UNIVERSITY of NICOSIA

Session 8

Cryptocurrency, Financial Institutions and Central Banking

DFIN 511: Introduction to Digital Currencies

Objectives

- Gain an initial understanding of the architecture and functions of the global financial system/infrastructure
- Gain an initial understanding of how blockchain/cryptocurrency-based systems could perform similar functions
- In particular, focus areas include:
  - Central Bank functions and cryptocurrency equivalents
  - Understand how central banks are potentially approaching CBDCs (Central Bank Digital Currencies) and what design / architecture tradeoffs exist
  - Distinguish the different types of settlement systems and how they relate to cryptocurrency/blockchain based settlement
  - Gain an initial understanding of the mapping of key cryptocurrency industry segments to the traditional financial services industry
  - Be able to distinguish between “services” provided natively on the blockchain vs by firms in the cryptocurrency financial services industry
  - Develop a sense of the level of maturity of the cryptocurrency financial services field

Agenda

1. Central Bank Functions
2. Central Banks vs Cryptocurrency
3. Central Bank Digital Currencies (CBDCs)
4. Settlement systems
5. Settlement in Digital Currencies
6. Financial Services
7. Cryptocurrency Financial Services
8. Conclusions
9. Further Reading

Session 8: Cryptocurrency, Financial Institutions and Central Banking

1. Central Bank Functions

CBs are responsible for the effectiveness of the monetary and banking system

Central banks are financial entities that are established in countries/currency zones to define and support the monetary system of their nation. Typical high-level responsibilities include:

- Creating the rules and regulations under which national banks should function
- Monitoring the stability of inflation rates, of the price of money and regulation of the debit and credit framework of the nation
- Controlling money issuance and supply
- Acting as "the lender of last resort" for banks or other eligible institutions. In simple terms, central banks provide liquidity to commercial banks in extraordinary circumstances.

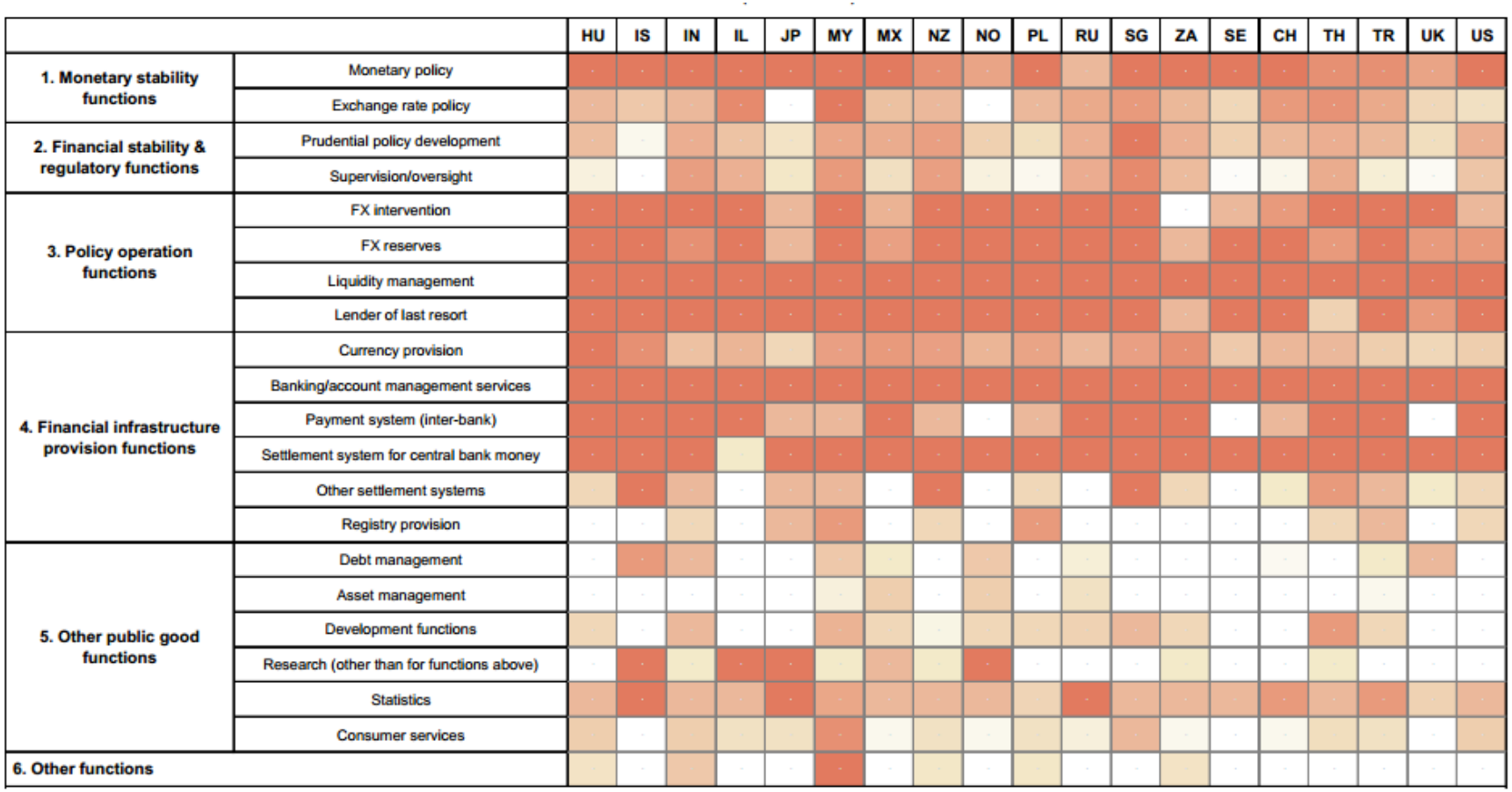
Public Cryptocurrencies typically provide a narrower set of “CB services”

Monetary Stability	Financial Stability/ Regulatory Functions	Policy Operations Management	Financial Infrastructure
Formulating, conducting, implementing and monitoring the proper functionality of the national monetary policy	Regulating the banking sector	Currency intervention	Payment and settlement systems
Balancing and managing (to their best of their ability) inflation, interest rates, exchange rates, while being supportive of economic growth.	Ensuring a stable financial system for the country they operate	Liquidity Management	Currency Provisions
Managing the money supply of a currency	Lender of last resort (the provision of liquidity to the banking system to counteract shocks and prevent bank runs from spreading from one institution to another. In a fiat currency system, Central Banks cannot “run out of liquidity”)		

Central Bank Functions by Country: BIS Survey 2008

		AR	AU	BR	BG	CA	CL	HR	CZ	HK	Eurosystem: ECB	BE	FI	FR	DE	IT	NL	PT	SK	ES
1. Monetary stability functions	Monetary policy																			
	Exchange rate policy																			
2. Financial stability & regulatory functions	Prudential policy development																			
	Supervision/oversight																			
3. Policy operation functions	FX intervention																			
	FX reserves																			
	Liquidity management																			
	Lender of last resort																			
4. Financial infrastructure provision functions	Currency provision																			
	Banking/account management services																			
	Payment system (inter-bank)																			
	Settlement system for central bank money																			
	Other settlement systems																			
	Registry provision																			
5. Other public good functions	Debt management																			
	Asset management																			
	Development functions																			
	Research (other than for functions above)																			
	Statistics																			
	Consumer services																			
6. Other functions																				

Central Bank Functions by Country: BIS Survey 2008



		HU	IS	IN	IL	JP	MY	MX	NZ	NO	PL	RU	SG	ZA	SE	CH	TH	TR	UK	US
1. Monetary stability functions	Monetary policy																			
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2. Central Banks vs Cryptocurrency

Some believe that cryptocurrencies are ‘algorithmic central banks’

- There is a large segment of the cryptocurrency community that believes certain public cryptocurrencies will supplement or replace national sovereign (central bank managed) currencies
- This segment views the currency (monetary) aspect of cryptocurrency as being very important
- Conversely, many CBs over the years have had quite negative views of cryptocurrencies in this context because they were also analysing them in this frame (monetary, not technological)
- For the purposes of this section:
  - We will look for analogies between public cryptocurrencies and CBs
  - Bitcoin will be the reference cryptocurrency used for the analysis, both because it is the most common/well developed but also because this political philosophy is most common among Bitcoin advocates

Public Cryptocurrencies typically provide a narrower set of “CB services”

Central Bank General Functions	Central Bank Detailed Functions	Cryptocurrencies
Monetary Stability Functions	Monetary Policy	Yes. Monetary policy fixed at inception but can be changed by majority of miners. In the case of Bitcoin, it is mildly inflationary (expansionary) money supply but with the rate of increase dropping rapidly over time, converging to zero
	Exchange Rate Policy	No
Financial Stability & Regulatory Functions	Prudential Policy Supervision	No
	Supervision/Oversight	No
Policy Operation Functions	FX Intervention	No
	FX Reserves	No
	Lender of Last Resort	No
Financial Infrastructure and Provision Functions	Currency Provision	Sometimes yes, through block rewards
	Banking/account management services	No
	Payment system (inter-bank)	Yes. Cryptocurrencies have a built-in payment system that, from one point of view, merges a variety of traditional payment and settlement systems
	Settlement system of central bank money	
	Other settlement systems	
	Registry Provision	No

Public Cryptocurrencies typically provide a narrower set of “CB services”

Key Topic	Central Bank	Public Cryptocurrency (e.g. Bitcoin)
Political Philosophy	"Keynesian" economics philosophy	"Austrian" economics philosophy
Money Supply	Tool to implement economy goals such as macro-economic stability, growth and employment	Fixed. It is assumed that this will drive positive and fairer economic results indirectly
Scope	1 per currency zone	Free market for different economic models across cryptocurrencies
Seigniorage	Accrued to state	Earned by miners in exchange for the costs they incur in providing transaction security
Lending	Supervisory authority	Out of scope for most blockchains
Financial Infrastructure	Focus on user protection and AML/KYC	Open; permissionless; high level of user responsibility

Common perspectives reflect these different philosophies

CB Perspective	Cryptocurrency supporters' perspective
Without tools to manage currency supply and be a market maker in the currency, the currency will always be (more) volatile. Cryptocurrencies have not shown the ability to maintain price stability to date	Most fiat currencies over the history of time have not ended well, due to over-issuance, devaluation or external events (wars, etc.). A limited digital currency will have lasting value and preserve wealth
Financial institutions will emerge and regulation, as well as the ability to provide backstops, will be needed. Most people, in practice, will give up some independence in exchange for less day-to-day personal responsibility for fraud, theft, etc.	Open, auditable records and better models (like multi-sig) will actually reduce fraud in the long run by forcing more transparency
While theoretically decentralized, many cryptocurrencies currently show centralization both in distribution of coins and distribution of hashing power	Ability to control the currency gives significant power to governments that is better devolved to individuals
Banking system support is needed to support economic stability	Liquidity support and “too big to fail banks” create distortions to incentives and markets
	Protocols are extensible for more advanced uses

Session 8: Cryptocurrency, Financial Institutions and Central Banking

3. Central Bank Digital Currencies (CBDCs)

Bank of International Settlement (BIS) Report Jan 2020

- Around 10% of the central banks surveyed are likely to issue a CBDC for the general public in the short term, representing 20% of the world's population
- Central banks are continuing to research CBDCs. Yet, there is no evidence of a widespread or general move to expand this research into experimentation and pilot arrangements
- A few central banks with sufficient motivation are proceeding to pilot various designs
- Motivations for CBDC research continue to be diverse. Cash use is the key to driving many central banks' plans, with Emerging Market Economies (EME) central banks aiming to reduce reliance on cash, and advanced economies acting to pre-empt any issues that might be faced by the general public in accessing central bank money
- Finally, collaboration on understanding the impact of private digital tokens may also need to intensify

