Everything you always wanted to know about CBDCs (but were afraid to ask)

Central Bank Digital Currencies are creating a new architecture for money

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Central bank digital currencies (CBDCs) are a hot topic among financial institutions, policymakers, regulators, cryptocurrency enthusiasts, and entrepreneurs around the world. But what are they, and why are they considered so important?

What are Central Bank Digital Currencies?

The general public (individuals & businesses) can hold money in two basic forms today:

- In *physical form*, i.e., coins & banknotes. These are issued by central banks and are, in fact, the *only* form of central bank money that the public is allowed to hold today.
- In *electronic form*, for example, in accounts held with commercial banks and other regulated financial institutions. These institutions, in turn, can hold some of *their* money (called *reserves*) in central bank accounts.

In other words, the public cannot open accounts directly with the central bank today or hold any form of central-bank-issued eMoney. A **Central Bank Digital Currency (CBDC)** would change that. It would be an electronic form of money, issued by a central bank, which households and businesses could use to store value and make payments. CBDC would be denominated in national currency, just like physical money, so 50 *e-euros* of a hypothetical ECB-issued CBDC would always be worth the same as a 50€ note. As such, CBDCs would be **a new form of digital legal tender**, performing all the essential functions of money (being a means of exchange, a unit of account and a store of value), just like physical cash.

Note: sometimes, a distinction is made between `wholesale` CBDCs (those used to settle transactions between financial institutions) and retail CBDCs (those used by everyone). This article is about retail CBDCs only.

Why the buzz?

While CBDCs may be initially viewed as just digital versions of physical cash, in practice their implications would be truly disruptive. CBDC innovation comes in two flavours:

- CBDCs are **a new *form* of money**. Not only are they stable in value and legal tender by definition (unlike cryptocurrencies or other forms of private money), but they can incorporate many additional features that do not exist in today's money. These features include **programmability** (the ability to write computer code, which is embedded on the monetary network or the money itself, rendering these the first form of **active money** in history), **smart contracts** (the ability to embed self-executable and self-enforceable code, which may acquire legal status, enforcing the execution of contractual obligations directly at the monetary/payment level) and **nano-payments** (the ability to split the currency into arbitrarily small units, which could be exchanged between humans and machines in a future **machine economy**). These innovations are big enough to deserve a separate article for each of them — suffice to say here that CBDCs promises to be a new form of cash designed for the digital age.

- CBDCs are also **a new *infrastructure* on which digital payments take place**. We live in a digital world, but our monetary system architecture is still very archaic compared to developments in other parts of our lives. **The digital era needs a new architecture for digital money** and CBDCs promise to deliver that. Most large-value interbank fund transfers today go through so-called *real-time gross*

settlement systems (RTGSs), which are limited to financial institutions and hence slow to innovate. In the digital age, we need an open, neutral payment architecture, which will enable fast innovation and competition. Finally, CBDCs can also speed up the **tokenisation of financial assets**, enabling all sorts of assets (from art and real-estate to people's future incomes) to be tokenised, thus changing forever the way we invest.

Why now?

All the usual disruptive innovation driving forces have combined to trigger the sudden spike in interest in the topic:

- **Demand pull**: Digital payments have become ubiquitous. Banks and fintechs serve the account-based portion of this market, but there's no reason not to have some of the digital payments be cash-settled, too. This is the prerogative of central banks and they will not want to leave this demand unserved.
- **Technology push:** The rise of **stablecoins** (decentralised digital currencies that aim at maintaining a steady exchange rate against some reference currency or commodity) and private sector initiatives (most notably Facebook's **Libra**) have shown that the technology to support the implementation of CBDCs is mature enough and is working in practice.
- **Competition with the private sector**: Privately-issued money used in digital payments are forcing central banks to consider CBDCs. Governments and central banks worldwide would obviously prefer a digital currency issued *by them* to play this role. For the larger of them (especially the USA and China), the potential to establish the global reserve currency for the digital age is also a strong motive.

- **Competition between central banks**: The recent announcement by the People's Bank of China regarding the so-called digital yuan (see later in this article) has triggered an arms race between central banks to become the first to issue CBDCs. There are huge first-mover advantages here: the first successfully launched major CBDC will probably see significant international demand (not to mention the overall efficiency and power/branding projection benefits). On the contrary, should a country forgo the issue of CBDC, while others do so, it will risk a weakened international trade position for its businesses and jeopardise the international power of their currency.

Are CBDCs Cryptocurrencies?

No, they are not (at least not necessarily).

In fact, this is one of the most common misconceptions about CBDCs. Because the discussion about them coincides (and is largely fuelled by) innovations behind decentralised digital currencies, like bitcoin, or other blockchain-based cryptocurrencies and digital assets, people tend to think that CBDCs are something like central-bank-issued bitcoins.

