% anonymity)*

How Bitcoin works

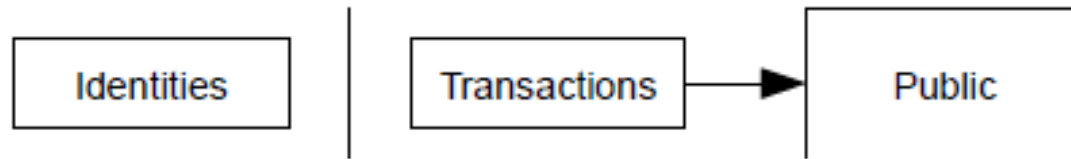
- 1. Ledger is distributed among participants, using secret access codes*
- 2. Transactions are*
 - i. public, but identities are not*
 - ii. grouped in blocks (“blockchain”)*
 - iii. validated by miners on a competitive basis
(solution of algorithm provides “proof of work”)*
- 3. New bitcoins are created by mining*
- 4. Max 21,000,000 (19.427.769 exist)*

Privacy

Traditional Privacy Model



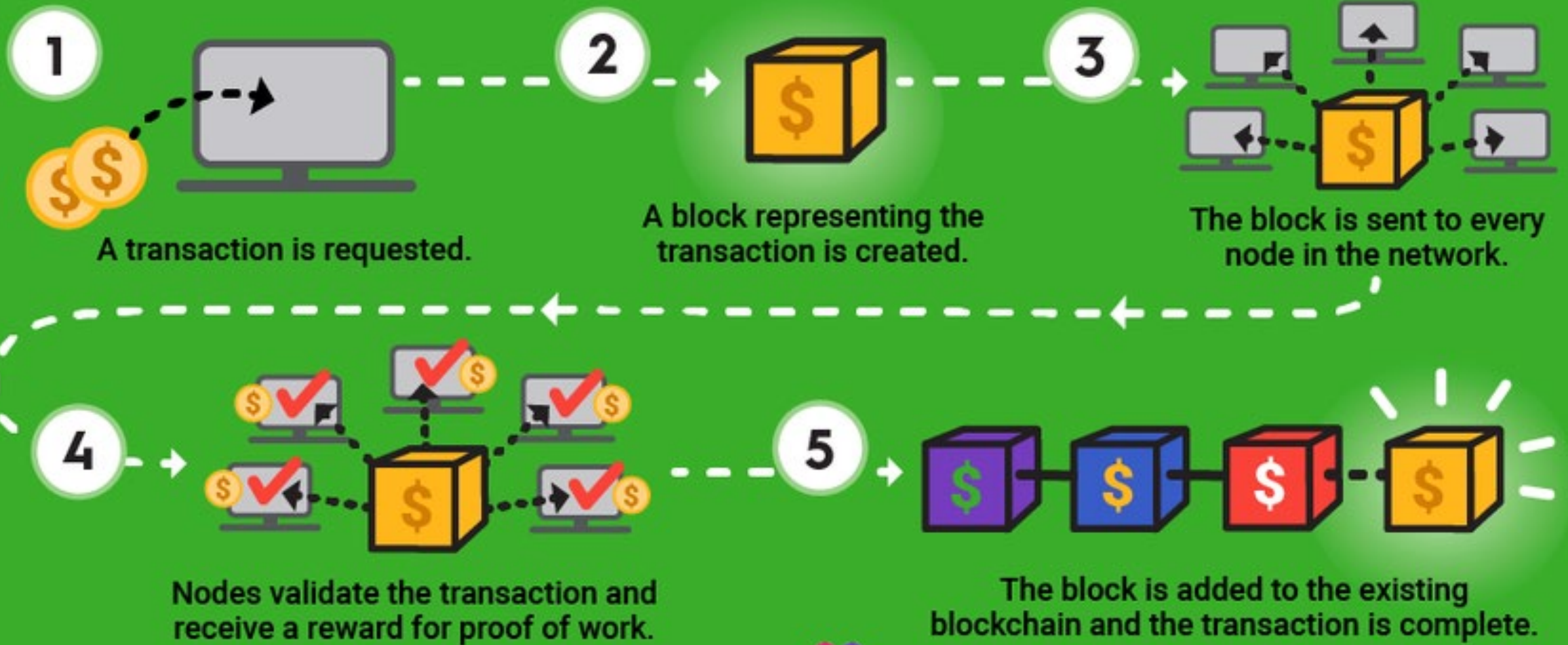
New Privacy Model



Source: Satoshi Nakamoto (2008)

PS However, the FBI and also market participants have been able to identify individuals behind Bitcoin transactions