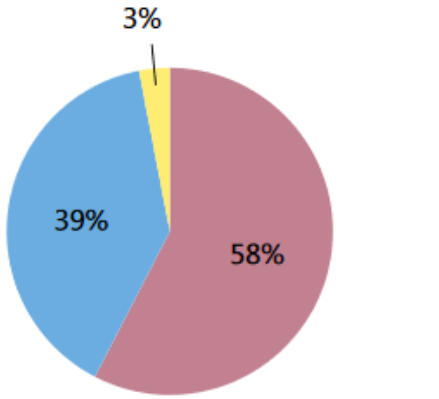
Source: https://www.bis.org/publ/cgfs51.pdf

Bank of International Settlement (BIS) Report Jan 2020

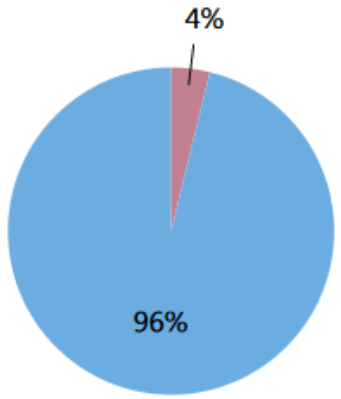
Many central banks are not yet analysing the impact of private digital tokens

In per cent of respondents — Graph 8

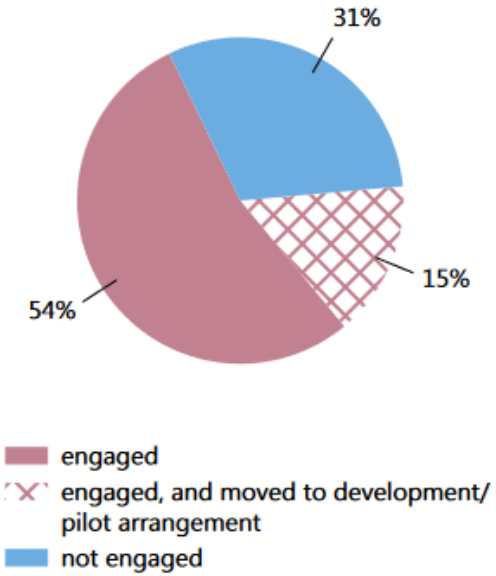
Are you analysing the potential impact on monetary and financial stability of stablecoins?



Central banks that responded "no"



Central banks that responded "no" (engagement in CBDC work)



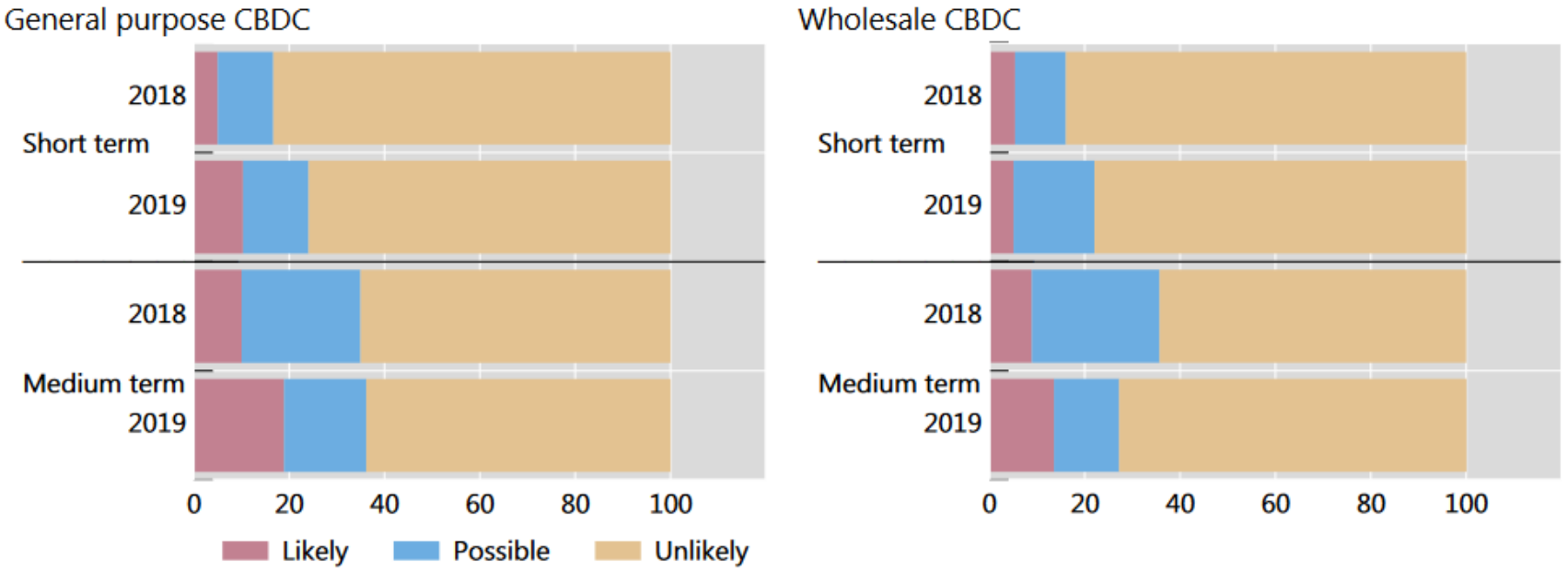
Source: Central bank survey on CBDCs.

Bank of International Settlement (BIS) Report Jan 2020

The likelihood of issuing a CBDC is increasing

Share of respondents

Graph 7

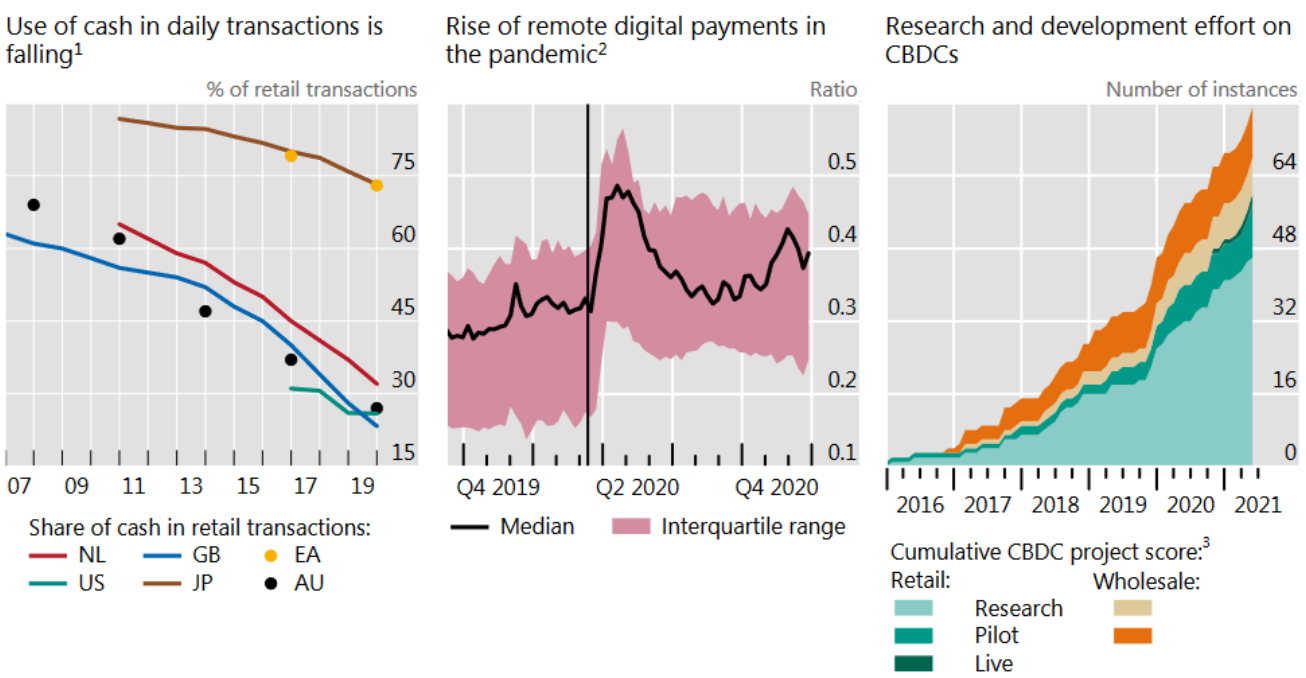


Short term: 1–3 years and medium term: 1–6 years. "Likely" combines "very likely" and "somewhat likely". "Unlikely" combines "very unlikely" and "somewhat unlikely".

Source: Central bank survey on CBDCs.

Bank of International Settlement (BIS) Report June 2021

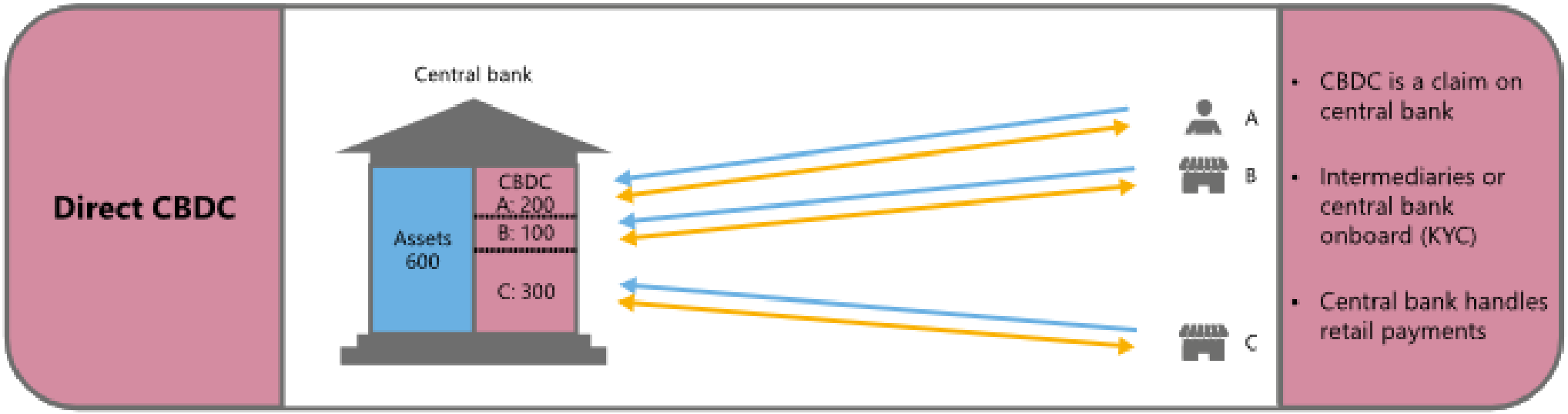
As cash use falls and digital payments rise, CBDC projects are moving ahead — Graph III.1



[1] Based on volume of transactions. For AU, excludes payments over A$9,999. For JP, based on value of transactions; excludes retail payments by bank transfer. [2] Share of card-not-present transactions in overall transactions, based on transaction counts. These remote transactions are often for online sales ("e-commerce"). The sample comprises AR, AU, BR, CA, CH, DE, ES, GB, HK, IN, IT, JP, NL, RU, SE, SG, US and ZA. The black vertical line in the centre panel indicates 11 March 2020. [3] Based on publicly communicated reports. Cumulative count of scores in each bucket. The score can take a value of 0 when there is no announced project, 1 in case of research studies, 2 in the case of an ongoing or completed pilot and 3 for a live CBDC. For more information see Auer et al (2020).

