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Central Bank Digital Currencies and the digital Euro

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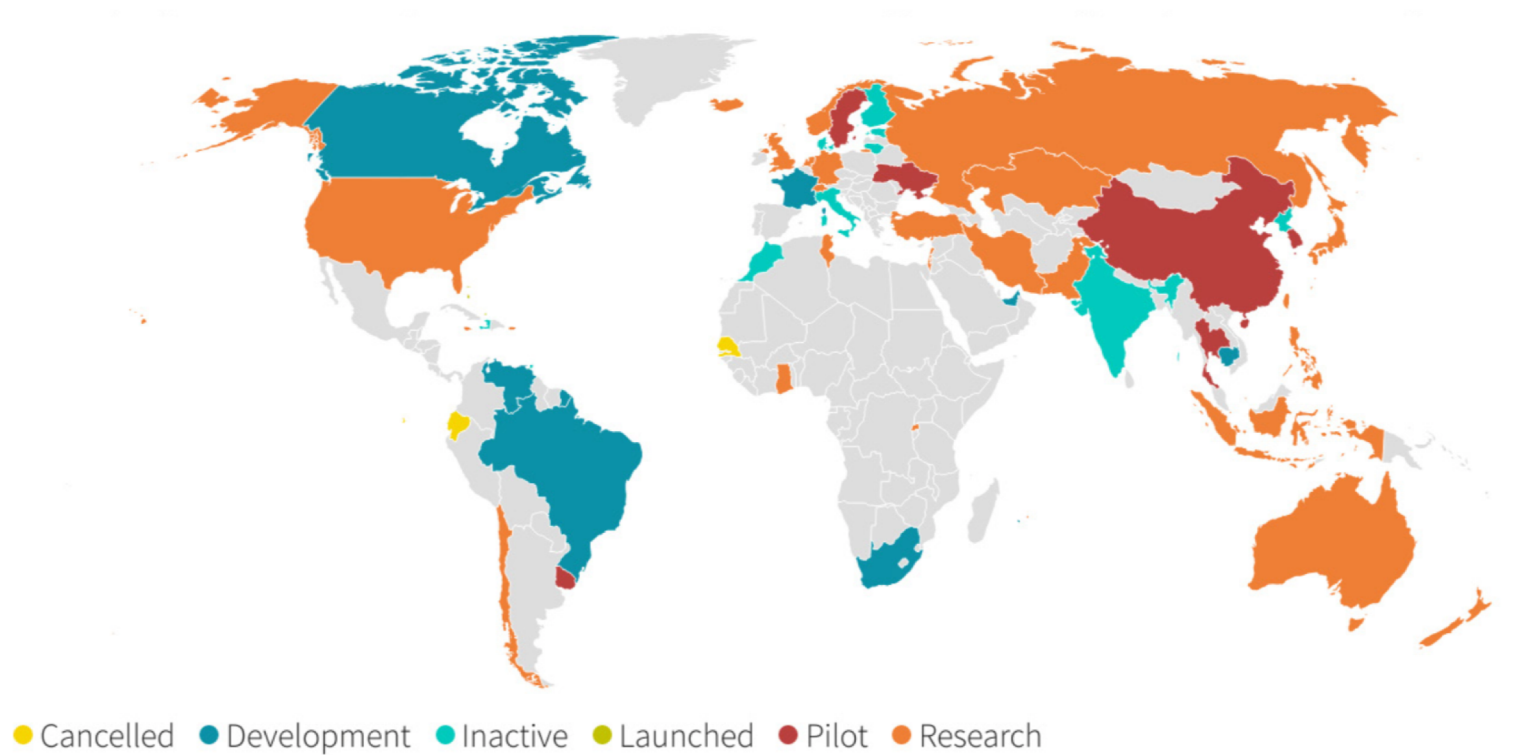
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Mainly based on:

EUBOF (2021) *Central Bank Digital Currencies and a Euro for the Future*



Global landscape of CBDCs



Source: Reuters research, Harvard Kennedy School Belfer Center & Atlantic Council

THE GLOBAL CBDC COMPETITIVE LANDSCAPE

Development Progress of Global Official Digital Currency	
China	Trials of DCEP have been carried out in various regions.
US	Still in development; the Boston Fed is working with researchers at the Massachusetts Institute of Technology to develop and test a hypothetical digital currency for central banks.
UK	In March 2020, the Bank of England published a discussion paper – “Central Bank Digital Currency: Opportunities, Challenges, and Design”. It has designed a model and is seeking opinions from payment industry and academia.
Europe	On September 29, 2020, the European Central Bank (ECB) released a 50-page report, claiming that it would consider the issuance of digital euro; on October 12, the ECB started seeking public opinions. By mid-2021, it will decide whether to introduce a digital euro.
Canada	In February 2020, the Bank of Canada unveiled its plan on CBDC. The document listed out the public policy considerations, possible risks, and high-level strategies.
Russia	On October 13, 2020, the Bank of Russia released a consultation paper called “A Digital Ruble”. It outlines potential ways to implement the roll-out of a digital ruble and the corresponding functional requirements.
Japan	On October 9, 2020, Japan published a document – “The Bank of Japan’s Approach to CBDC”, saying it would conduct the experiment in three phases. In the first two phases, the bank will develop a test environment for the CBDC system and implement functions of CBDC in the test environment; in the phase III, the bank will consider a pilot program. The Bank of Japan aims to start the phase I in early fiscal year 2021.
South Korea	It plans to start pilot programs in early 2021 and complete preliminary technical design and evaluation of CBDC in the summer of 2021.

Graphic © Asia Briefing Ltd.

CBDC – Central Bank Digital Currencies

A form of digital money issued by a central bank

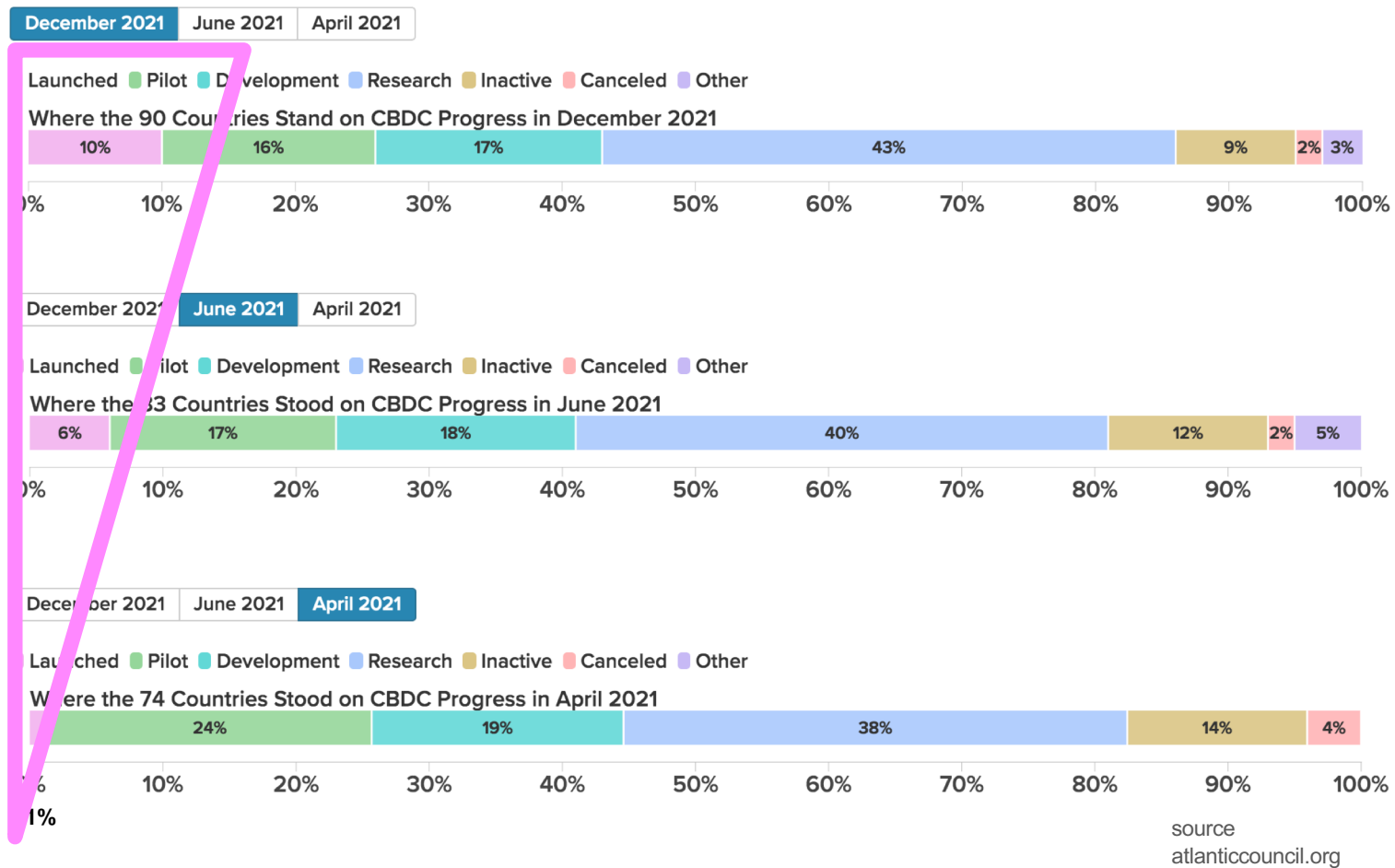
Almost **90%** of the world's central banks are engaged in **studying, developing** or **using** the potential of central bank-issued digital currency (it was 30% in 2018)

40% are making **prototypes**

16% are conducting **pilot studies**

The **PBOC** (People's Bank of China) will issue the digital *Renminbi* (Yuan - RMB) in the **spring 2022**

RMB 2 billion (US \$ 299.07 million) was spent using digital *yuan* in four million transactions in China



Current payment infrastructure in the Euro zone

1999 - **Introduction of the Euro**

2002 - **Trans-European Automated Real-time Gross Settlement Express Transfer System for Europe (TARGET)**

2007 - **TARGET2**

- support the implementation of the Eurosystem's monetary policy and the functioning of the [euro money market](#)
- [minimise](#) systemic [risk](#) in the payments market
- increase the [efficiency of cross-border](#) payments in euro
- maintain the integration and [stability of the Eurozone](#) money [market](#)

2018 - TARGET Instant Payment Settlement, or **TIPS**

to address the growing consumer demand for **instant payments** without reintroducing the complexity and **fragmentation of national solutions**

The common denominator of each **new advancement** is the promise of further **speed** and **efficiency** in payments, costs **savings**, **pan-European** coverage, and additional features to address the modern needs of consumers and the Central Bank.

**A European CBDC (or digital Euro) would
be the next step in this process**

CBDC: a form of digital money issued by a central bank

... not an entirely novel concept.