HOW BLOCKCHAIN WORKS



Bitcoin price

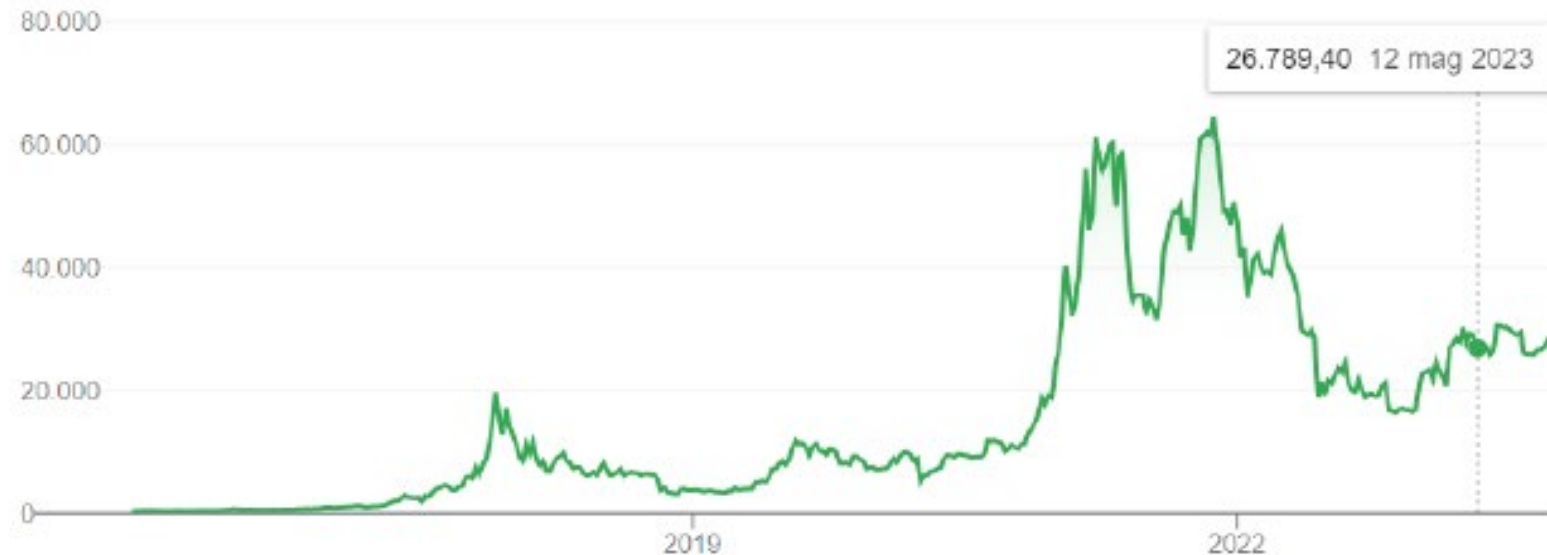
26.701,90 USD

+ Segui

+26.374,90 (8.065,72%) ↑ dall'inizio

12 ott, 7:34 PM UTC · Limitazione di responsabilità

1G | 5G | 1M | 6M | YTD | 1A | 5A | Max



Who are the miners?



?








Your typical miner



Huge energy consumption

1. Estimated energy use of mining: around 110 Terawatt Hours per year
2. Mainly, to cool down the computers
3. This is 0.55% of global electricity production
4. Or roughly equivalent the annual energy consumption of Sweden

Bitcoin objectives

1. *Cash equivalent* 
2. *No need for central authority* 
3. *Irreversibility (finality)* 
4. *Privacy (100% anonymity)* 
5. *Major environmental damage* 