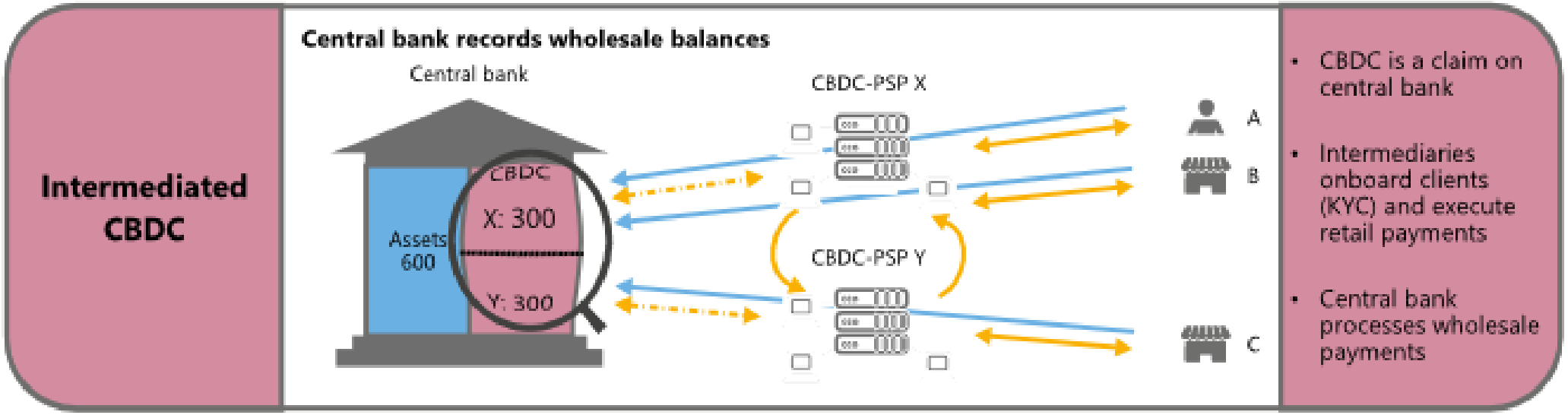
Sources: R Auer, G Cornelli and J Frost, "Rise of the central bank digital currencies: drivers, approaches and technologies", BIS Working Papers, no 880, August 2020; F Alvarez, R Auer, G Cornelli and J Frost, "The impact of the pandemic on cash and retail payments: insights from a new database", mimeo; central banks' websites; Japan's Ministry of Economy, Trade and Industry; global card networks; BIS calculations

Retail CBDC Architecture: Single-tier retail CBDC



Source: https://www.bis.org/publ/arpdf/ar2021e.pdf

Retail CBDC Architecture: Two-tier retail (Intermediated) CBDC



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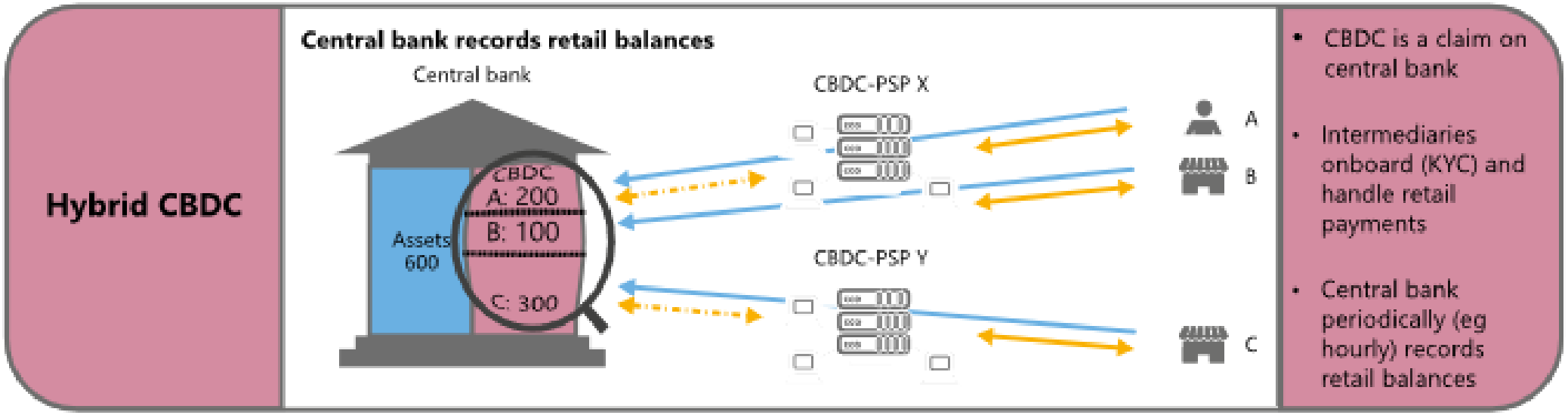
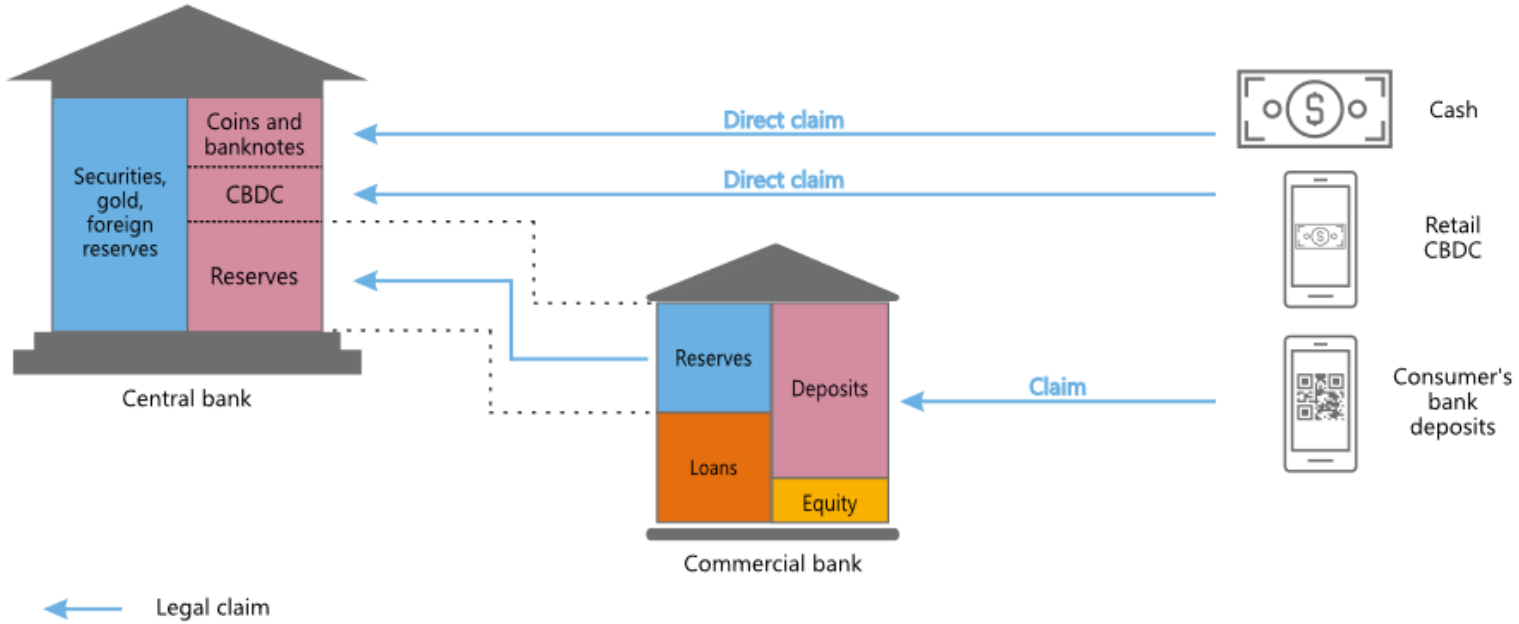
Retail CBDC Architecture: Two-tier retail (Hybrid) CBDC



Source: https://www.bis.org/publ/arpdf/ar2021e.pdf

Retail CBDC Architecture: Bank of International Settlement (BIS)

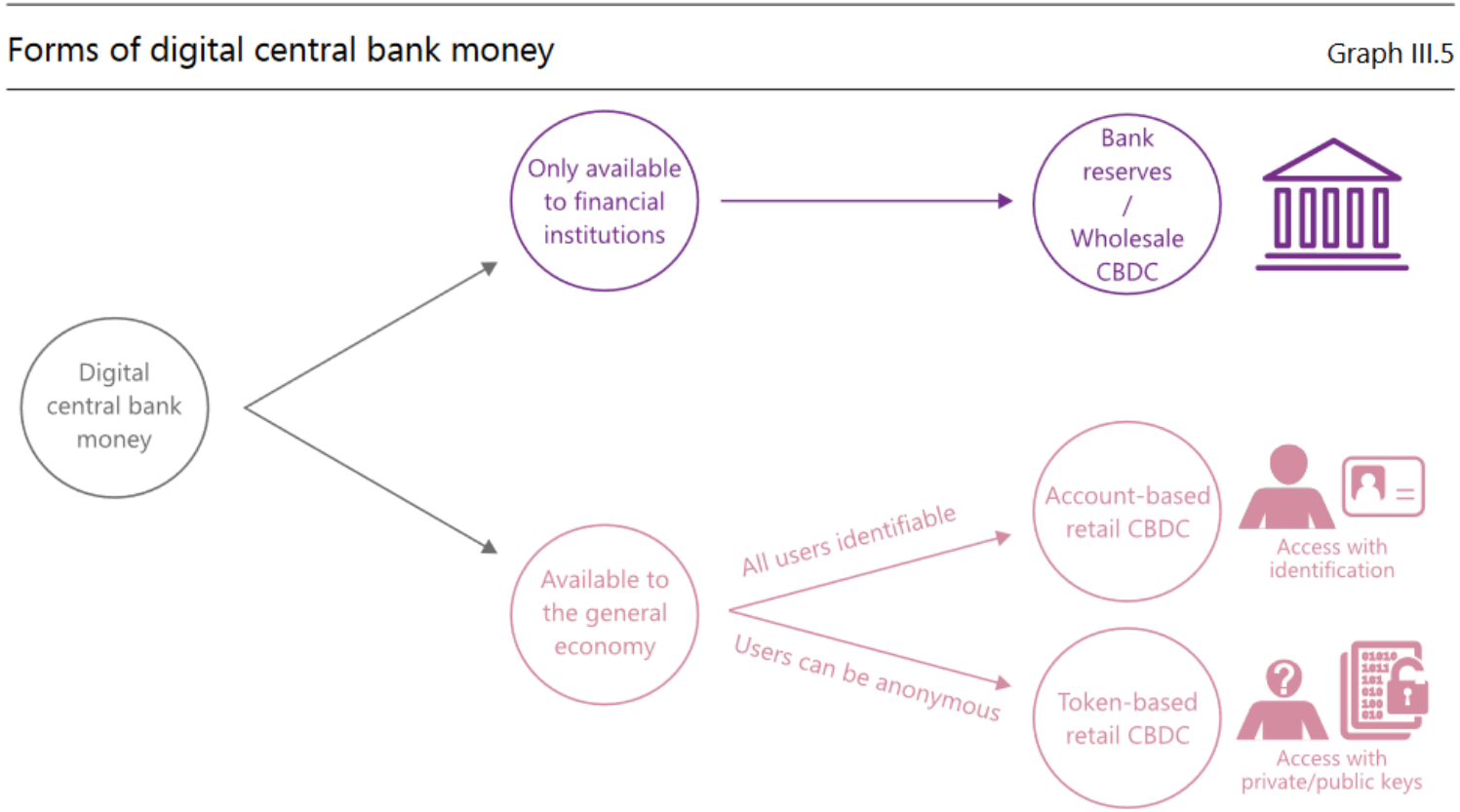
The monetary system with a retail CBDC — Graph III.4



Source: R Auer and R Böhme, "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June 2021.