Commercial banks hold a minimum amount of cash, as well as deposits with the central bank in the form of **reserves** (**fractional model of the bank**)

These reserve accounts fulfil the definition of a CBDC presented above, as they are digital representations of value, recorded as a liability of the central bank and an asset for the commercial bank.

The **novelty** of CBDCs and the digital Euro:

digital liability of the central bank available to the **private sector**

In terms of CBDC availability, there are two models:

Wholesale CBDCs

pertain to the expansion of the fractional model described above to include *other legal entities besides commercial banks*, whether those are financial institutions or otherwise.

Retail CBDCs

to fulfil the necessary functions of money, serving as a *medium of exchange, store of value, and unit of account*, for individuals, households and businesses.

Rationale behind issuing a CBDC

- 1. Payment efficiency and security**
- 2. Inclusion**
- 3. Financial sovereignty**
- 4. Futureproofing of economies**

1. Payment efficiency and security

Cash remains the preferred medium for exchanges today:

73% of Point-of-sale (POS) transactions

48% of the total value of POS payments (down from 78% and 53% 2017).

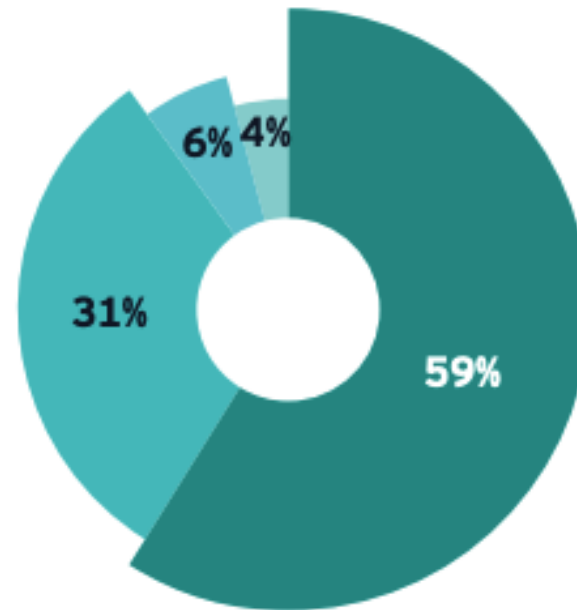
cash → tangible nature, speed, lack of fees, instant transfer of value
convenient for retailers local payments

However

International and non-cash payments have grown significantly, following the exponential rise of ecommerce.

From 2018 to 2019, the aggregate number of electronic payments in the euro area increased by 8%, to a total of approximately €100 billion, with a total value of more than **€160** trillion.

What will be the most common form of payment in 2030?



- Mobile payments through devices and wearables
- Biometrics – facial recognition, fingerprinting, retinal scanning
- Crypto payments
- Cards

The future of payments
(source EUBOF 2021)

Expanding services previously reserved for the commercial banking system to the wider **private sector** would need **resilience and efficiency** of the payments system

by

- *improved Real Time Gross Settlement System - RTGS/TIPS*
- *new Distributed Ledger Technologies - DLT*

A CBDC tied to real-life identities could prevent

money laundering and terrorist financing.

Level of **pseudonymity/anonymity** adjusted according to the central bank

2. Inclusion

While cash is gradually phased out, commercial banks might find it fruitless to expand their services to financially excluded groups, such as the

unbanked.

A CBDC could address the consequences of the declining use of cash extending financial services to the

1.7 billion unbanked of the world
26% in Europe (2016)

To achieve this, some minimum infrastructure would be required:
Internet, computers and/or smartphones.

3. Financial sovereignty

Central banks face two distinct types of risks for their financial sovereignty:

- **monetary policy inefficiencies**
- **rising competition** from alternatives developed in the **private sector**

Central banks use unconventional methods (negative interest rates and quantitative easing) to drive monetary policy.

A CBDC could add

new weapons to the arsenal of a central bank

to facilitate monetary policy and address future crises.

Competitors of the central bank in the monopoly of money creation:

- **Bitcoin and stablecoins**
- **Privately-issued digital assets**, such as **Facebook's *Diem* (*Libra*)**
- **Competing CBDC** deployments by other central banks

4. Futureproofing of economies

CBDC could also accommodate for trends that will define the future of payments and finance.

Programmable money (*smart contracts*)

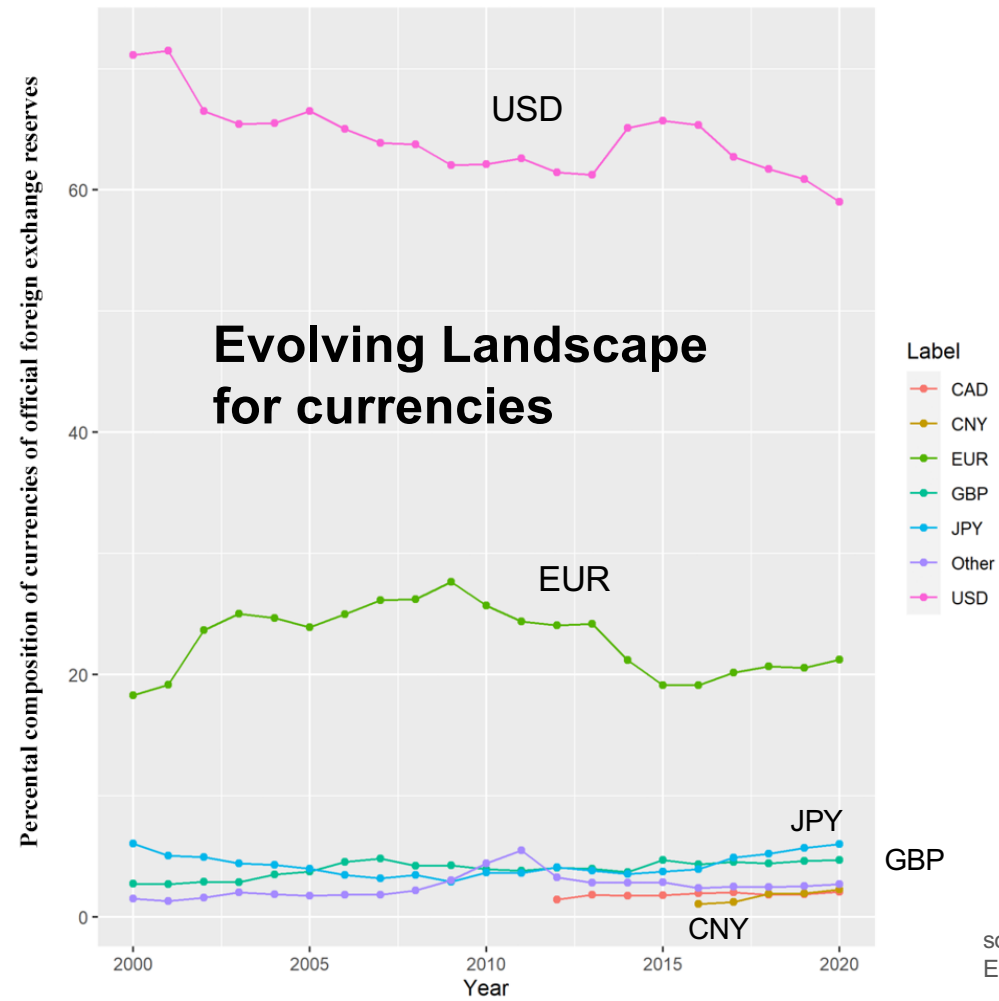
could allow a CBDC to operate according to **complex conditions and rules**.

so as to create

novel features that cannot be implemented otherwise.

Interoperability with other digital systems

can allow for the convergence between the *Internet of Things* and value systems, enabling new forms of commerce, such as machine-to-machine (M2M).



This diagram is not enough informative to capture the effect of new technologies disrupting the bank sector.

"Fintech's ability to merge social media, use data smartly and integrate with other platforms rapidly (often without the disadvantages of being an actual bank) will help these companies win significant market share"

(J. Dimon, CEO JP.Morgan Chase & Co., 2020)

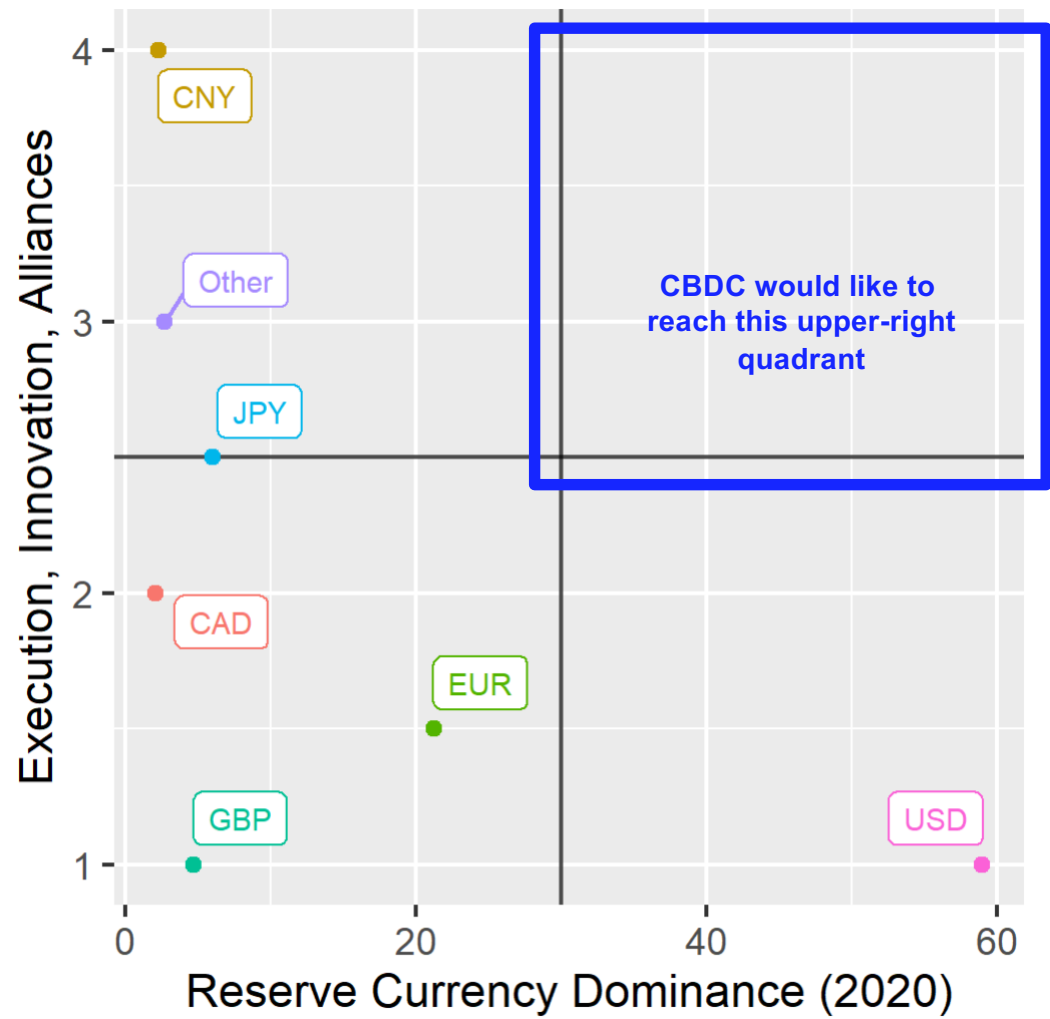
Better is to use the **Gartner Magic Quadrant** (or similar two-axis scatter plots) in assessing emerging markets, particularly for assessing disruption and opportunity