Collateralized stablecoins

i. Intermediaries, with assets and liabilities in their balance sheets

ii. Share unit value=1US\$

iii. Traded on crypto-exchanges

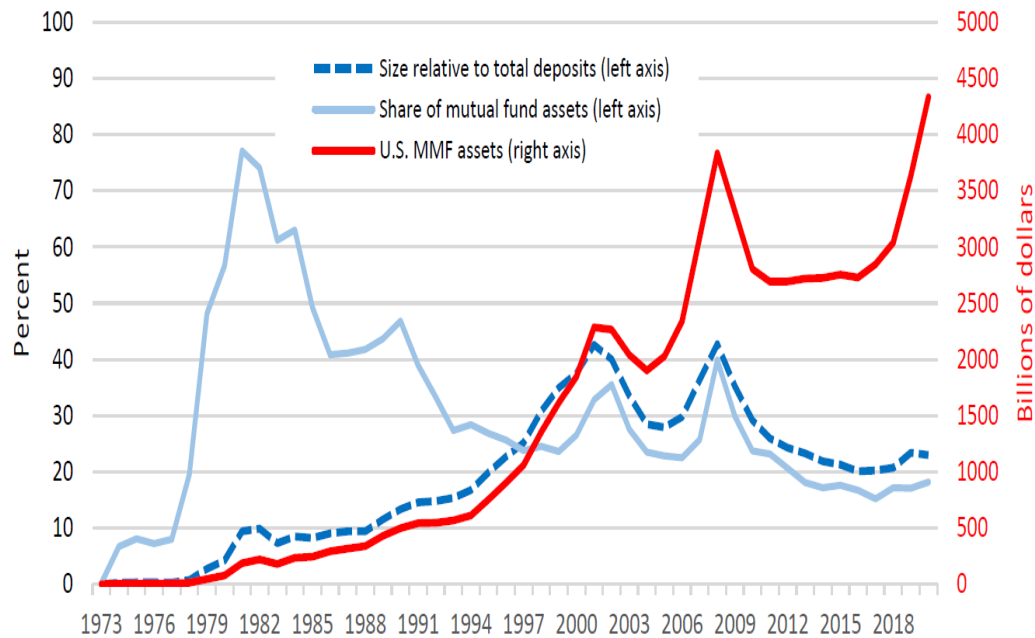
iv. Unregulated

v. Backed by a diversified and liquid asset pool

Q: Is this reminding of something?

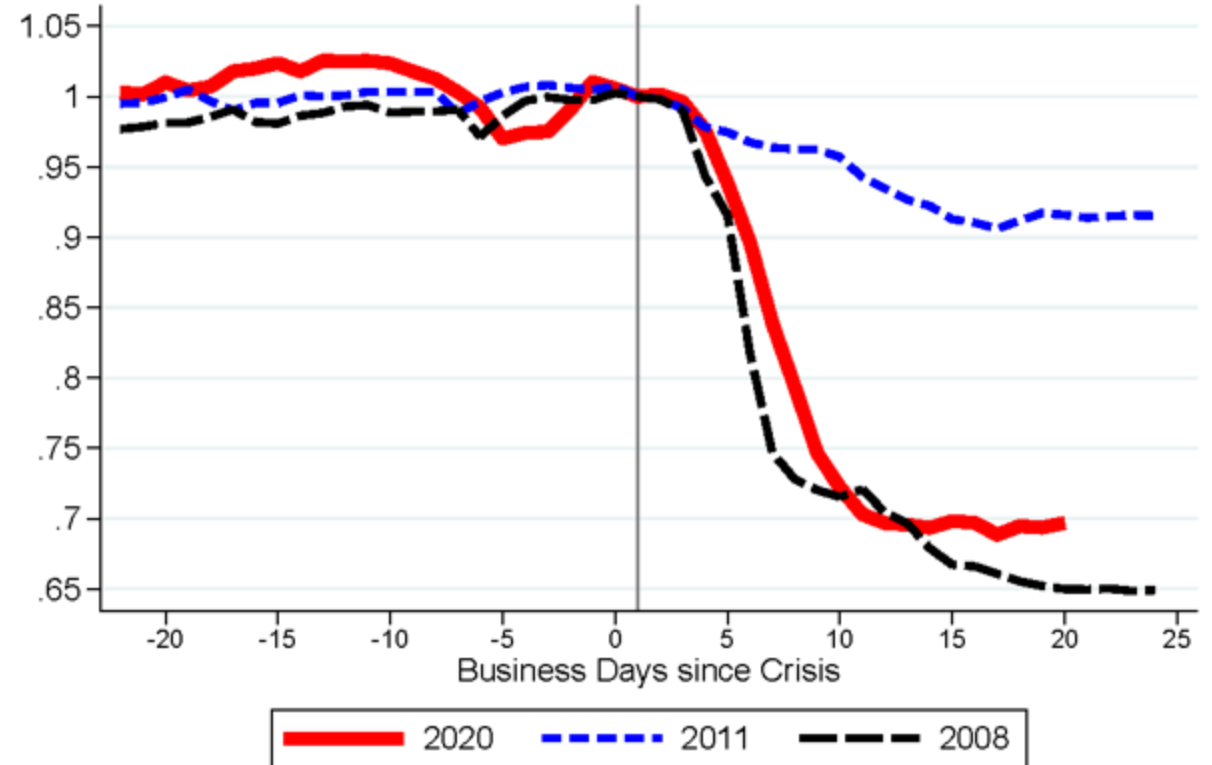
Money market funds (MMFs)

Chart 1: U.S. MMF assets under management and size relative to all mutual funds and to deposits



Notes. Data are annual. Total deposits is checkable deposits (excluding those issued by the Federal Reserve) plus time and savings deposits. Sources: Investment Company Institute; SEC (1975); Federal Reserve Board, Financial Accounts of the United States.