Sources: R Auer, G Cornelli and J Frost, "Rise of the central bank digital currencies: drivers, approaches and technologies", BIS Working Papers, no 880, August 2020; F Alvarez, R Auer, G Cornelli and J Frost, "The impact of the pandemic on cash and retail payments: insights from a new database", mimeo; central banks' websites; Japan's Ministry of Economy, Trade and Industry; global card networks; BIS calculations

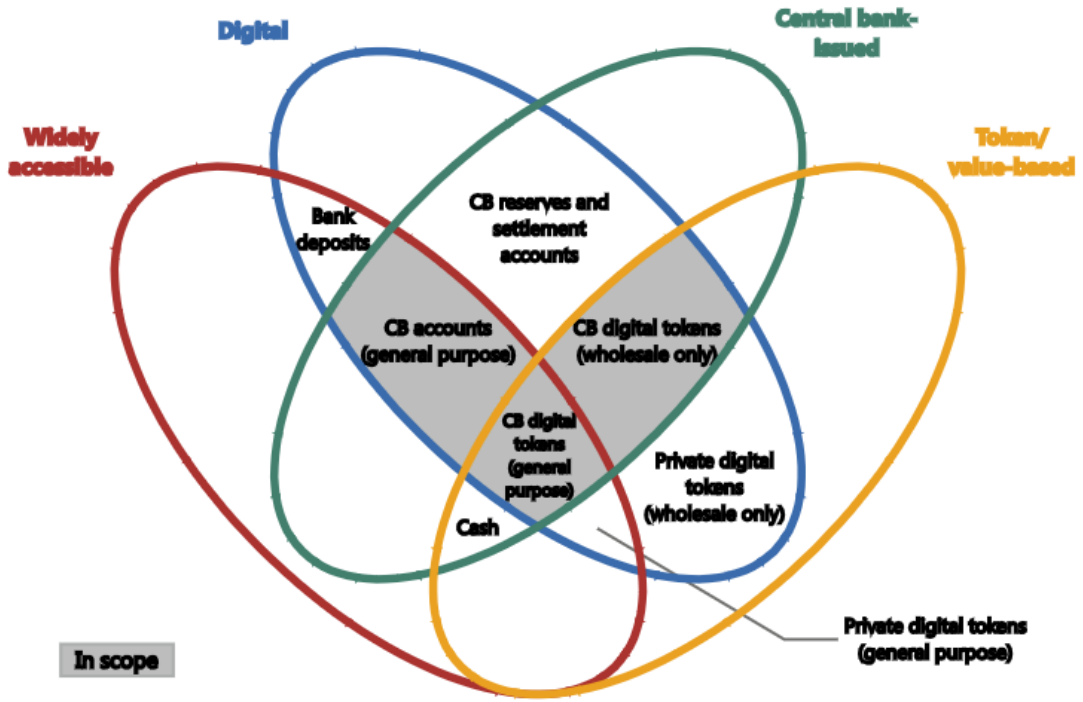
Forms of digital central bank money



Source: https://www.bis.org/publ/arpdf/ar2021e.pdf

The money flower: where are CBDCs classified?

The money flower: a taxonomy of money — Graph 1



The Venn diagram illustrates the four key properties of money: *issuer* (central bank or not); *form* (digital or physical); *accessibility* (widely or restricted); and *technology* (account-based or token-based). CB = central bank. *Private digital tokens (general purpose)* include cryptocurrencies, such as Bitcoin. For examples of how other forms of money may fit in the diagram, please refer to the source.

Sources: CPMI-MC (2018); Bech and Garratt (2017).

Source: https://www.bis.org/publ/bppdf/bispap101.pdf

CDBC Design Space (EUBOF) Report June 2021

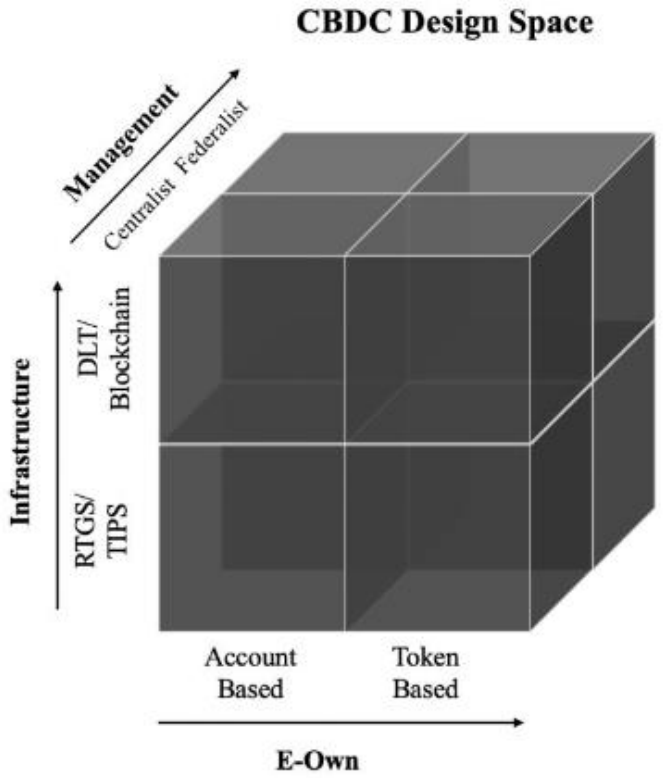


Figure 7 CBDC Design Space. Source: (EUBOF)

Sources: https://www.eublockchainforum.eu/sites/default/files/reports/CBDC%20Report%20Final.pdf

Fundamental difference between a fiat backed stablecoin and CBDCs

- The key fundamental difference is the issuer and the spectrum of the issuer
- The issuer maybe a country's central bank, an organization or anyone else
- With a CBDC who also is the issuer of the fiat currency, there will always be a stable value of 1 CBDC with 1 fiat currency
- With anyone other than the central bank issued stablecoins, the fact is that they are not the issuers of the fiat currency
- Thus, the challenge with such stablecoins, is to keep the price stable, worth 1:1 rate with the fiat national sovereign currency
- Stablecoins are operating in an environment actively hostile in maintaining the peg, with markets trying to take advantage of the slightest price fluctuation (go short or long)

Fundamental difference between a fiat backed stablecoin and CBDCs

- Potential reasons: may not in reality have the fiat currency claimed, thus not being 100% fiat backed, contractual obligations, delays on delivery etc. leading for the stable coin to trade lower
- Approaches: be institutionally credible (trust), over-collateralize, frequent audits
- A CBDC is the only true stablecoin, anything else is some deviation away from a perfect stablecoin: fully collateralized, fully audited, highly professional, very trustworthy issuer

CBDCs and exchange protocol interoperability

In a CBDC world how would one type of CBDC (i.e. e-Dollar) trade with another type of CBDC (i.e. e-Euro) and how would protocols communicate with each other?

- Depending on the design decision of the central banks multiple types could exist:
- Use a centralized exchange or liquidity provider who holds both coins and trade one digital currency for another
- Use a decentralized exchange and trade BTC on an Ethereum exchange (wrapped BTC)
- Integrate compatible blockchains
- Use other solutions than blockchain i.e. contemporary databases

CBDCs may extend existing practices to a digital format

- Issued and backed by the Central Bank
- Holders of CBDCs have a claim against the Central Bank
- No credit or liquidity risks
- Can help Central Banks retain sovereignty over monetary policy in a tokenised asset market
- May provide opportunities for new regulatory monitoring and enforcement tools
- May lead to cheaper cross-border remittances, reducing charges and waiting times
- Could improve the interbank payment infrastructure (transfer, settlement, clearing, reconciliation of asset transactions)
- May be a replacement for physical cash
- Could be an opportunity to rethink the relationship between central banks, commercial banks and depositors

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4. Settlement Systems

Payment Systems

- "A payment system refers to the complete set of instruments, intermediaries, rules, procedures, processes and interbank funds transfer systems which facilitate the circulation of money in a country or currency area"

- A payment system consists of three elements:
  1. Payment instruments
  2. Processing (which includes clearing)
  3. A way of settlement

Main Source: Kokkola, T. ed., 2010. The payment system: Payments, securities and derivatives, and the role of the Eurosystem. European Central Bank. https://www.ecb.europa.eu/pub/pdf/other/paymentsystem201009en.pdf

Scenario 1: Two accounts in the same bank

- This is the most simple scenario. Bob wants to send $100 to Lucy and they are both customers of Chase Bank

- Chase will debit Bob's account $100 (aka, they will say that they owe Bob $100 less) and will credit Lucy's account $100 (aka they will say they owe Lucy $100 more)

- The whole transaction is internal to Chase meaning that:
  - It can occur using Chase's internal systems,
  - There is no credit / counterparty risk for Chase
  - It does not impact Chase's liquidity in any way (Chase nets against itself)

Scenario 2: Corresponding Banks

- Now, let us assume that Bob and Lucy are at different banks. Bob (at Chase) wants to send $100 to Lucy (at Citibank). Citibank and Chase have a correspondent relationship, aka they maintain accounts with each other
- Chase can debit Bob's account $100 (aka, they will owe Bob $100 less) and credit Citibank's account $100 (aka they will owe Citibank $100 more), so Chase nets out
- In turn, Citibank will credit Lucy's account $100 (aka they will owe Lucy $100 more), which nets out against the $100 credit they received at Chase, so Citibank nets out
- This is an effective system but has some weaknesses:
- It is not at all practical for every bank to have a correspondent relationship with every other bank
- The banks are exposed to credit risk / counterparty risk with each other

Scenario 3: Settlement Systems

- This is the most generic system. Bob (at Chase) wants to send $100 to Lucy (at Citibank). Citibank and Chase use the same settlement system and have accounts at that system
  - Chase can debit Bob's account $100 (aka, they will owe Bob $100 less)
  - The settlement system debits Chase's settlement system account $100 & credits Citibank's settlement system account $100
  - Citibank credits Lucy's account $100

- The settlement system can be a private company or, in the case of the ultimate settlement systems, the Central Bank of the country