Example of a Gartner Magic Quadrant for meeting solutions



source
Gartner (October 2020)

Gartner Magic Quadrant for currencies



The global CBDC landscape

source
EUBOF 2021

A key aspect of this competitive landscape is to recognize that there are two distinct types of players:

1. **Institutional players** (Central Banks, IMF, BIS, World Bank, G7, G20, ...)
2. **the uninvited guests**, that is non-sovereign actors

Example of uninvited guests (non-sovereign actors):

- **Bitcoin and its ecosystem**
- **Ethereum and the smart contracts**
- **Stablecoins**

Bitcoin and its ecosystem

It **already exists** and has operated for over a decade

It has an easily **recognizable brand**; already used by hundreds of millions of people

It has a **vibrant ecosystem** of service providers

It has a large “**total addressable market**”

Algorithmic (and capped) **inflation schedule**

Censorship resistance

Perceived as a **store of value** and an hedge to inflation

Legal tender in San Salvador: Panama, Paraguay and Guatemala next in 2022

It could appeal to users who are wary of the motives in introducing CBDCs,
(economic surveillance)

Main Bitcoin's drawbacks:

- Its throughput is extremely limited (**scalability**)
- **Energy consumption** (and environmental impact) of its consensus mechanism, based on the PoW
- Vulnerable to severe **deleveraging** during a crisis, due to fixed inflation schedule

Ethereum and the smart contracts

Ethereum begins where Bitcoin ends:

- **Turing-complete language**
(Solidity)
- **Smart-contracts**
- **De-Fi, DEX, NFT, etc.**

Main Ethereum's drawbacks:

- **Halting problem, Rice theorem**
- Bitcoin evolves slowly but surely, Ethereum **changes rapidly** and sometimes it is not clear to users whether the changes are positive.
- Too much **centralization** and governance power under a single person (Vitalik Buterin)
- **Weight** of a full node (**7TB** of space, 400 GB for Bitcoin)
- Path from **PoW to PoS risky**

Stablecoins

Stablecoins are cryptocurrencies tied to a fiat currency, such as the dollar, euro, or a basket of currencies.

Almost **60** projects as today

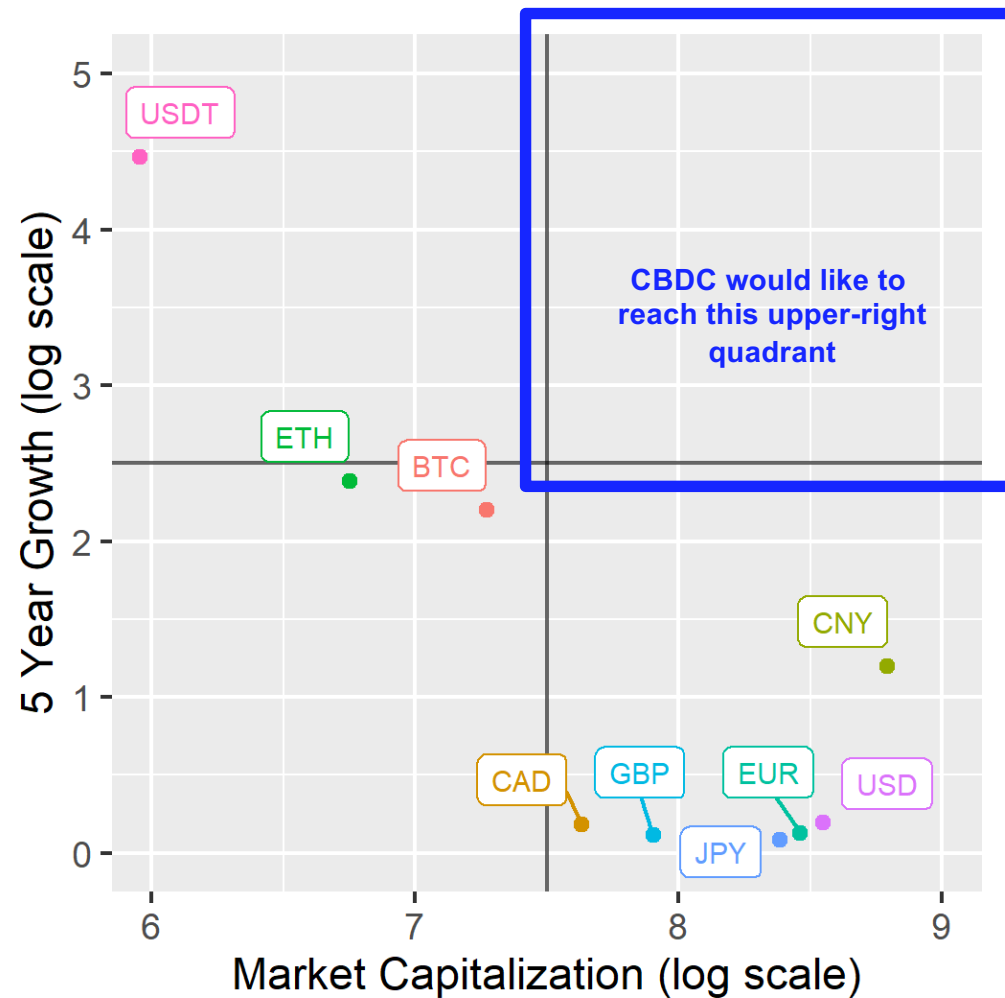
USDT, USDC, BUSD, UST, DAI, TUSD, USDP, are examples of stablecoins pegged to US \$

UST is an algorithmic stablecoin

JPM coin (JP Morgan Chase)

DIEM (ex-Libra), the next stablecoin of Facebook, accused by the US Congress to **threaten financial stability of the FED**

Gartner Magic Quadrant for (crypto-)currencies



source
EUBOF 2021

A Framework for action

Central banks **must maintain** their core user base against:

- **other central banks'** efforts to expand their influence globally
- **non-sovereign actors**

The **exponential growth of alternative currencies** and the **relentless innovation**, tie-ins to social media, and efforts to form alliances among less-established players

pose a serious threaten

to **Central Banks sovereignty**.

A case study: *Minitel*



Minitel 1. Built 1982



1985 TELIC-1 Alcatel Minitel terminal

A case study: *Minitel*

Minitel was the *France Telecom's* offering for the nascent e-commerce space.

Backed by the federal government

9 million terminals, used by **25 million people**, **26000** different **services** available

Efforts to expand internationally

At the time Internet was nothing more than an overgrown academic experiment, with no security, no official backing, and skepticism from the business community.

And yet the Internet's uncoordinated, decentralized growth rapidly dwarfed the Minitel effort, first overseas, and then within France itself.

Its last users were a group of dairy farmers who lacked access to broadband in remote areas of the country.

So, **competition** to any single national CBDC could come from **other fiat currencies** or from **non-sovereign actors**, who end up evolving more useful features or **create dominating network effects** accelerated by strategic alliances, all at **exponential rates** that **shrink the timeframe for appropriate response**.

что делать?

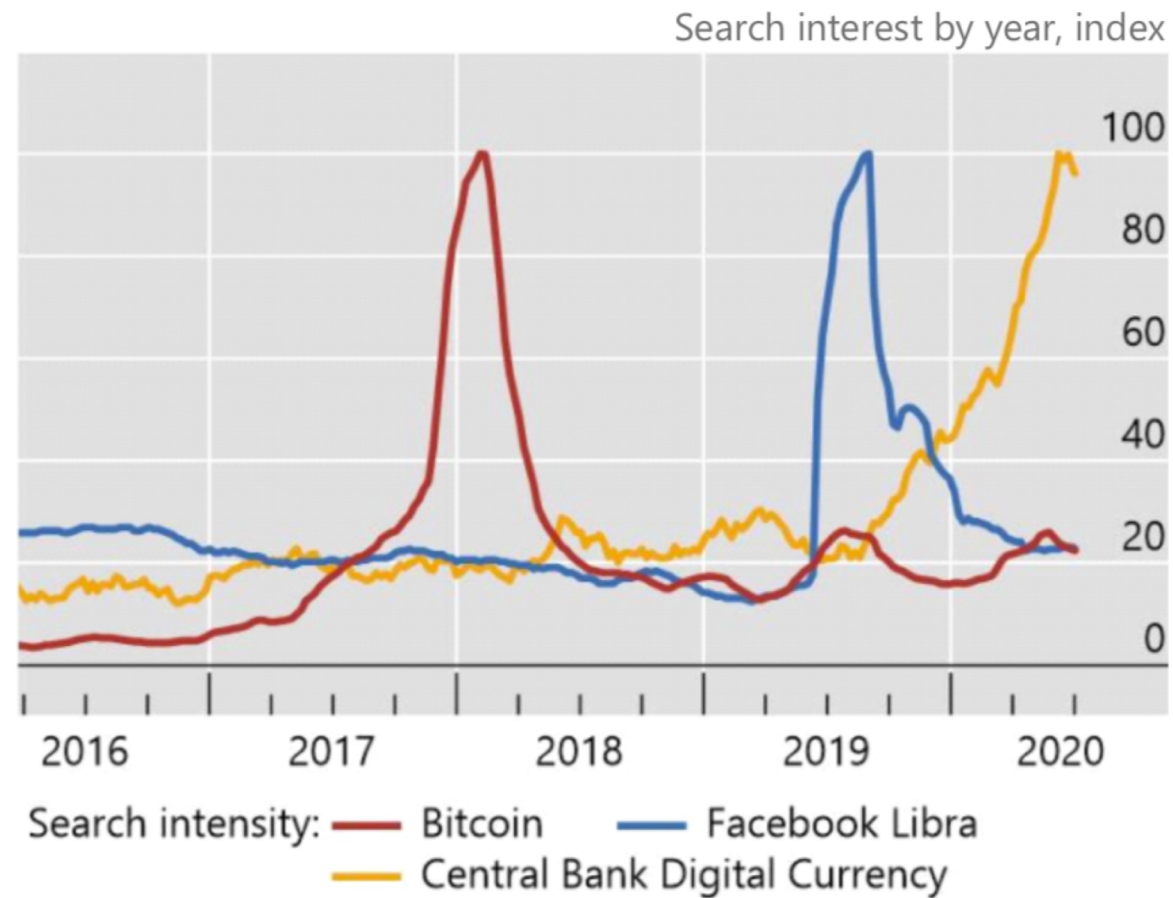
First: do no harm!