Runs on Institutional Prime MMFs: by Crisis



Note: AUMs are normalized to one on the first day of the crisis.

Different contagion risk

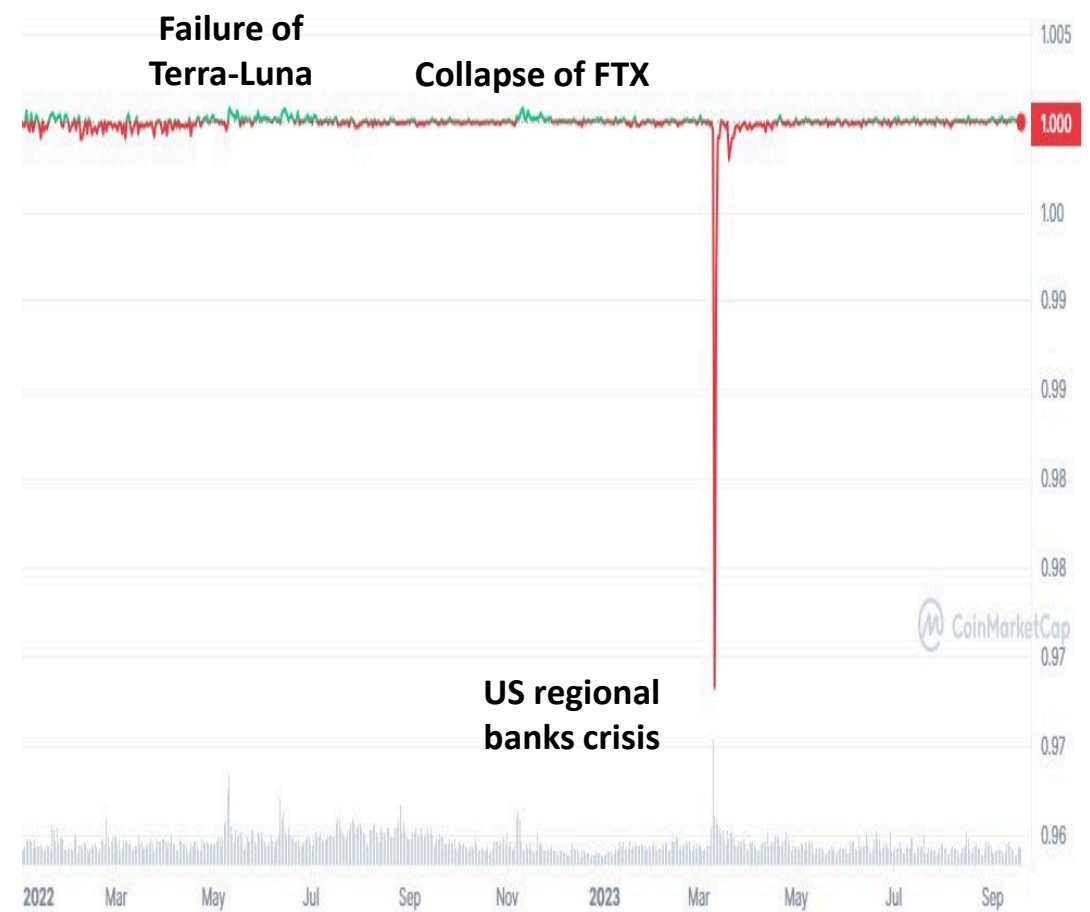
- *MMFs were (and still are) “sponsored” by banks (hence they are a source of systemic risk)*
- *Stablecoins are not (lesser source of systemic risk)*