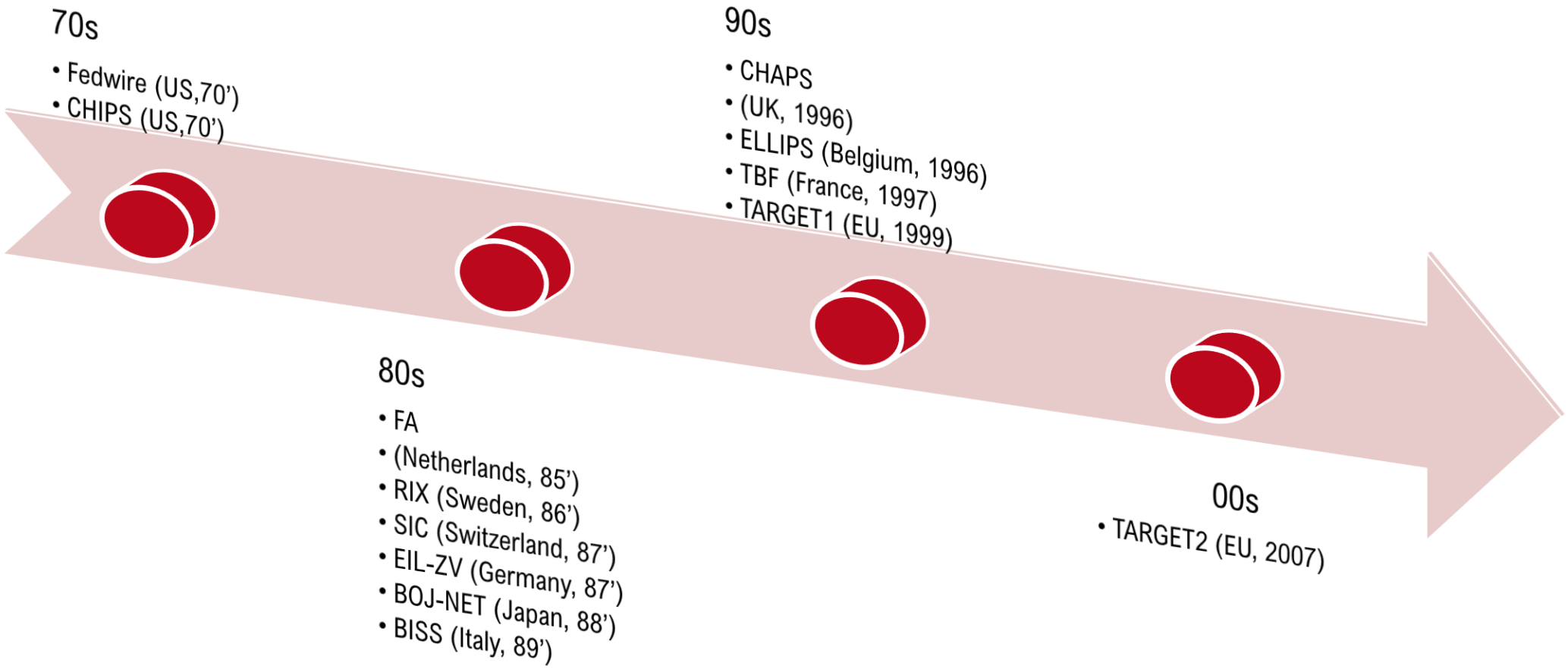
- Settling with Central Bank money has significant advantages to system users:
  - No counterparty / credit risk
  - (Usually) provision of credit/overdraft as needed
  - (Usually) low costs

Three Types of Settlement Systems

Gross Settlement System	Net Settlement System	Hybrid Systems
Each transaction processed as it happens (not bundled or netted or batched with others)	Transactions netted out at specific times each day (usually end of day), so only the 'net' amount is settled	Systems that are effectively near real-time systems but look for opportunities to reduce liquidity needs such as:
Reduces intra-day credit risk	Reduces liquidity needs as only the net amount has to be available from a liquidity perspective	Netting of queued orders Prioritization of orders Delaying orders above certain liquidity limits
Increases liquidity needs (you need to fund each transaction at a time) and, subsequently, cost of liquidity (more reserves or interest charges)	Increases intra-day credit risk	Prioritization of orders Delaying orders above certain liquidity limits

- Most developed economies now have Real-Time Gross Settlement (RTGS) systems backed by their Central Bank.
- (Deferred) Net Settlement (DNS) approaches are more popular for other systems, but have largely migrated to hybrid models

RTGS and their launch dates



Settlement Systems

Current RTGS for US, Eurozone and UK

	United States	Eurozone	UK
Name	FedWire	Target2 (Trans-European Automated Real-time Gross settlement Express Target system)	CHAPS (Clearing House Automated Payment System)
Administered by	Federal Reserve	Eurosystem	Member-owned (under supervision of the Bank of England). 17 direct members which operate as correspondants for the rest
Daily Transactions	680,000	350,000	190,000
Daily Volume	$2.7T	€1.7T	£315B
Settled at	Federal Reserve	National Central Banks	Bank of England

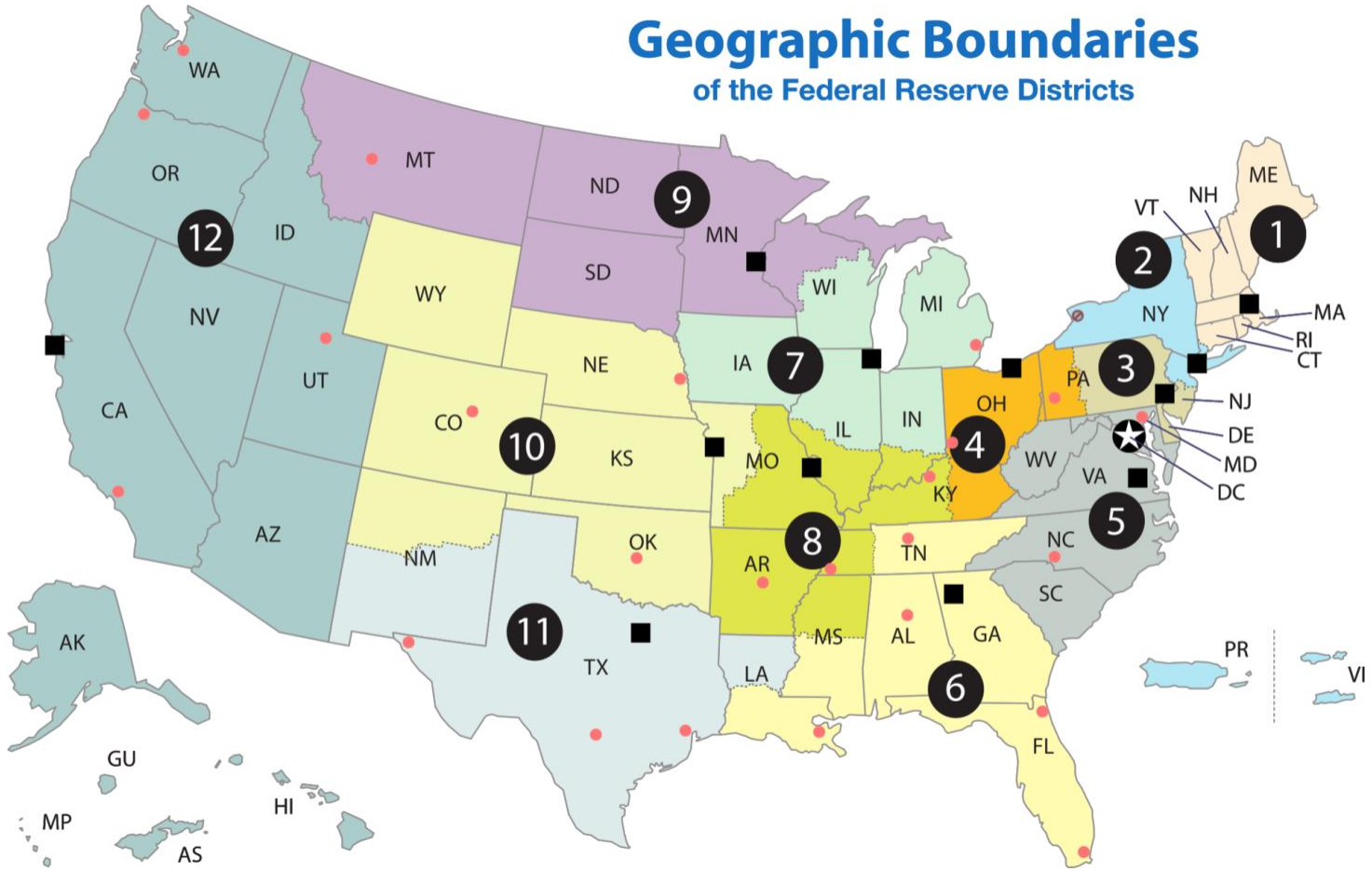
United States RTGS: Fedwire

- Fedwire is the oldest RTGS system and is operated by the Federal Reserve (the Central Bank of the United States)
  - It first began operations in 1918, using Morse code over telegraph lines (!)
  - It become computerized and effectively 'real-time' by the early 1970s, over a decade before countries built their own RTGS
- Fedwire is an extremely broad program and is available to roughly 7,000 depository institutions that have accounts with the 12 regional Federal Reserve Banks.
- The Federal Reserve Banks act as the RTGS ledger by debiting/crediting the individual participants accounts at their respective regional Federal Reserve Banks
- As with all RTGS, the primary uses are: operations relating to the Central Bank, settlement for other payment/settlement/securities systems, high value time-sensitive financial transactions, settlement of real estate transactions

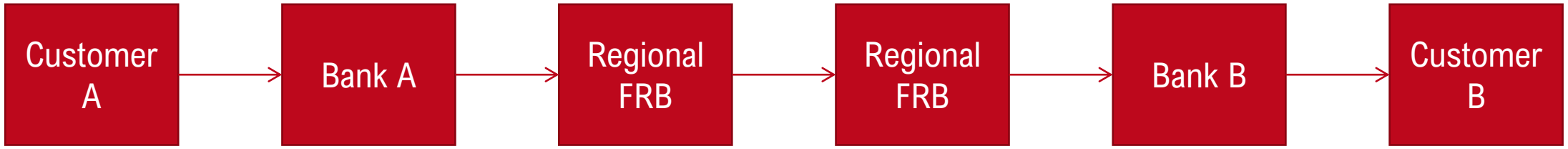
Federal Reserve Banks

The 12 Federal Reserve Banks

- Atlanta
- Boston
- Chicago
- Cleveland
- Dallas
- Kansas City
- Minneapolis
- New York
- Philadelphia
- Richmond
- San Francisco
- St. Louis



FedWire (US): Representative Transactions



Debit
Bank A
Central
Bank
Account

Credit
Bank B
Central
Bank
Account

FedWire (US): Key Policy Issues

- Fedwire is required to charge market rates for its services. Fees can fall as low as $0.03 to $0.82 per transaction.

- Fedwire takes a variety of steps to manage credit risk and liquidity risk
  - The receiving institution faces no credit risk as it receives Central Bank funds with immediate finality
  - The Central Bank faces both credit and liquidity risk to the degree they offer 'daylight' credit (overdraft during the day). This risk is mitigated through by reviewing the bank's reserves, deposits with the Fed and posted collateral

- The Reserve Banks charge interest on their extension of credit that is calculated on a minute-by-minute basis

United Kingdom RTGS: CHAPS

- The Clearing House Automated Payment System (CHAPS) is the RTGS system for the United Kingdom / GBP. It is the equivalent of Fedwire in the United States. Even though it is nominally a private company, it is owned as a cooperative and supervised by the Bank of England.

- As with FedWire, it is primarily used for wholesale transactions between banks, large corporations and the Bank of England, with the main retail use being real estate purchases.