The stability of the financial system within the EU is paramount

Second: raise concern, without being alarmist

The race for the upper right quadrant of the Gartner Magic Quadrant is well underway.

Google search interest over time²



source
BIS 880 (2020)

THE DIGITAL EURO TIMELINE



Figure 6 Digital euro timeline.

Source: (EUBOF)

The Digital Euro Design Space

Core principles
as fundamental requirements for a digital Euro

1. be convertible at par with the regular Euro
2. controlled by the Eurosystem
3. be available on equal terms in countries of the Eurozone
4. market neutrality: **not to rule out private solutions**
5. it must remain a **trusted** solution by end-consumers

Scenario-Specific Requirements

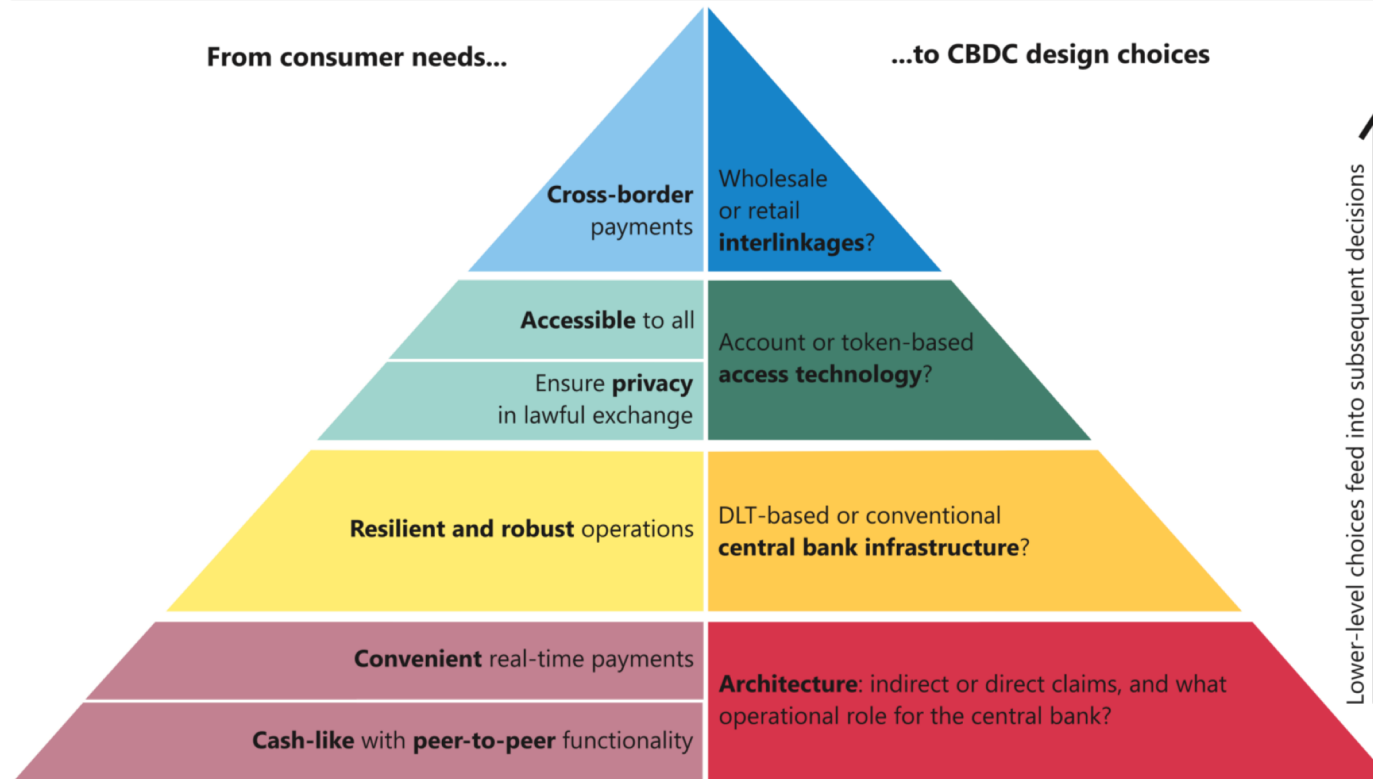
- a. support of digitalization
- b. address the **declining use of cash**
- c. combat the risks of private money creation**
- d. expand the monetary toolbox
- e. improve payment system resilience
- f. strengthen the relevance and international utility of the euro
- g. facilitate cost efficiency, and environmental sustainability

General requirements

1. the ability to control the amount of digital euro in circulation
2. the need to **coexist** (cooperate) with other market participants
3. to comply with regulatory standards
4. the requirement of safety and efficiency in the fulfilment of the Eurosystem's goals
5. its accessibility throughout the euro area through standardized and interoperable solutions
6. use **outside** of the **euro area**
7. cyber resilience

The CBDC pyramid

Graph 1

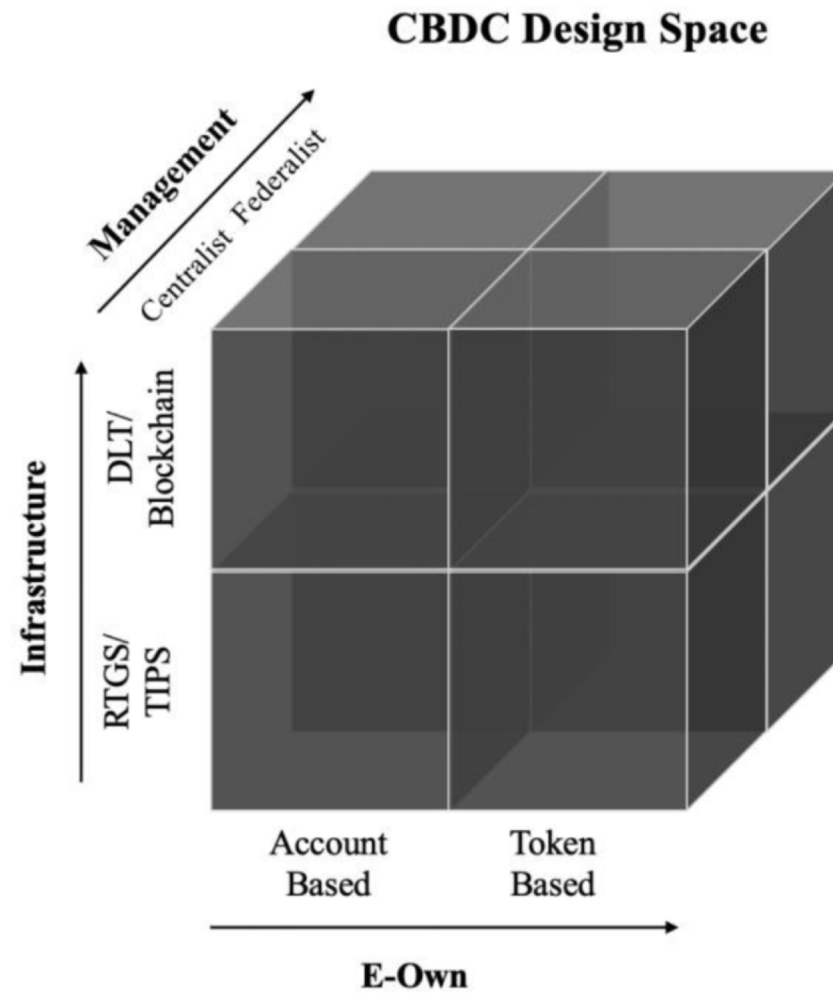


The CBDC pyramid maps consumer needs (left-hand side) onto the associated design choices for the central bank (right-hand side). The four layers of the right-hand side form a hierarchy in which the lower layers represent design choices that feed into subsequent, higher-level decisions.

Auer and Böhme 2020

DESIGN OPTIONS

1. **Architecture** (Management)
the nature of claims of a CBDC and the corresponding role of the central bank (**centralist** vs **federalist**);
2. **Infrastructure**
conventional (**RTGS/TIPS**) vs **DLT** infrastructure;
3. **Access Technology** (Evidence of ownership)
account-based vs **token-based**
4. **Interlinkages**
wholesale vs **retail** use.



EUBOF (2020)

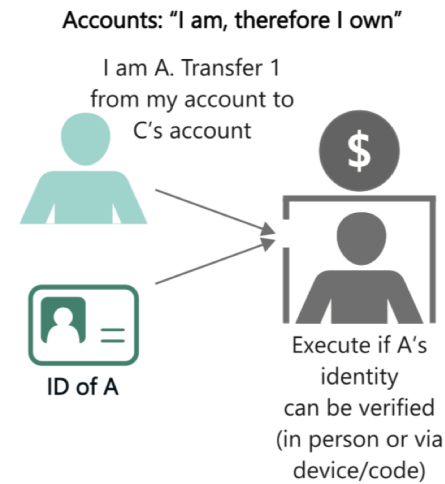
E-own or evidence of ownership

Account-based vs Token-based

Most relevant literature utilises the terms “Proof of Ownership”, “Proof of Access” and similar patterns to describe this dichotomy of account-based versus token-based infrastructures.