Contagion vs safe haven effects

Tether USD

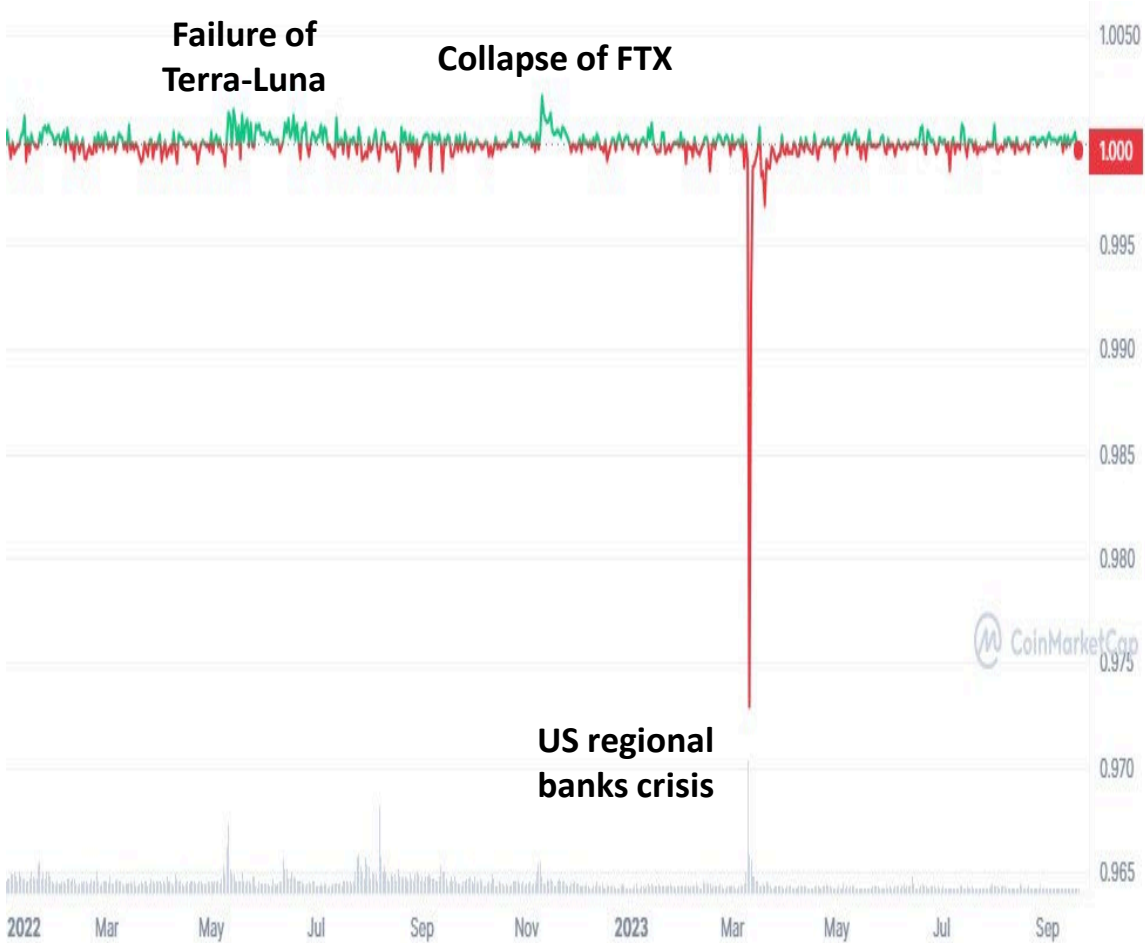


Coin USD

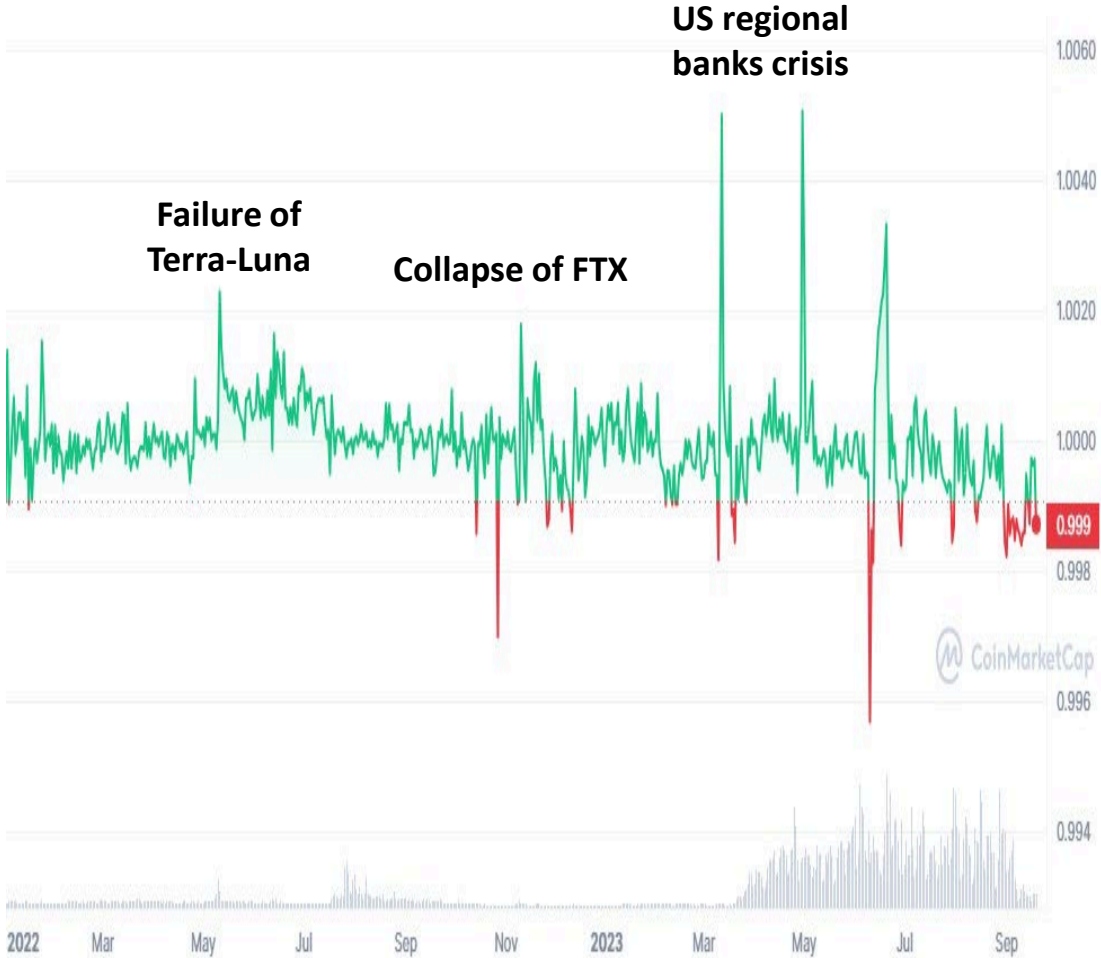


Contagion vs safe haven effects

Dai USD (backed by cryptoassets)



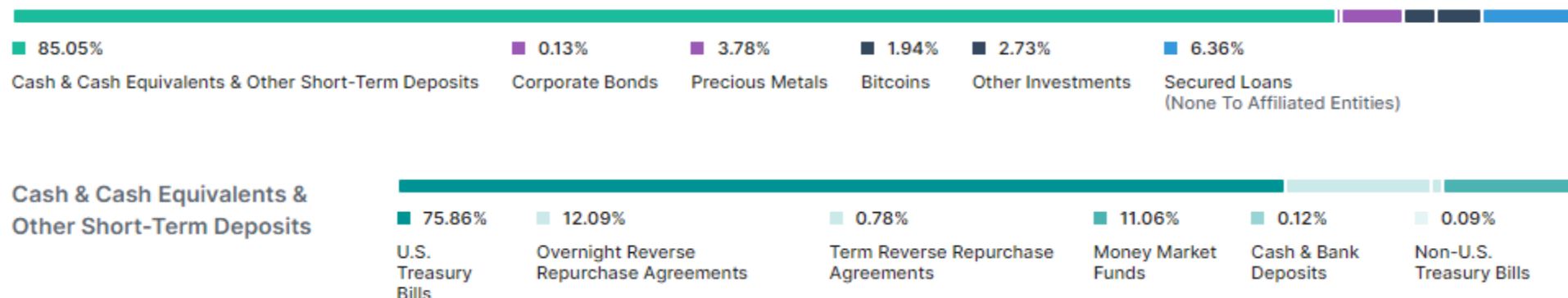
True USD



Transparency (*Tether website*)

			See more →
Independent Auditors' Report on the Consolidated Reserves Report June 30, 2023	Independent Auditors' Report on the Consolidated Reserves Report March 31, 2023	Tether Assurance Consolidated Reserves Report December 31, 2022	