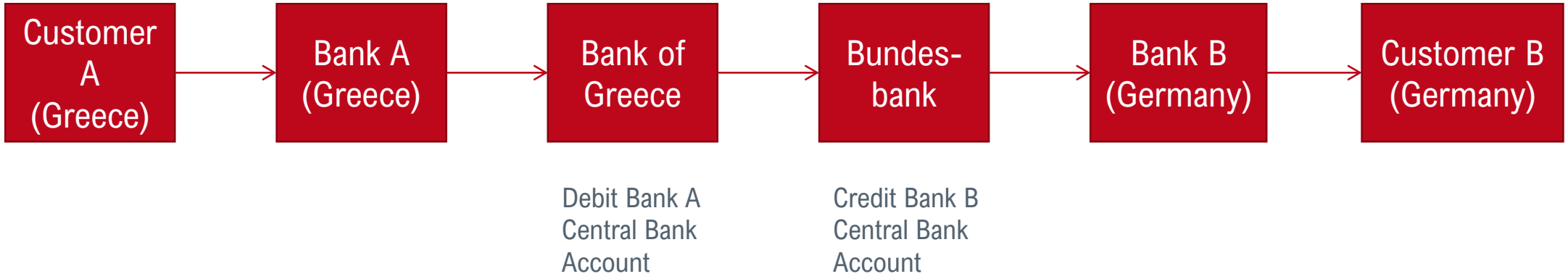
- CHAPS has around 30 direct participants and over 5,000 indirect participants

- CHAPS suffered a very rare breakdown for a RTGS in October 2014, when a system's crash took both the main and backup system offline for several hours . This episode highlighted the systemic nature of RTGS - 140,000 payments were delayed, tying up real estate transactions and financial transactions that were only processed by working additional hours.

Eurozone RTGS: TARGET2

- TARGET2 (Trans European Automated Real-Time Gross settlement Express Transfer) is the RTGS system of the ECB and the Eurosystem. Participation in TARGET2 is mandatory for new member states joining the Eurozone.
- It is the second iteration of an RTGS for the Eurozone, replacing Target1 in 2007. Main changes between Target1 and Target2 were: (a) a centralized technical platform, (b) better liquidity management, (c) support for payments with a debit time indicator (for FX purposes) and (d) support for ancillary settlement systems
- Target2 includes all 19 euro area central banks (including the ECB) plus Bulgaria, Denmark, Lithuania, Poland and Romania.
- Target2 has 999 direct participants, 3,386 indirect participants and 13,313 correspondents (2012). In addition, it settles the cash position of 85 other ancillary settlement systems
- Target2 operates on a single technical platform but it settles in a manner similar to Fedwire where national central banks each hold the accounts for the participants in their country. So, if a company in Greece is sending money to a company in Germany, the Bank of Greece would debit the company's account and the Bundesbank would credit the recipient's account

Target2: Representative Transaction



Target2 operates in a manner similar to the Federal Reserve where accounts are credited and debited at the national level (with national Central Banks) and national Central Banks hold credit/debit balances with each other

While this is unremarkable in the Federal Reserve system, it has raised questions in Target2 about possible credit risk to national central banks in the event of a member state exiting the Euro. More detail on this issue can be found here: http://www.bis.org/publ/work393.pdf

Three Types of Settlement Systems: FedACH

FedACH
ACH stands for Automated Clearing House, payment network run by NACHA (the National Automated Clearing House Association) that is supervised by the Federal Reserve
FedACH is one of two ACH providers that run over NACHA. FedACH processes about 60% of the ACH transactions in the United States (Clearing House ACH / EPN processes the remaining)
ACH is used for high volume, lower value, lower time-criticality transactions such as utility bills, payroll, business to business transfers and so on
It processes about 60M transactions per day (compared to the approximately 680,000 Fedwire transactions) ACH transactions typically
ACH transactions typically settle next day, but can take up to 3 days. On the retail and corporate side, ACH transactions are priced far less expensively than wire transfers

Three Types of Settlement Systems: CHIPS

CHIPS
CHIPS (**C**learing **H**ouse **I**nterbank **P**ayments **S**ystem) is a private clearing house ("The Clearing House") for high value transactions that competes with Fedwire
It is also a customer of Fedwire as it uses Fedwire for Central Bank money settlement of outstanding balances at the end of the day
The Clearing House is owned by its members and has a much smaller set of members than Fedwire (~50 direct participants). Other financial institutions that want to use CHIPS, use one of the 50 members as a correspondent bank

Three Types of Settlement Systems: Clearing House ACH

Clearing House ACH
ClearingHouse ACH (The Electronic Payments Network / EPN) is the private ACH provider in the United States
It is operated by “The Clearing House” (that also operates CHIPS) and processes about 40% of all ACH transactions in the United States
FedACH and EPN collaborate when the originating institution and the receiving institution use different systems. In that case, the Federal Reserve banks settle between FedACH and EPN

Other Major Systems: United Kingdom - BACS

BACS
BACS (Bankers' Automated Clearing Services) is the highest volume settlement system in the United Kingdom
It was founded in 1968 and it historically played a similar role as ACH in that it was used for low-cost payments, recurring payments, standing orders and so on. Standing orders have since moved to the Faster Payments Service
BACS settles on T+2 (the 3rd day -> one day to submit, one day to clear, one day to settle)
There are 24 direct members of BACS. They can support indirect users
BACS is a multilateral net settlement system
In 2018, BACS cleared 17M transactions per day

Other Major Systems: UK – Faster Payments Service

Faster Payments Service
Faster Payments is a more recent settlement system built at the insistence of the UK government to operate more quickly than BACS
FPS operates 24/7 and settles transactions 3 times per day
There are 32 direct participants in Faster Payments
In 2018, FPS cleared on average 7M transactions per day
Both BACS and Faster Payments are now operated by the leading retail payments authority in the UK, called Pay.UK

Other Major Systems: Eurozone - SEPA

SEPA
SEPA (Single Euro Payments Area) is the most important initiative for bank transfers in the Euro area. Through the Payment Services Directives (PSD and PSD2), it is working toward a common market for payments
The goal of SEPA is to standardize national systems and have them adopt a common set of protocols so that it becomes as easy to transfer money across member states as it is to transfer money within member states. Specifically, SEPA guarantees a time to settlement and disallows higher charges for cross-border transfers than for domestic transfers
SEPA includes the 28 EU member states (not just the Euro states), along with Iceland, Liechtenstein, Norway and Switzerland as well as Andorra, Monaco, San Marino and Vatican City
SEPA payments normally take 1 to 2 banking days to complete. SEPA Instant Payments launched in November 2017

Other Major Systems: Eurozone - IMPLICATIONS

IMPLICATIONS
The political rationale for SEPA is to promote the European Union's objective of a common area for capital and reduce the cost and friction of moving capital within the European Union
SEPA is not, itself, a new payment system. It should be thought of more like a series of protocols, directives and deadlines for interoperability and fee pricing
SEPA is effectively fully implemented for debit and credit as of 2017 (100% compliance)
How SEPA was generally implemented in practice is that large 3rd party CSMs (Clearing and Settlement Mechanisms) became compliant with SEPA, bringing their customers (PSPs, payment service providers) into compliance

Continuous Linked Settlement (CLS)

- CLS is a fairly recent development in settlement systems and is a bank specialized in FX settlement. FX (Foreign Exchange) transactions were viewed as a source of system risk because:
  - FX flows are very large (total currency trading can exceed $1.3T / day)
  - FX could not be settled simultaneously by Central Bank backed RTGS so there was credit risk in FX settlement
- CLS was launched in 2002 to reduce this risk via PvP (payment vs payment) settlement, initially with 39 members and 7 currencies, since expanded to 18 currencies
- CLS works as follows:
  - It collects all trades for the day and performs multilateral netting across institutions
  - It holds accounts at each of the RTGS of each currency it supports
  - During a window when all the relevant RTGS are open, it simultaneously nets the member multi-currency accounts at CLS that have been funded via the RTGS systems
  - In other words, it is a net, multi-currency, multilateral settlement system, itself settled to national RTGS
- In July 2019, CLS launched CLSNow which enables banks to exchange currency on an almost real-time basis

SWIFT messaging

- The **S**ociety for **W**orldwide **I**nterbank **F**inancial **T**elecommunication is a member owned cooperative operating with more than 11,000 financial institutions in more than 200 countries
- SWIFT is a perpetual point of confusion for people from outside the industry in that it is NOT a payment or settlement system, it is simply a messaging system that is used by other payment or settlement systems (funds settlement, securities settlement, etc.) to pass along the relevant information as it relates to a transaction
- SWIFT exchanges more than 32M messages per day on average, of which 50% correspond to funds settlement

Source : https://www.swift.com/about-us/swift-fin-traffic-figures#

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5. Settlement in Digital Currencies

Is Bitcoin a RTGS?

Real Time	Bitcoin transactions are verified for validity and propagate through the network's nodes globally in roughly 2 seconds. They are not immediately irreversible however. As they appear in more and more blocks (every ten minutes approximately), they become more irreversible. They are considered 'confirmed' for most high value uses within an hour
Gross	Transactions are not netted with others but they are settled on an individual basis when transacting **within the protocol**. Not only that, but the inputs of a transaction must be the outputs of a previous transaction, meaning that no netting ever takes place, and full clients verify each transaction all the way back to the Genesis block.
Settlement	Settlement on the blockchain is final and increasingly irrevocable the more blocks are added on the blockchain. Funds are immediately available after the transaction is confirmed (in some cases, even before). An exception is newly mined coins which must "mature" for 100 blocks.

Main Source: Kokkola, T. ed., 2010. The payment system: Payments, securities and derivatives, and the role of the Eurosystem. European Central Bank. https://www.ecb.europa.eu/pub/pdf/other/paymentsystem201009en.pdf

Is Bitcoin a RTGS?

	RTGS	Net Settlement Systems	Bitcoin
Type of Settlement	Gross	Net	Gross
Liquidity Management	No	Yes	No
Overdraft Facilities	Usually Yes	Varies	No
Settlement Time	< 5 minutes	1-3x / day	10-60 minutes
Hours of Operation	Business hours +/-	Business Hours / Extended Business Hours	24/7/365
Ledger	Centralized	Centralized	Decentralized/Blockchain
Responsible Organization	Central Bank or Consortium	Central Bank or Consortium	Nobody / (miners?)
Participants	Vetted financial institutions	Vetted financial institutions	Anyone

Bitcoin as a RTGS: Advantages/Disadvantages

- If we assume Bitcoin is an RTGS, what are the major advantages / disadvantages relative to traditional RTGS?
- Advantages:
  - Globally accessible. Any person on the planet without authorization can access this RTGS vs. the vetted financial institutions (usually national) that are allowed to participate in an RTGS. This would seem to eliminate the need for correspondent relationships to access an RTGS
  - Operates on a 24/7/365
  - Programmable for more complex cases than simple settlement
- Disadvantages:
  - Somewhat slower settlement times
  - Native currency unit not in widespread real economy use so far

Bitcoin as a RTGS: What else?

- If we assume Bitcoin is an RTGS, what other parts of a settlement ecosystem would we expect to emerge based on parallels to existing ecosystem?
  - Net Settlement Systems? (for lower time sensitive, lower cost, lower liquidity transactions?)
  - Internal ledger system for large FX institutions?
  - CLS-style systems for FX?
  - Settlement for other ledgers? Trading, assets, etc.