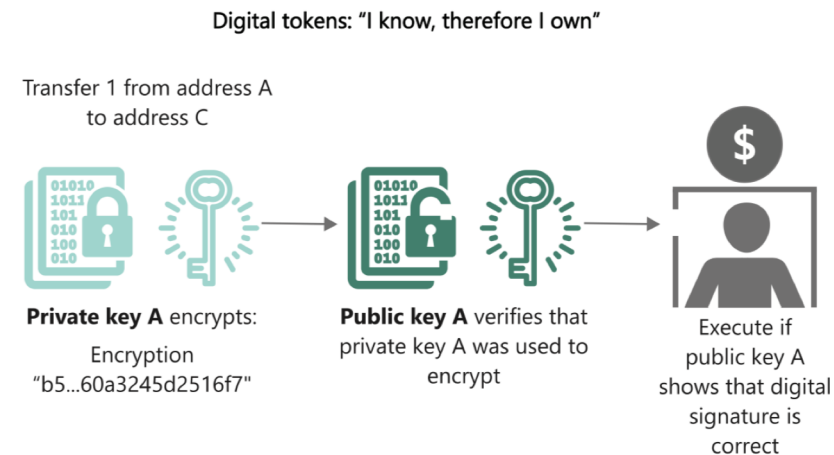
Account-based approach

I am, therefore I own



Token-based approach

I know, therefore I own



Auer and Böhme 2020

Account-based approach

Pros

- simplicity, proven reliability, and **interoperability with the existing payment systems**
- it may facilitate a **smooth and cost-effective transition to a digital euro**, as commercial and central banks already operate on an account-based system

Cons

- **no financial inclusion**
- **no privacy**

Token-based approach

Pros

- **privacy, accessibility** and relative cash-likeness
- financial **inclusion**

Cons

- **KYC, AML requirements**

Account-based vs Token-based

Philosophy in the crypto world: **Code is law**

Philosophy in the ECB: **Law is law**

... as to say that transactions as a result of unauthorized access, fraud, or technical malfunctions, **open to dispute in court or otherwise.**

Ledger Infrastructure

RTGS/TIPS vs Blockchain/DLT

RTGS - Europe's Real Time Gross Settlement System, or
TIPS (TARGET Instant Payment Settlement)

DLT - Distributed Ledger Technologies

Pros

RTGS/TIPS

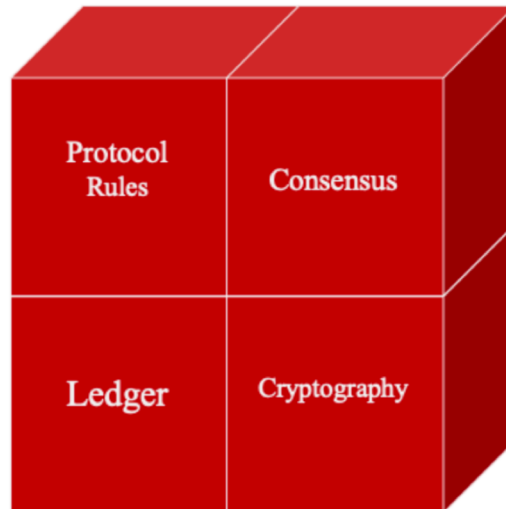
- Proven a **safe, stable, scalable**, and user-accepted real-time 24/7/365 payments system
- **Almost instant transactions**, 99 per cent settling in under 5 seconds, 40 million payments/day, 500 trans/sec up to 2000
- Employing **existing technologies** and infrastructures comes with a plethora of benefits

Cons

- Strictly **limited to institutions participating** in its network
- It **lacks interoperable bridges** with solutions deployed in the open blockchain space
- A **token-based scenario** may **necessitate modifications to TIPS** to accommodate for the differences in data structures.

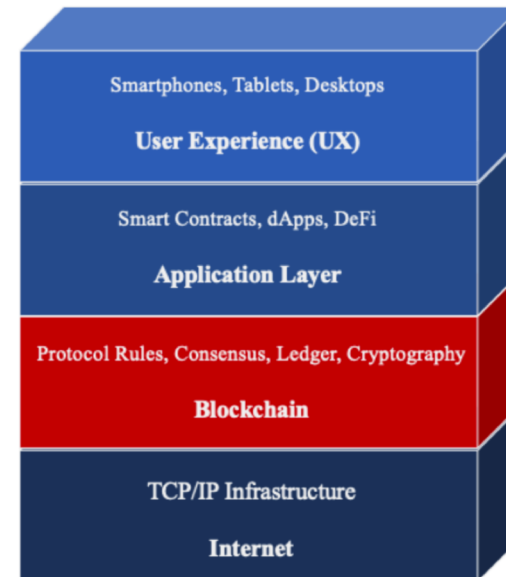
Blockchain/DLT

Elements of Blockchain



Source: EUBOF

Blockchain Technology Stack



Source: Arun Devan

Blockchain/DLT

Permissioned vs permissionless

Permissioned systems reserve participation for appointed, vetted and known entities

They operate in comparably **less adversary environments**

They can rely on the **accountability of their nodes** for the validity of information; the scheme is known as **Proof of Authority (PoA)**.

PoA systems rely on a **small set of trusted and reputable entities** to act as transaction validators and update the ledger.

In the case of a European CBDC the **list of validators can be adjusted to include the Central Bank, national banks of European Member States**, commercial banks and even other stakeholders from the private sector.

Blockchain/DLT

PoA blockchains abolish decentralised features as

transparency, openness and immutability

in favour of

efficiency, **speed**, **scalability**, flexibility, control, and

reversibility

Pros **Blockchain/DLT**

- PoA DLT/blockchain system would facilitate the adoption of either account-based or token-based
- Make **interoperability** with other blockchain deployments easier, due to a similar structure.
- Code and **app developed for the open blockchain could run natively** in a digital euro, thus achieving programmability of money.
- **PoA** blockchains **need not costly consensus algorithms** to verify transactions

Cons

- **Overhead costs of its deployment**
- **Non-interoperability** with existing RTGS/TIPS payment infrastructure

Management Scheme

Centralist vs Federalist

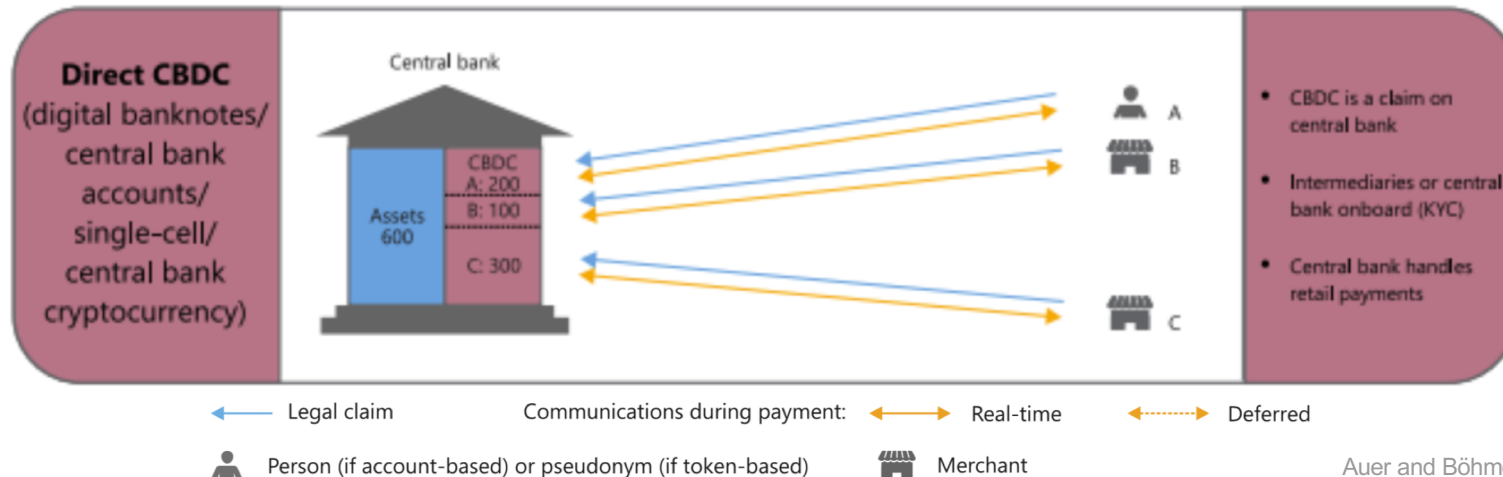
Centralist:

ECB responsible for managing accounts, **KYC/AML**, and the critical components of the technology stack, including holding accounts or token metadata of end-users, and for updating TIPS or blockchain ledger.

Federalist:

retails hold **accounts with commercial banks** and other depository institutions. Accounts are backed 1:1 with digital euro held by commercial banks at the Central Bank.

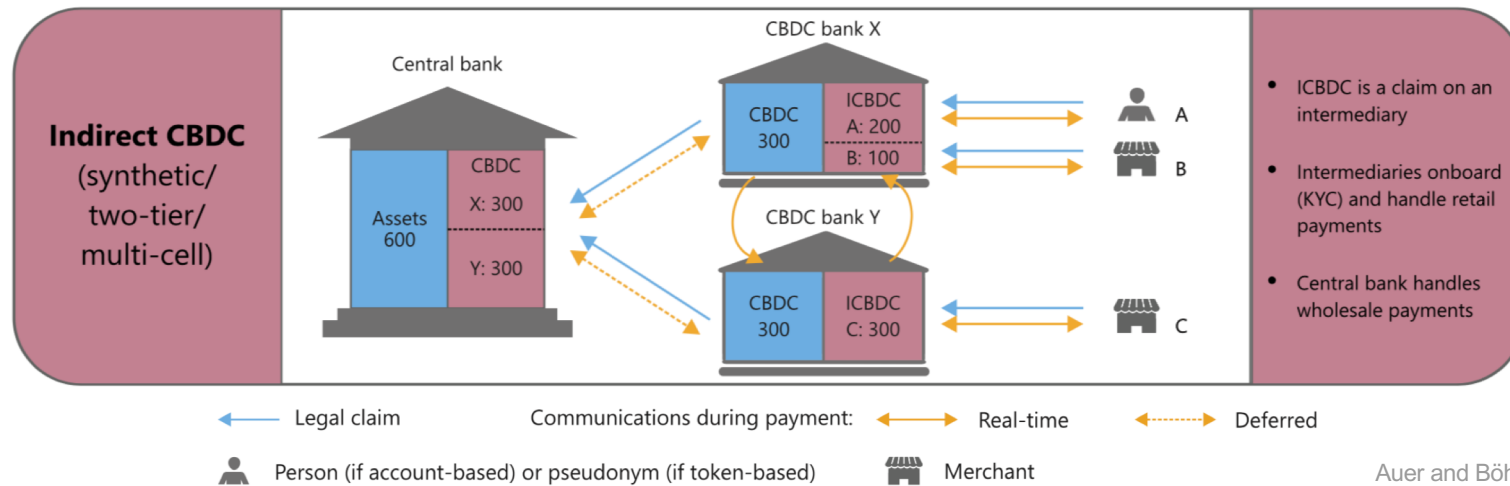
Centralist/Direct model



Cons

- **ECB would have to expand its operations** substantially to accommodate its **new responsibilities** and develop the necessary expertise to manage retail customer relationships (**KYC/AML**)
- **Disintermediation** of commercial banks

Federalist/Indirect



Pros

- **Minimal disruption of established banking sector**, which remains responsible for acquiring and onboarding customers (KYC, AML)

Digital Euro Design Options

Infrastructure:

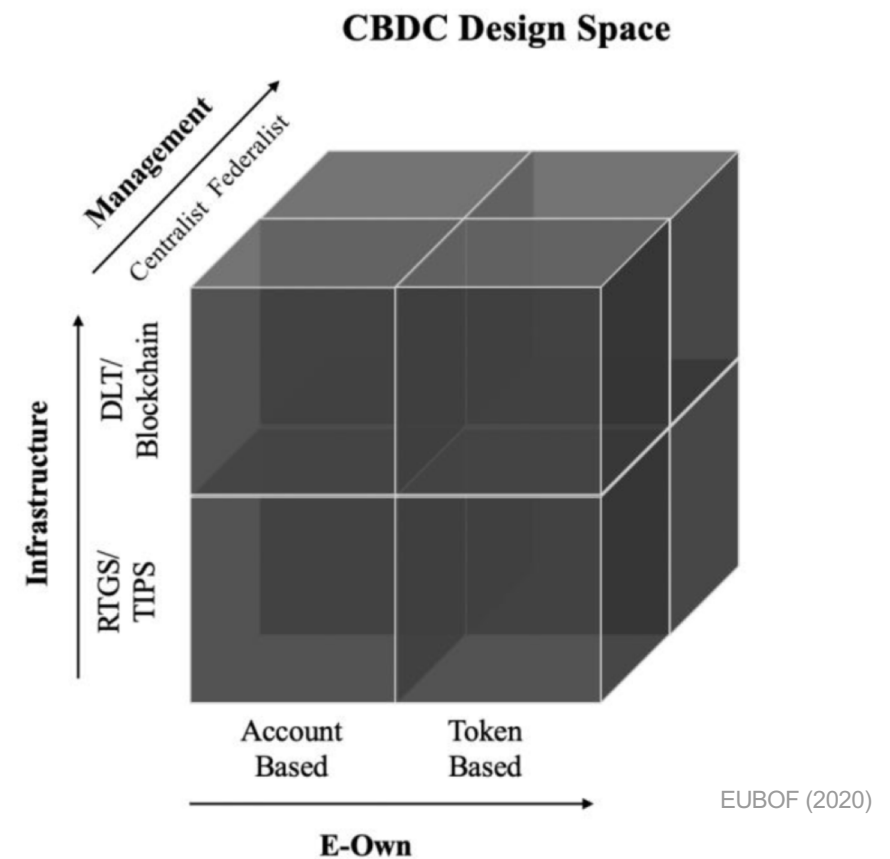
- RTGS/TIPS
- DLT/Blockchain

Management:

- Centralist
- Federalist

E-Own:

- Account-based
- Token-based



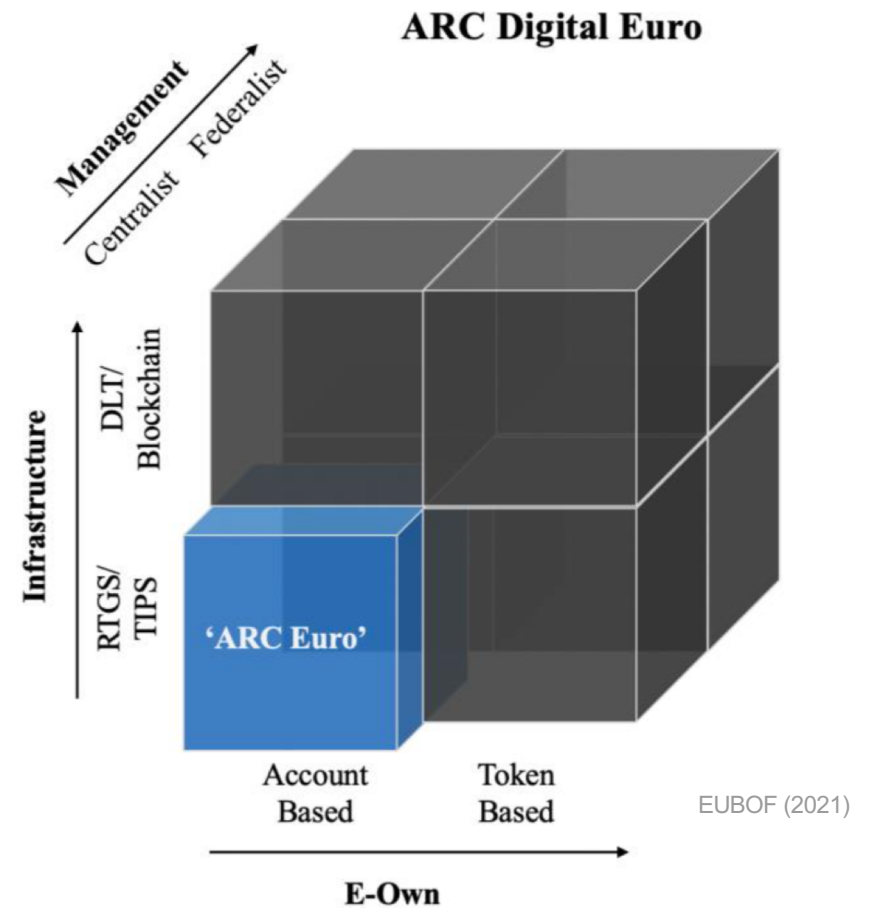
Digital Euro Design Options

ARC	Account-Based RTGS/TIPS Centralist Digital Euro
ARF	Account-Based RTGS/TIPS Federalist Digital Euro
ADC	Account-Based DLT/Blockchain Centralist Digital Euro
ADF	Account-Based DLT/Blockchain Federalist Digital Euro
TRC	Token-Based RTGS/TIPS Centralist Digital Euro
TRF	Token-Based RTGS/TIPS Federalist Digital Euro
TDC	Token-Based DLT/Blockchain Centralist Digital Euro
TDF	Token-Based DLT/Blockchain Federalist Digital Euro

Account-Based
RTGS/TIPS
Centralist Digital Euro

ARC

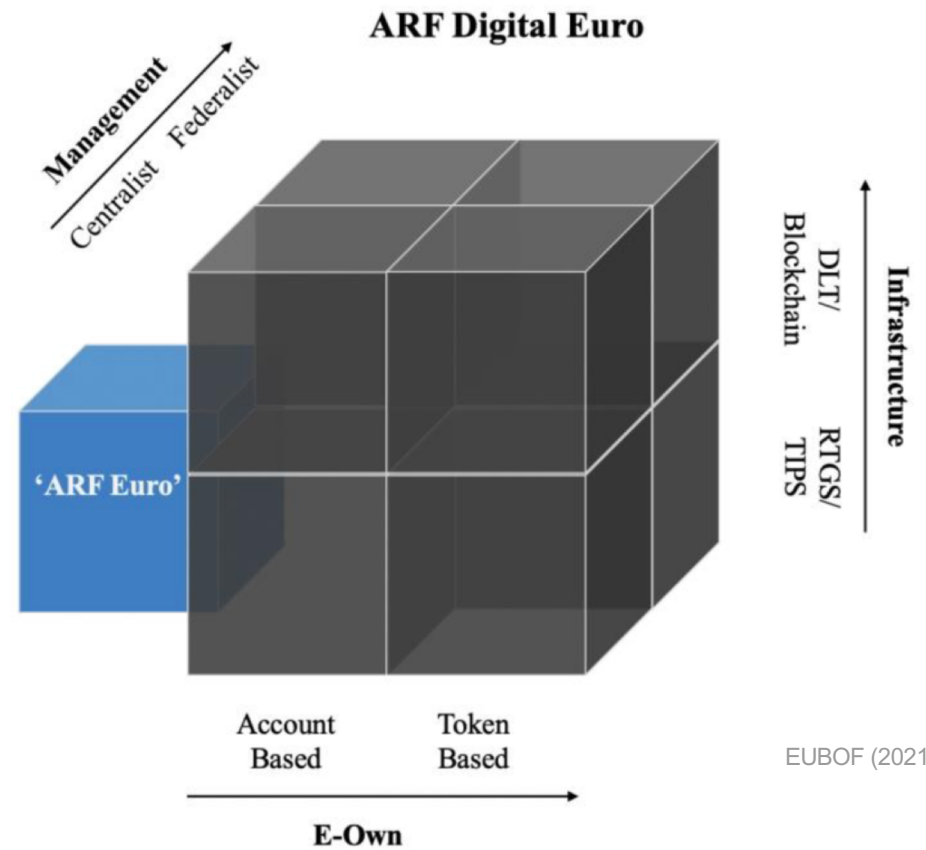
- All transactions handled by debiting and crediting accounts held with the Central Bank



Account-Based
RTGS/TIPS
Federalist Digital Euro

ARF

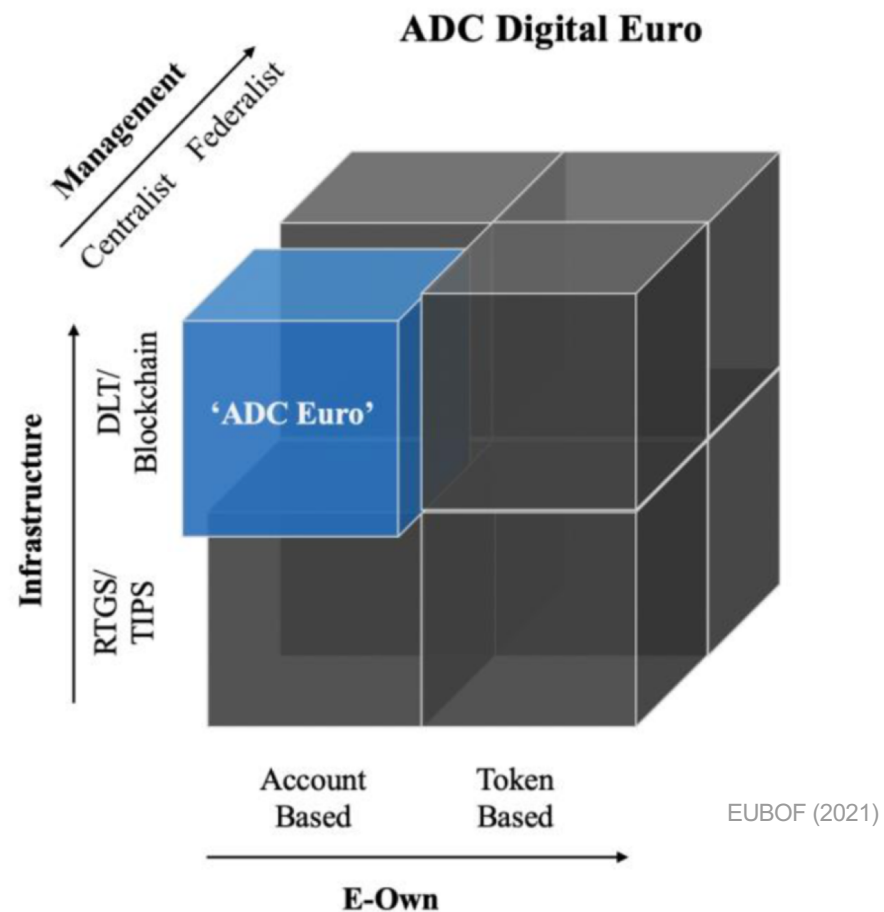
- Closest resemblance to existing systems and procedures