Reserves Breakdown



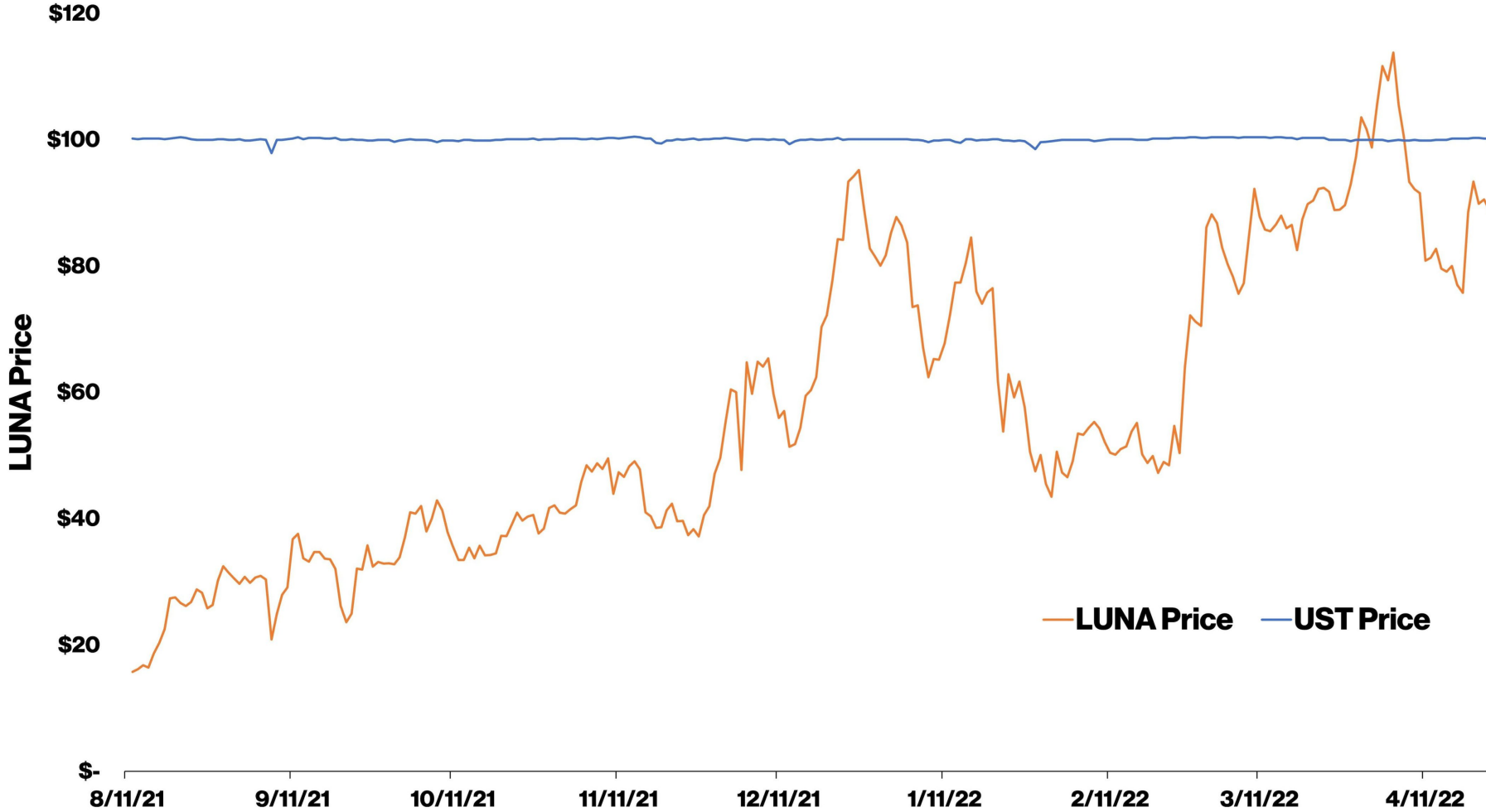
The Tether Auditing Report by BDO, available here <https://tether.to/en/transparency/>

Terra-Luna failure *(May 2022)*

1. *Terra USD was an “algorithmic” stablecoin pegged to the US\$*
2. *No collateral*
3. *The peg of Terra was supported by an automated trading rule (“Burn and Mint”) using an ancillary asset, Luna*
4. *Luna was sold (bought) against Terra whenever Terra was weak (strong) relative to the peg*