Net Settlement Systems

- Net settlement systems exist in a world of gross settlement systems largely for cost/efficiency savings for lower priority payments:
  - Lower liquidity needs (over the course of a day)
  - Typically a larger number of transactions but of lower value

- It seems conceivable that the same needs would emerge in a Bitcoin-centric economy. E.g. two firms that trade with each other daily may not want to tie up BTC for hour long intervals for each transaction but instead aggregate at the end of the day

- Is there a net settlement system in the Bitcoin ecosystem? If not, what would a future system of this type look like? Is Liquid a net settlement system?

Internal Settlement Systems

- When two customers share the same financial institution, settlements are typically done on an internal basis.
  - E.g. when Bob at Chase transfers money to Sally at Chase
  - Advantages of this model are faster transaction times and no fees
- This seems to have a direct parallel in the large online hosted wallet companies.
  - E.g. When you transfer a Bitcoin balance from one Coinbase account to another, there is no Blockchain transaction occurring, it is only a simultaneous entry on the firm's internal ledger ("off-chain")
- Are there other areas where internal settlement systems will emerge?
- How should we classify 2nd layer networks like the Lightning Network?

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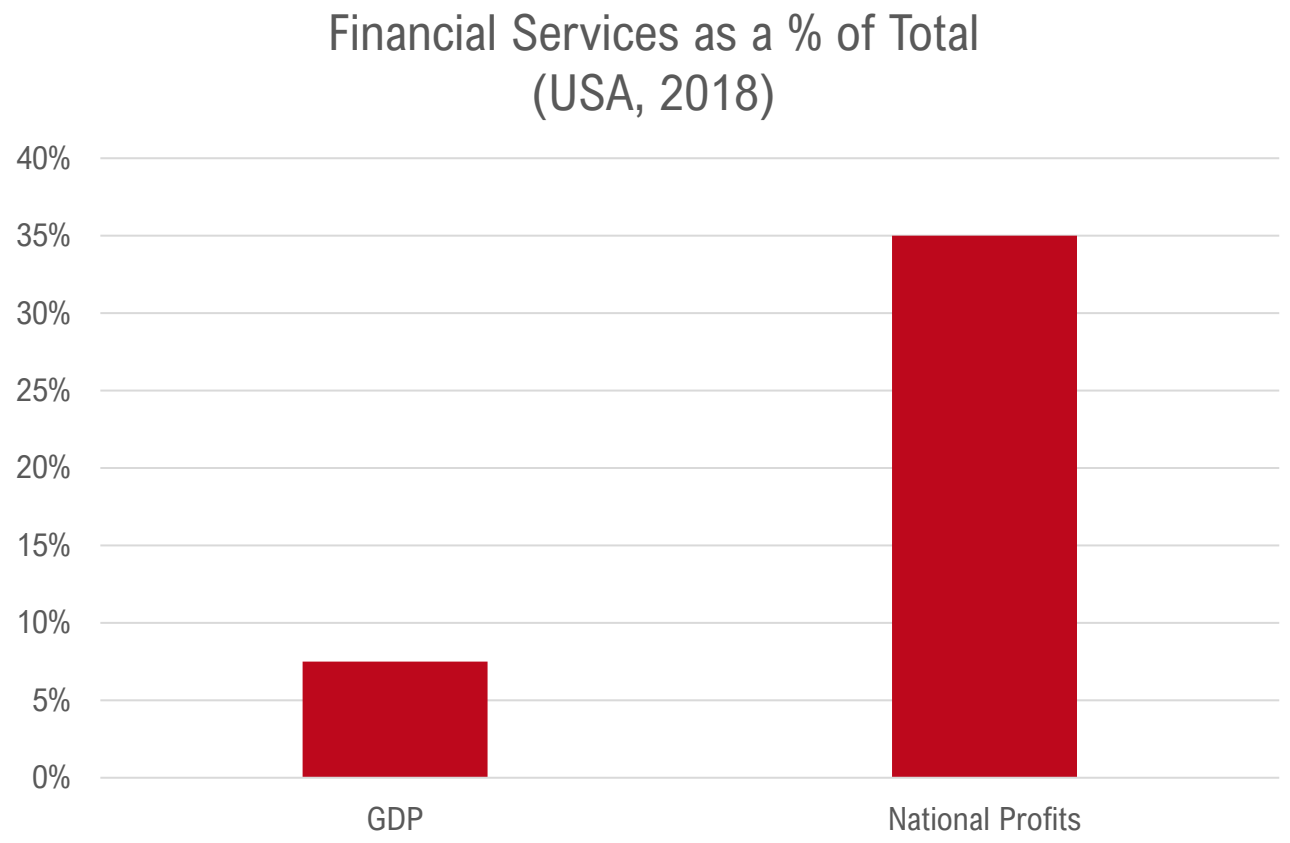
6. Financial Services

Each sub-category of financial services below is a multi-hundred-billion or multi-trillion industry.

Retail /Commercial Banking	Investment Banking	Markets Infrastructure	Asset Management	Insurance
Depository	Corporate Finance/ M&A	Exchanges	Mutual Funds	Life
Lending	Sales & Trading	Custody/Clearing	Mandates	Property & Casualty
Non-Depository Credit Institutions	Underwriting	Stocks	Alternatives	Accident & Health
Payments	Structured Finance	Commodities	Wealth Management	Specialty
Merchant Processing	Prime Brokerage	Foreign Exchange		Reinsurance
Remittances		Futures & Options		Brokerage

Financial services is the most profitable industry in the United States



Financial services is a very developed industry with significant barriers to entry

- Hundreds of years of financial systems development has led to a very developed and sophisticated field, serving many different needs
- Most consumers in developed countries have a friendly consumer environment:
  - Generally, taxpayer protection for deposits <$100K
  - Generally, consumer protection for misuse or fraudulent use of payment systems
  - Makes use of financial system low-risk for an individual user
- Regulation and taxation is quite clear
- Significant trust in financial institutions
- Costs well hidden from consumer and mutualized. Fraud detection and customer reward costs (aka airline points) are embedded in merchant processing fees and not directly seen by consumer (instead they enter the cost of products)

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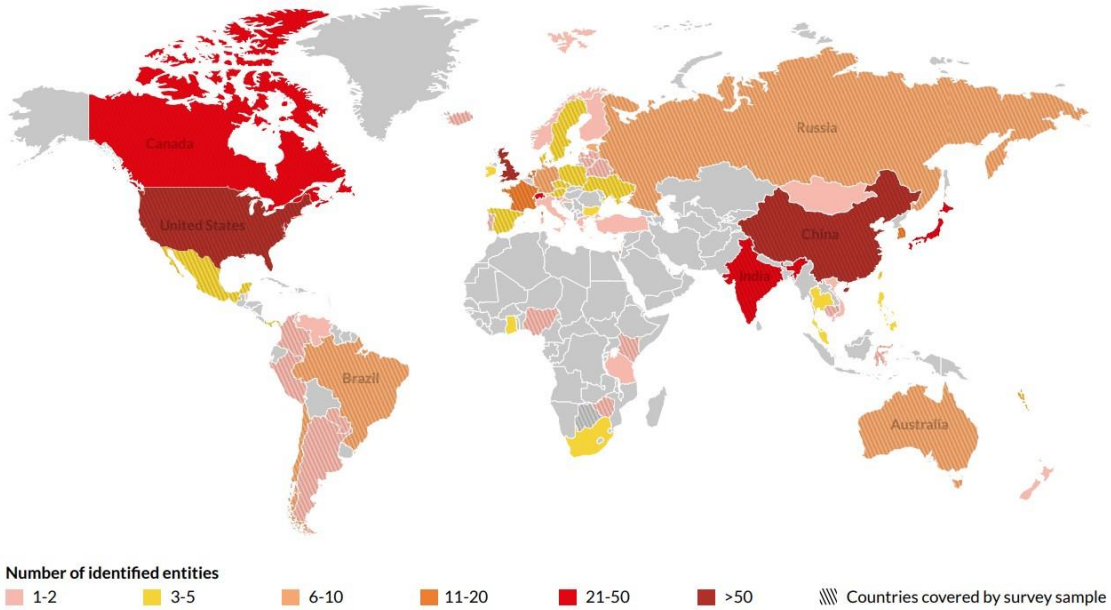
7. Cryptocurrency Financial Services

The cryptocurrency industry is centered in the US and China

Figure 10: While global in nature, the cryptoasset industry is primarily driven by companies based in North America, China, India, and Western Europe



Note: *this map is based on operational HQ data from 561 companies active in at least one of the four major cryptoasset industry segments. Colours represent the total number of identified entities from each country; stripes indicate when a country is also covered by our study sample.*

Source: 2nd Global CryptoAsset Benchmarking Study, December 2018, Cambridge Centre for Alternative Finance

The industry is still a very niche field by financial services standards

Daily Trading (FX) Volume	
USD:	$5,824,036,000,000[1]
BTC:	$59,550,000,000[2]
Ratio:	1%

Total Capitalization	
Total financial assets:	$297T[3]
Cryptoassets:	$1.8T[2]
Ratio:	0.06%

Source: 1 - BIS Triennial Central Bank Survey 2019; 2 – CoinmarketCap (March 18, 2021); 3- Deutsche Bank 2015

Key Question: Where is the function and value located?

In The Blockchain / Token  **In A Firm Providing Services?**

Decentralized (Possibly)  **Centralized**

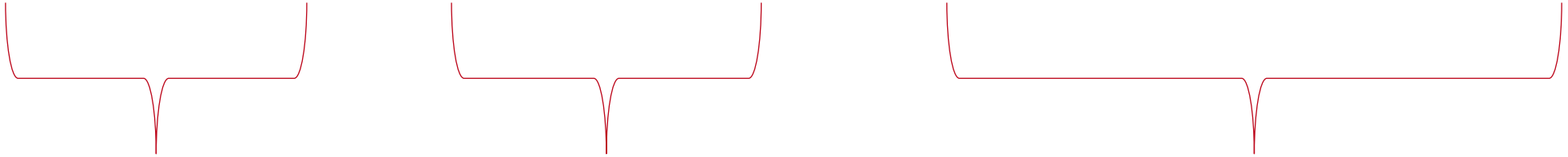
What ‘traditional’ financial services does Bitcoin theoretically provide ‘directly’?

Settlement

Payments

Depository

Remittances



Provided By Central Banks
(Fedwire, TARGET2, etc.)