Account-Based
DLT/Blockchain
Centralist Digital Euro

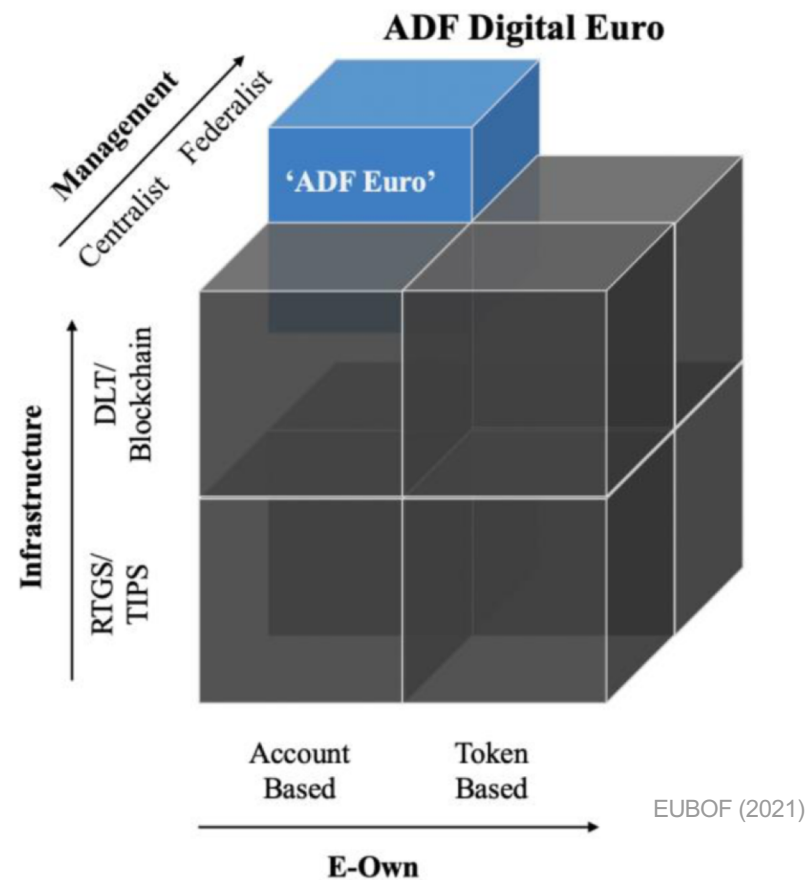
ADC

- Use of DLT redundant in a Centralist system



Account-Based
 DLT/Blockchain
 Federalist Digital Euro
ADF

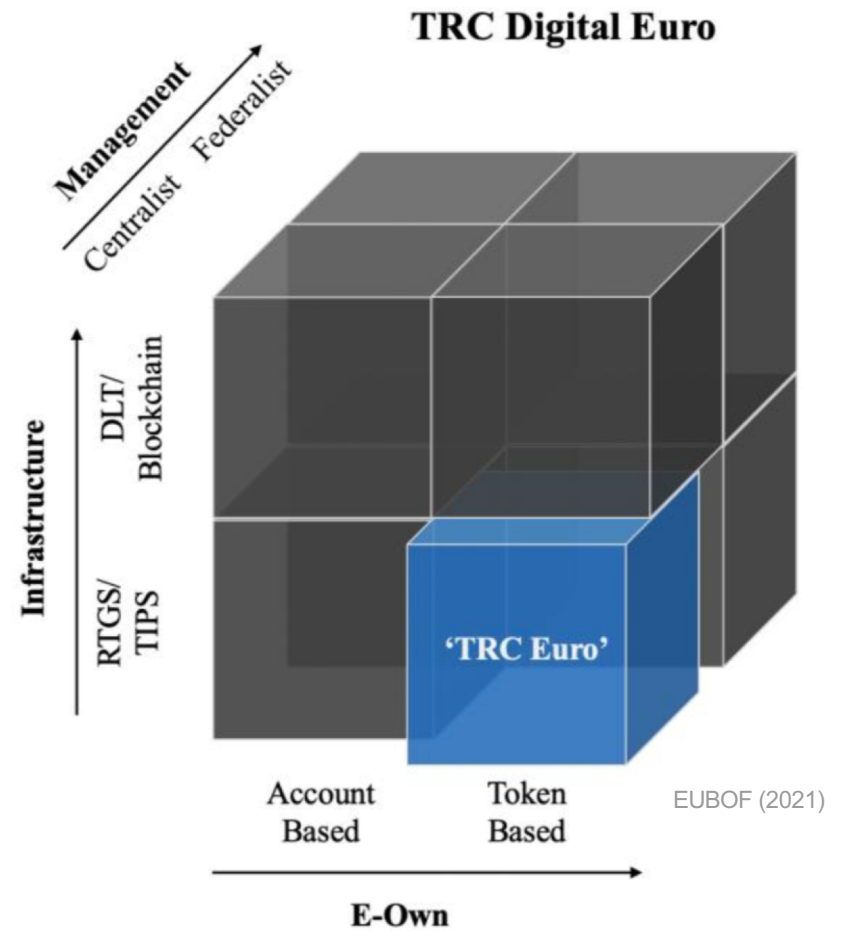
- ECB, commercial banks, and other payment serving as the trusted nodes in a PoA blockchain



Token-Based
RTGS/TIPS
Centralist Digital Euro

TRC

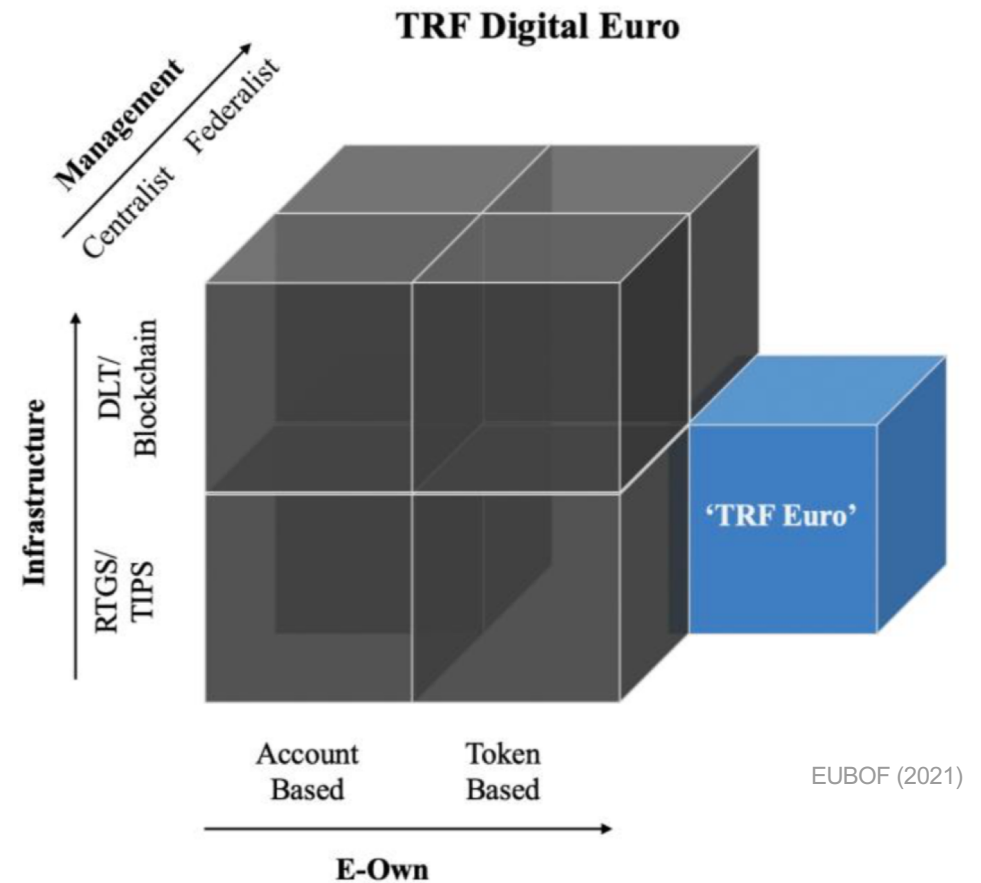
- ECB responsible for maintaining the only mempool and chainstate



Token-Based
RTGS/TIPS
Federalist Digital Euro

TRF

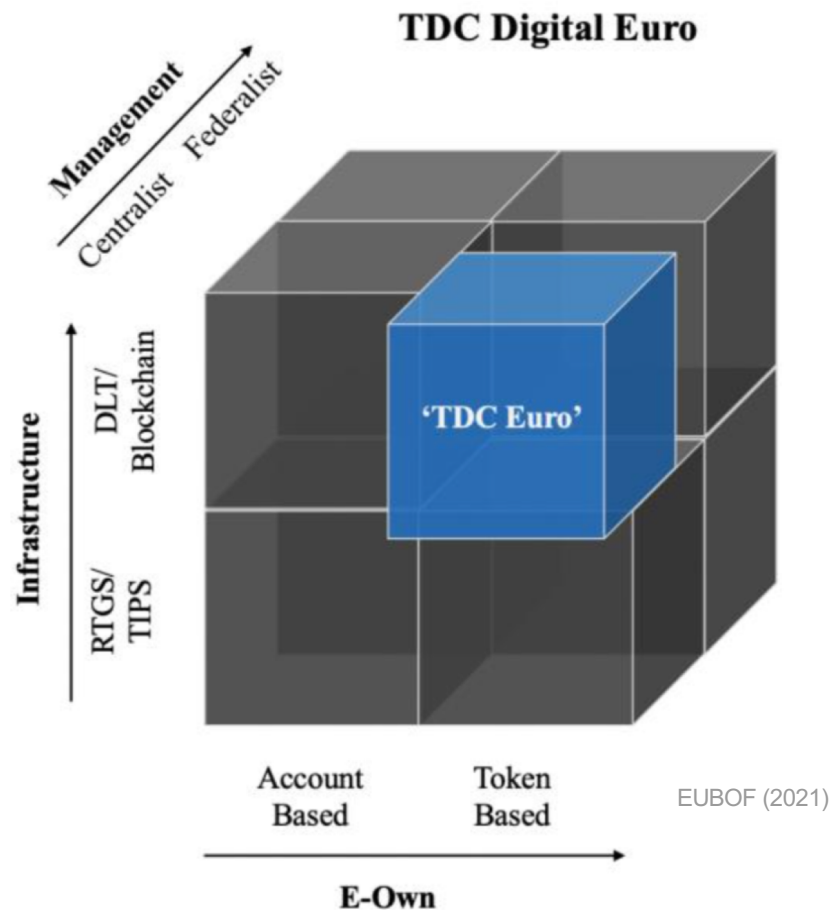
- uses a token/UTXO model in conjunction with TIPS