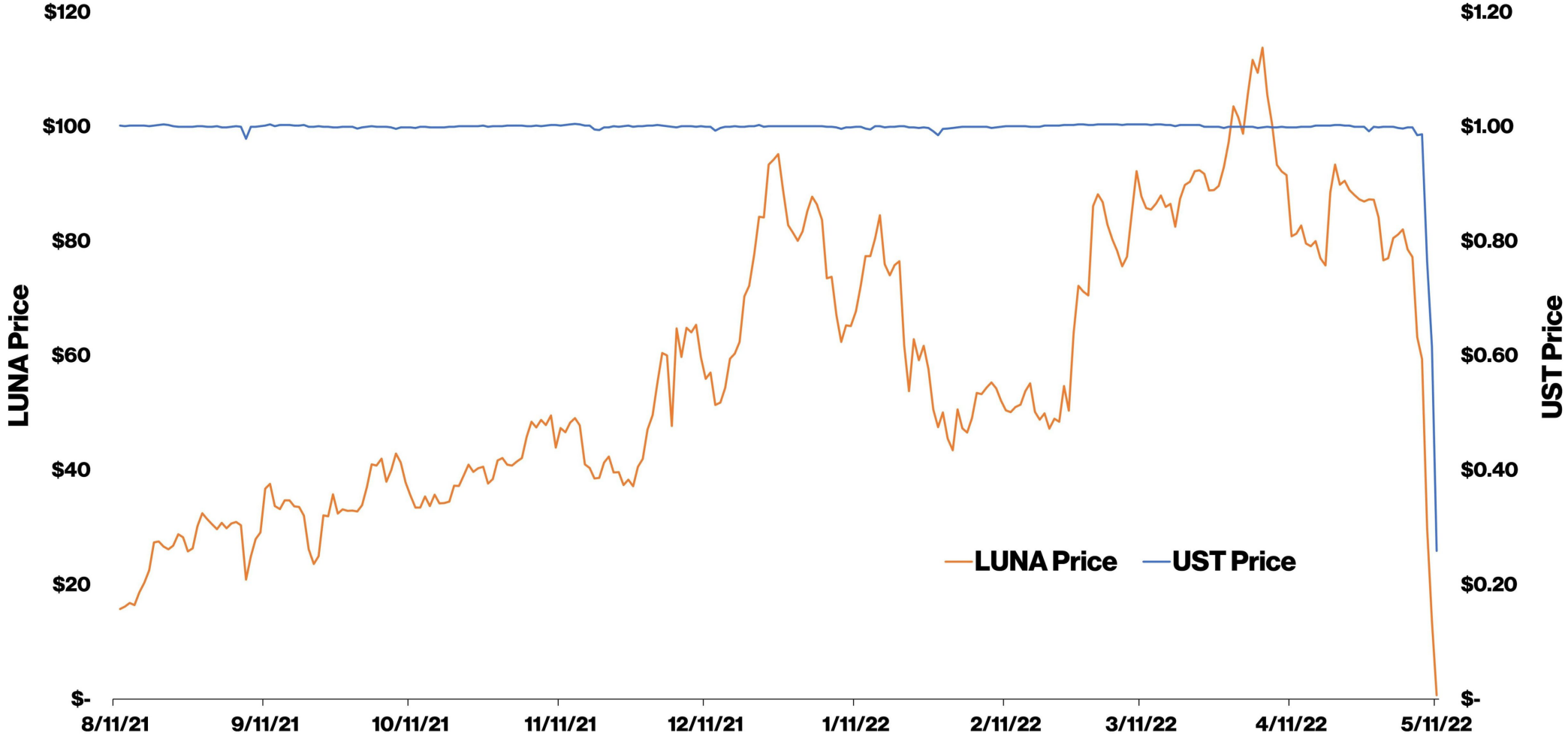
Q: What is the flaw?

LUNA and UST Price Movement



Source: CoinDesk Research
As of May 11, 2022

LUNA and UST Price Movement



Source: CoinDesk Research, TradingView
As of May 11, 2022

SOME INDICATIVE DATA

		FEES / LIMITS		SPEED (minutes)	Rooted in ...
		Deposit	Transfer		
<i>Digital monies:</i>					
NEW	BITCOIN (<i>crypto</i>)	0	Fee is uncertain (depends on miners' competition)	40	Miners supply/speculative demand (unregulated)
	TETHER (<i>stablecoin</i>)	150\$ (min. 100K \$)	0	5	
STANDARD	CREDIT CARD	0	1,3 to 3.5% (retailer)	0	Bank account (regulated and insured)
	PAYPAL	0	3% (retailer)	0	Bank account (regulated and insured)
	GIRO DEBIT, SEPA	0	0.33-034€ (retailer)	0	Bank account (regulated and insured)

Summing-up....

- 1. Money is (almost fully) digital. It has been so for many years*
- 2. “Standard” digital monies have solid roots, supported by institutions and rules*
- 3. “New” private digital currencies... not so much ...*

Readings

G. Leibbrandt and N. De Teran, *The payoff*, Elliot & Thompson, 2021

C. M. Kahn and W. Roberds, “The Economics of payments finality”, *Federal Reserve Bank of Atlanta Economic Review*, 2002.

S. Quinn and W. Roberds, “The evolution of the check as a means of payment: A historical survey”, *Federal Reserve Bank of Atlanta Economic Review* vol. 93, 2008, 4.

Kenneth Rogoff, *The curse of cash*, Princeton University Press, 2016

Eswar Prasad, *The future of money*, Belknap Press 2023