Provided By Central Banks (Cash) and Banks/Payment Networks (Digital)

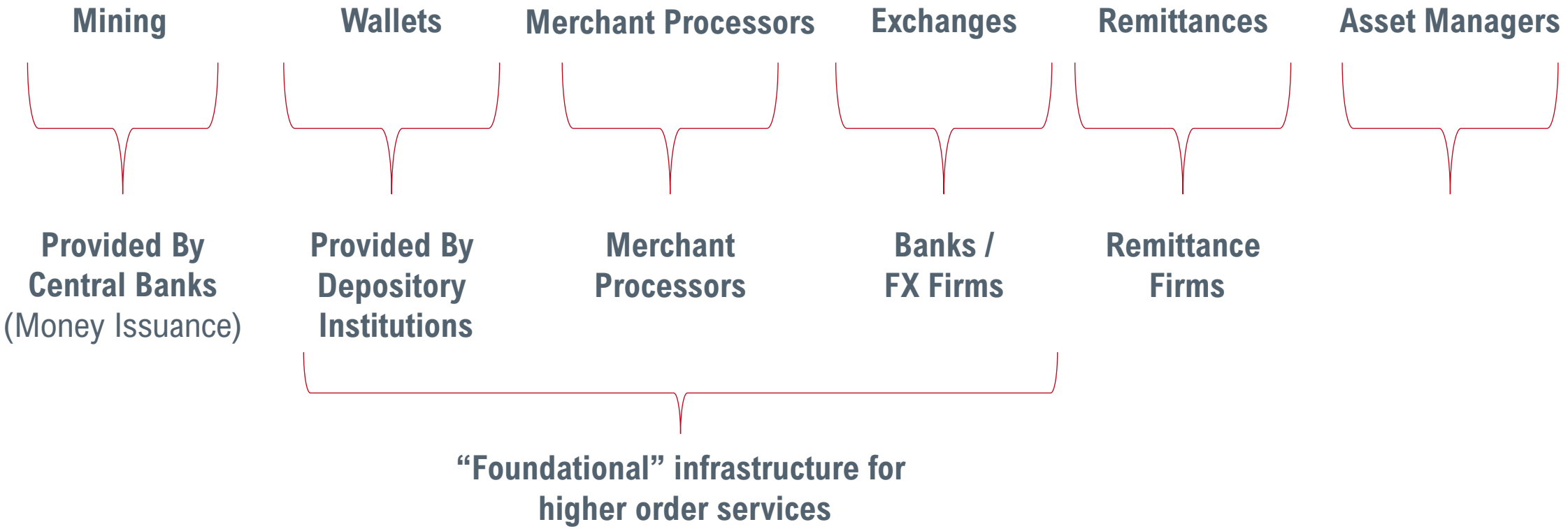
Provided By Banks and Remittance Firms

Intermediaries always emerge in financial services

Why did the prior page say “theoretically?”

Because most consumers/merchants don’t want to interact directly with the protocol, but instead through an intermediary.
The same model is developing in cryptocurrency.

What are the main components of the cryptocurrency financial services industry and where do they map to financial services segments?



The initial (small) footprint of crypto-financial services is in the areas in red.

Retail /Commercial Banking	Investment Banking	Markets Infrastructure	Asset Management	Insurance
Depository	Corporate Finance/ M&A	Exchanges	Mutual Funds	Life
Lending	Sales & Trading	Custody/Clearing	Mandates	Property & Casualty
Non-Depository Credit Institutions	Underwriting	Stocks	**Alternatives**	Accident & Health
Payments	Structured Finance	Commodities	Wealth Management	Specialty
Merchant Processing	Prime Brokerage	**Foreign Exchange**		Reinsurance
Remittances		Futures & Options		Brokerage

All other areas are still unproven and experimental.

- ICOs (Initial Coin Offerings) / STOs (Securities Token Offerings) / IEOs (Initial Exchange Offering):
  - ICOs “work” from a technical perspective, but they did not “work” in practice from an investor protection perspective
  - After the ICO boom of 2017-2018, it appears that the large majority of offerings of this type will not be considered legal in most jurisdictions today
  - The regulatory issues must be sorted out for this area to be revitalized
- Decentralized Finance (DeFi):
  - Became really popular after the summer of 2020, with liquidity and volumes exploding
  - Lending and structured products built with or above decentralized protocols
- Insurance and Prediction Markets:
  - These are hugely interesting experiments, but with tiny volumes and unproven execution

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8. Conclusions

Central Banks

- Central banks play a wide variety of roles in a modern economy, including monetary stability, financial stability / regulatory, policy operations, and financial infrastructure and provisioning.

- Some public cryptocurrencies provide a subset of the monetary policy and financial infrastructure functions of a modern central bank but are overall a much more laissez-faire political philosophy.

- There has been significant progress in CBDCs in the last two years and we should expect CBDCs to start developing in the near future.

  Depending on the approach of CBDCs (direct, indirect or hybrid), CBDCs might challenge the architecture / relationship of central and commercial banking.

Settlement Systems

- All major currency zones have a Central Bank backed RTGS. This serves as the backbone of the payment system, both directly and indirectly:
  - Directly: For high value, time-critical transactions
  - Indirectly: As an ultimate settling system for other payment systems
  - In all cases with no counterparty risk for the users of the system

- Despite the existence of RTGS, there are a variety of (a) economic, (b) liquidity, (c) historical or (d) specialization reasons that other net settlement payment systems exist, creating a heterogeneous payments and settlement environment
- Some of the main issues with settlement in existing payment systems are related to the speed, cost, risk and transparency in transactions

Settlement Systems

- Bitcoin mostly resembles a RTGS system!
- As adoption increases, additional solutions would need to be provided to handle larger volumes of transactions. Layer 2 solutions and increasing block size are two potential competing solutions
- In the cross-border payment environment, it would be interesting to watch how the SWIFT and Ripple solutions evolve

Financial Services – Market Opportunity Related

- Financial services is an extremely complex, extremely large and extremely profitable industry, protected by significant barriers to entry.
- It is one of the largest and, in some countries, the most profitable industry in the world
- The size of the financial services industry drives a large part of the investment energy in cryptocurrency and supporting firms.
- The simplified theory is that that any cryptocurrency or related firm that could capture even a small part of one sub-set of the financial services industry would be extremely valuable in its own right and a potentially very interesting acquisition candidate for incumbent financial services firms
- By this metric, the crypto-industry has been both very successful and very unsuccessful
- The industry has generated in the range of low hundreds of billions in value (in cryptocurrencies and supporting ecosystem) which is exceptional for a start-up technology.
- On the other hand, it still represents only around 0.06% of the financial services industry by any metric and has only effectively addressed a small subset of financial services industry segments

Financial Services – Structure Related

- The base protocol and particularly Bitcoin map well to certain parts of the settlement and payments infrastructure of the financial services industry, including activities handled by Central Banks and parts handled by retail banks and payment networks
- Conversely, core cryptocurrency companies overlap with services provided by Central Banks and services provided primarily by retail/commercial banks
- Cryptocurrency financial services are still at the foundational, building block stages but each of mining, exchanges, asset management and, possibly, remittances and merchant processing has reached viability as business models
- Lending, investment banking, most asset management and insurance still do not have viable cryptocurrency analogues, though there are interesting experiments growing rapidly across dozens of teams globally

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10. Further Reading

Further Reading

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- Key Aspects around Central Bank Digital Currencies - Policy report by Central Bank Digital Currencies Working Group: https://www.cemla.org/fintech/docs/2019-06-KeyAspectsAroundBankDigitalCurrencies.pdf
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Tip: Clicking while pressing Cltl key opens a new tab in Chrome browser on non-Apple devices

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- Simple Overview of How Money Moves Around Banking System (Richard Gendal, IBM, 2014) http://gendal.me/2013/11/24/a-simple-explanation-of-how-money-moves-around-the-banking-system
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- Fed Now announcement https://www.federalreserve.gov/newsevents/pressreleases/other20190805a.htm

General RTGS

- Real time Gross Settlement Systems, (Bank of International Settlements, 1997): http://www.bis.org/cpmi/publ/d22.pdf. Ignore the details about national systems in Europe as they are outdated but review for the general concepts
- Historical and future trends in payment systems, (New York Fed, 2008) http://www.newyorkfed.org/research/epr/08v14n2/0809prei.pdf

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Optional Readings

United Kingdom

- Overview of payment system settlement: https://www.bankofengland.co.uk/payment-and-settlement
- Annual Summary of Payment Clearing Systems for the UK in 2018 (Bank of England, 2019): https://www.bankofengland.co.uk/-/media/boe/files/payments/chaps/annual-summary-of-payment-statistics-2018
- Timing and Funding of CHAPS Sterling Payments (New York Fed, 2008): http://www.newyorkfed.org/research/epr/08v14n2/0809becher.pdf
- CHAPS crash (The Guardian, 2014): http://www.theguardian.com/business/2014/oct/20/bank-of-england-payment-system-crashes

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Optional Readings

Eurozone

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  https://www.ecb.europa.eu/pub/pdf/targetar/ecb.targetar2018.en.pdf?aa2d0e202f47597369f834184ccfda62
- SEPA for Billers (European Payments Council, 2012)
  https://www.youtube.com/watch?v=dDD9gF7HINI

United States

- CHIPS, (New York Fed, 2002)
  http://www.newyorkfed.org/aboutthefed/fedpoint/fed36.htm
- Turnover in Fedwire Funds Has Dropped (New York Fed, 2014)
  http://libertystreeteconomics.newyorkfed.org/2014/08/turnover-in-fedwire-funds-has-dropped-considerably-since-the-crisis-but-its-okay.html#.VL9E90fF8t0

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Optional Readings

Other systems

- SWIFT in figures (SWIFT) https://www.swift.com/about-us/swift-fin-traffic-figures

Recent research on settlement systems

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Optional Readings – Videos (cont.)

- mooncryption. 2018. Hoping for a Lightning Strike — Bitcoin Scaling Debate Explained. [ONLINE] Available at: https://steemkr.com/bitcoin/@mooncryption/hoping-for-a-lightning-strike-bitcoin-scaling-debate-explained
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- Andreas Antonopoulos, 2018. “Bitcoin Q&A: Lightning's security model” https://www.youtube.com/watch?v=_GNsT_ufkec

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Optional Readings – Videos (cont.)

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- Bronson Tang. 2018. Why Atomic Swaps Are Important. Available at: http://www.mangoresearch.co/why-atomic-swaps-are-important/
- Andreas Antonopoulos, 2018. "Bitcoin Q&A: Atomic swaps" Available at: https://www.youtube.com/watch?v=fNFBA2UmUmg&t=115s
- Matthew Hrones, 2017. "Atomic Swaps: What They Are, How They Work, And What They Mean For Digital Currencies". Available at: http://bitcoinist.com/atomic-swaps-what-they-are-how-they-work-and-what-they-mean-for-digital-currencies/
- John Westbrook. 2018. "Atomic Swaps & Etomic Swaps, Explained in Plain English". Available at: https://medium.com/@EthAdvisor/atomic-swaps-etomic-swaps-explained-in-plain-english-4c3936c7adb8 .

Tip: Clicking while pressing CItl key opens a new tab in Chrome browser on non-Apple devices

Optional Readings – Videos (cont.)

- Euroclear Announces New Blockchain-Based Gold Settlement https://news.bitcoin.com/euroclear-blockchain-gold-settlement/
- Euronext: 7 Major Financial Institutions Join Forces to Develop Blockchain Infrastructure for SME Post-Trade http://www.businesswire.com/news/home/20160621006306/en/Euronext%C2%A07-Major-Financial-Institutions-Join-Forces-Develop
- Blockchain Updates On-Chain Settlement for Thunder Network : https://www.cryptocoinsnews.com/blockchain-updates-chain-settlement-thunder-network
- Bitcoin is Being Hot-Wired for Settlement https://medium.com/@jgarzik/bitcoin-is-being-hot-wired-for-settlement-a5beb1df223a#.b6mm05slt

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Optional Readings

Ripple and Swift

- Global Trade Review: Ripple - "We are not replacing Swift"

https://www.gtreview.com/news/fintech/ripple-we-are-not-replacing-swift/

- SWIFT sees success with global instant cross-border payments with Singapore's FAST

https://www.swift.com/news-events/press-releases/swift-sees-success-with-global-instant-cross-border-payments-with-singapore_s-fast

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Further Reading

2nd Global Cryptoasset Benchmarking Survey, Cambridge Centre of Alternative Finance

https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-global-cryptoasset-benchmark-study/#.XnLSOYgzbOg

This report is the most systematic look at the cryptocurrency / cryptoasset financial services field. It is very slightly dated now but still is the best quantitative view of the field at a 'survey' level.

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Questions?

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