Token-Based
DLT/Blockchain
Centralist Digital Euro

TDC

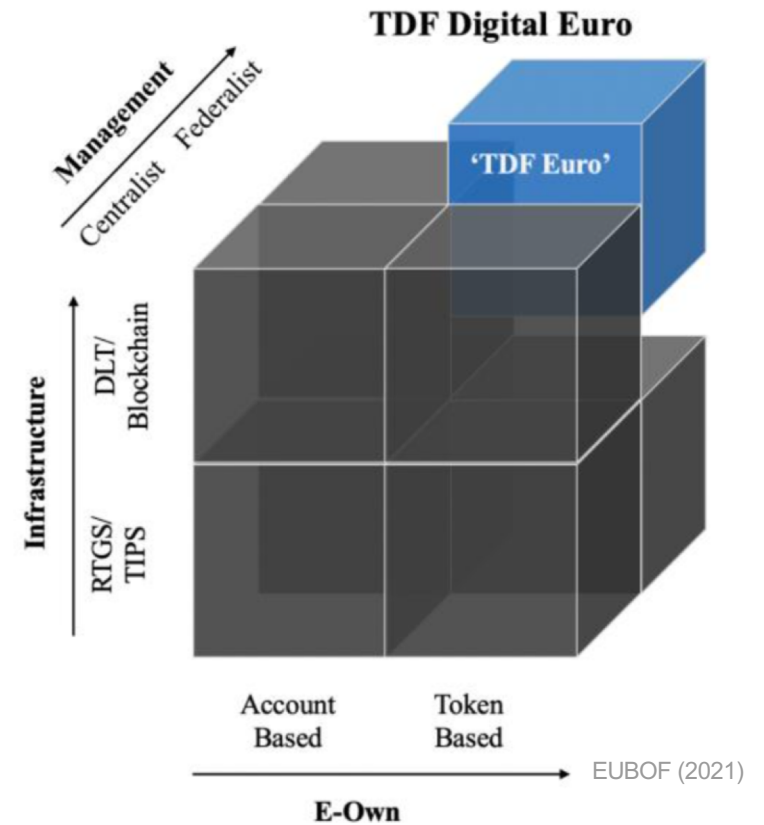
- Closely resembling a permissioned Bitcoin deployment with the ECB acting as the sole validator.
- Use of DLT redundant in a Centralist system



Token-Based
DLT/Blockchain
Federalist Digital Euro

TDF

- Closest to the open blockchain sector
- Closely resembling a permissioned Bitcoin system.
- ECB, commercial banks, and other PSPs would work collaboratively in a PoA system to maintain a blockchain ledger of transactions.



Prerequisite/ Requirement	Core requirements satisfied according to CDBC type:							
	ARC Euro	ARF Euro	ADC Euro	ADF Euro	TRC Euro	TRF Euro	TDC Euro	TDF Euro
Convertibility at par	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Liability of the Eurosystem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
European solution	Possibly	Yes	Possibly	Yes	Possibly	Yes	Possibly	Yes
Market neutrality	No	Yes	No	Yes	No	Yes	No	Yes
Trust	Possibly	Yes	Possibly	Yes	Possibly	Yes	Possibly	Yes

EUBOF (2021)

Prerequisite/ Requirement	Scenario-specific requirements satisfied according to CDBC type:							
	ARC Euro	ARF Euro	ADC Euro	ADF Euro	TRC Euro	TRF Euro	TDC Euro	TDF Euro
Enhanced digital efficiency	Possibly	Yes	Possibly	Yes	Possibly	Yes	Possibly	Yes
Cash-like features	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Competitive features	Possibly	Possibly	Yes	Yes	Possibly	Possibly	Yes	Yes
Monetary policy option	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Back-up system	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
International use	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cost saving	Possibly	Yes	No	Possibly	Possibly	Yes	No	Possibly
Environment friendly	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

EUBOF (2021)

Prerequisite/ Requirement	General requirements satisfied according to CDBC type:							
	ARC Euro	ARF Euro	ADC Euro	ADF Euro	TRC Euro	TRF Euro	TDC Euro	TDF Euro
Control money in circulation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cooperation with market participants	No	Yes	No	Yes	No	Yes	No	Yes
Compliance with regulation	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Safety and Efficiency for European goals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accessibility throughout the euro area	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Use by non-EU area residents	yes	yes	yes	yes	Yes	Yes	Yes	Yes
Cyber Resilience	yes	yes	yes	yes	Yes	Yes	Yes	Yes

EUBOF (2021)

Final assessment

NiRvAna is focused on this

	Total 'Yes'	Total 'Possibly'	Total 'No'	Total Marks
ARF Euro	16	4	0	18
TRF Euro	16	4	0	18
ADF Euro	16	4	0	18
TDF Euro	16	4	0	18
ARC Euro	10	8	2	14
ADC Euro	11	6	3	14
TRC Euro	10	8	2	14
TDC Euro	11	6	3	14

E-Own:

- Account-based
- Token-based

Infrastructure:

- RTGS/TIPS
- DLT/Blockchain

Management:

- Centralist
- Federalist

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Prerequisite/ Requirement	Federalist Options satisfied according to CBDC type				Centralist Options satisfied according to CBDC type			
	ARF Euro	TRF Euro	ADF Euro	TDF Euro	ARC Euro	ADC Euro	TRC Euro	TDC Euro
European solution	Yes	Yes	Yes	Yes	Possibly	Possibly	Possibly	Possibly
Market neutrality	Yes	Yes	Yes	Yes	No	No	No	No
Trust	Yes	Yes	Yes	Yes	Possibly	Possibly	Possibly	Possibly
Enhanced digital efficiency	Yes	Yes	Yes	Yes	Possibly	Possibly	Possibly	Possibly
Cash-like features	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Competitive features	Possibly	Possibly	Yes	Yes	Possibly	Yes	Possibly	Yes
Cost saving	Yes	Yes	Possibly	Possibly	Possibly	No	Possibly	No
Cooperation with market participants	Yes	Yes	Yes	Yes	No	No	No	No
Compliance with regulation	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Accessibility throughout the euro area	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly

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Prerequisite /Requirement	Account-based options satisfied according to CBDC type				Token-based options satisfied according to CBDC type			
	ARF Euro	ADF Euro	ARC Euro	ADC Euro	TRF Euro	TDF Euro	TRC Euro	TDC Euro
Convertibility at par	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Liability of the Eurosystem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
European solution	Yes	Yes	Possibly	Possibly	Yes	Yes	Possibly	Possibly
Market neutrality	Yes	Yes	No	No	Yes	Yes	No	No
Trust	Yes	Yes	Possibly	Possibly	Yes	Yes	Possibly	Possibly
Enhanced digital efficiency	Yes	Yes	Possibly	Possibly	Yes	Yes	Possibly	Possibly
Cash-like features	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Competitive features	Possibly	Yes	Possibly	Yes	Possibly	Yes	Possibly	Yes
Monetary policy option	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Back-up system	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
International use	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cost saving	Yes	Possibly	Possibly	No	Yes	Possibly	Possibly	No
Environmentally friendly	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control money in circulation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cooperation with market participants	Yes	Yes	No	No	Yes	Yes	No	No
Compliance with regulation	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Safety & Efficiency for European goals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accessibility throughout the euro area	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly	Possibly
Use by non-EU area residents	yes	yes	Yes	yes	Yes	Yes	Yes	Yes
Cyber Resilience	yes	yes	Yes	yes	Yes	Yes	Yes	Yes

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Summing up...

1. **Federalist schemes** are **more attractive** when compared to Centralist schemes
2. The design choice between **token-based vs account-based** systems is **not an issue**
3. **Blockchain/DLT** is in most cases **redundant** when trusted parties are involved.

however...

- A **DLT/Blockchain** which supports a **programmable environment** (smart-contracts), would enable **competitive features** similar to those of the **open blockchain space**, but also **backed by** the protection and guarantees of the **Central Bank**.
- Moreover, **open-source code** originally composed for **dApp** or **DeFi** applications **would be** natively **supported** on a digital euro, bootstrapping the development of applications.
- Finally, an **EVM compatible digital euro**, would also benefit from **interoperable solutions** and standards developed for the open blockchain space.

INTEROPERABILITY

- The **technical ability of two or more disparate systems to exchange information** in a manner that maintains the “state and uniqueness” of the information being exchanged.
- There could be a **strong preference** for the **CBDC to be interoperable** with other systems, whether those are existing payment systems, permissioned, or permissionless blockchain-based solutions.

PROGRAMMABILITY OF MONEY

Benefits associated with programmability of digital payments:

- 1) various **processes** associated with payments can be **automated**, enabling for more efficient processes;
- 2) they can be **automated** in a **trusted, undisputable, verifiable manner**, such that the various stakeholders can fully trust and enter into (digital and automated) agreements with other parties.
- 3) This **trust** is built through guarantees **provided by the CBDC** system.

This is exactly what smart contracts on top of DLTs provides, a means to agree to digital processes amongst different parties, without the ability for any party to modify the code that will be automatically executed.

CBDC Programmability use-cases & Programmability models required

1. **parameter-only** programmability
2. **domain specific language (DSL) or visualisation** programmability
3. **smart contract-like** language

Scoring: 0 = Low, 10 = High	Parameter-only (template)	Domain Specific Language (DSL) or Visualisation	Smart Contract-like Language
Ease of use	10	5	0
Level of configurability provided to users	0	5	10
Level of support users will require; and likelihood of users making mistakes	0	5	10

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CBDC Programmability use-cases examples

Automated VAT Settlement

Trade Finance

Retail-based Delivery Automated Payment Release use-cases

Notary Services

Automated Payment Schemes

Automated Process Initiation upon Payment

DeFi – Decentralised Finance

Custodianship Services

Non-Fungible Tokens and Real-world Assets

Programmable money could also be used to

- **prevent** the execution of **transactions** with **sanctioned parties** (indicted, condemned, ...)
- **automatically report** transactions that meet certain regulatory criteria, such as monetary thresholds, association with “**dark web**” activity, and **other red flags**

TRACEABILITY, COMPLIANCE KYC/AML

The development of a digital euro presents a unique opportunity to address the inherent limitations of the current

Anti-Money Laundering/Counter-Terrorist Financing (AML/CTF) framework;

However, **its effectiveness** - along with the required tradeoffs between financial transparency, consumer privacy, and financial inclusion – **will depend on the particular design adopted.**

IMPLICATIONS OF A DIGITAL EURO FOR FINANCIAL STABILITY

Risks associated with a CBDC digital Euro

- **financial disintermediation** in calm times

withdrawal of funds from banks and their conversion into CBDC

- **systemic bank runs** in times of financial distress

In times of financial distress, households and firms tend to convert their deposits into safe assets and cash. A CBDC, being a liability of the central bank, would have a higher degree of safety with respect to bank deposits.

NiRvAna CBDC Blockchain proposal

based on:

- | | | |
|----|---|---|
| 1) | Account-Based
DLT/Blockchain
Federalist Digital Euro | Token-Based
DLT/Blockchain
Federalist Digital Euro |
| | ADF | TDF |
| 2) | Proof of Authority PoA | |
| 3) | Private | |

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