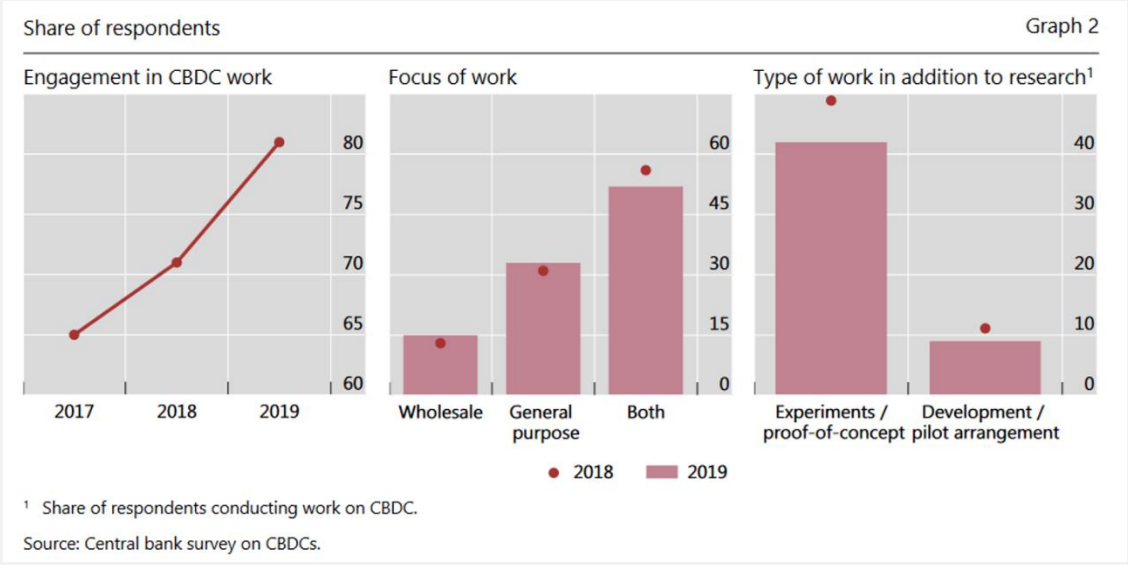
In fact, there's no necessary connection between a CBDC and the underlying technology of its implementation. Since most designs will centre around their issuer (the central bank), there are actually many advantages to **centralised CBDCs**, which are not blockchain-based.

Having said that, there's also nothing to prevent a central bank from adopting a more distributed design approach and developing **decentralised CBDCs** that would share some design principles with cryptocurrencies.

Do CBDCs exist yet?

No, they don't — at least, not in full deployment/use.

Having said that, it's worth noting that almost *every* major central bank in the world is exploring CBDCs, while many have already embarked on pilots implementing them. According to the Bank of International Settlements (BIS), also known as *the central bank of central banks*, 80% of central banks worldwide are exploring CBDCs in one way or another, while 10% have started pilot projects and are considered close to launch.



Central Banks conducting work on CBDC (Source: BIS; full report here)

Here's a quick summary of the most important developments to date:

- **People's Bank of China**: China is, publicly at least, the most developed jurisdiction piloting the introduction of CBDC. The PBoC has confirmed that it is testing a new digital currency (called *DC/EP — digital currency electronic payment*), while the city of Suzhou is planning to give some DC/EP to government employees in June 2020 to pilot their use in paying for local transportation costs. The project is at such advanced stage that even screenshots of a mobile CBDC wallet application have circulated in Chinese social media.

- **Sveriges Riksbank**: The central bank of Sweden is, alongside China, leading the CBDC race. As early as the spring of 2017, it has announced a pilot for the *e-krona*, which will be a digital version of its currency for retail use. According to the bank, "*e-krona can be described as Swedish krona that can either be held in an account at the Riksbank (account-based) or be stored locally, for example on a card or in a mobile phone app (value-based).*"

- **European Central Bank**: The ECB has published a number of working papers and reports on the concept of a European CBDC. In the latest (December 2019), the bank explores the issue of anonymity, concluding that it is possible to design a digital euro in which low-value transactions can be conducted anonymously, while higher-value ones are subject to appropriate KYC/AML checks. Regardless of the specifics of its final design, a digital euro would be a very challenging project, since the currency is legal tender in 19 different countries, with fragmented national payment systems and not always harmonised regulatory frameworks.

- **Bank of England**: The BoE has opted for a **hybrid CBDC** architecture, where the central bank is the only party able to issue (and destroy) CBDC tokens, while the private sector is assigned the responsibility of KYC checks and the ability to provide additional CBDC-related services to households and businesses. This approach is

also known as the *platform model* (since the central bank functions as the core platform and collaborates with so-called *Payment Interface Providers or PIPs*) and seems to be the currently preferable approach to CBDC implementation also in Australia and Canada.

- **Federal Reserve Bank**: Studies on the potential impact of CBDCs have started very early in the US. In a paper from 2018, the Federal Reserve Bank of St. Louis has found that "*the introduction of interest-bearing CBDC increases financial inclusion [and …] it need not disintermediate banks in any way. CBDC may, in fact, lead to an expansion of bank deposits if CBDC competition compels banks to raise their deposit rates.*" Jerome Powell, Chair of the US Federal Reserve System, has confirmed, in a four-page letter to the Congress, on 19 November 2019, that the FED has "*assessed and [continues] to carefully analyse the costs and benefits of pursuing such an initiative in the US.*" To date, however, there has been no public confirmation of the actual implementation of a digital dollar.

- **Bank of International Settlements**: The Switzerland-based BIS has issued one of the most influential papers on the technology considerations surrounding the design of a CBDC. According to the bank, a successful CBDC should be "*secure and accessible, offer cash-like convenience and safeguard privacy.*" The bank does not take a stance regarding the appropriate implementation model, noting that "t*he design of a retail CBDC needs to balance the credibility of direct claims on the central bank with the benefits of using payment intermediaries.*"

It is also telling that it is not only central banks that are active in this space. Commercial banks and the private sector are very keen on developing CBDC-like money. While it may initially sound like an oxymoron that anyone but a central bank would be able to issue a

CBDC, in practice the private sector has been quicker in introducing digital money and payment instruments. Initiatives like Alipay, WeChat Pay, M-Pesa, USDT, JPM Coin and Libra, although different to each other, share a common theme: they aim to issue means of payment and/or stores of value, backed by fiat currency. As such, they can, as the IMF has argued, be considered a form of *synthetic CBDCs*:

if eMoney providers can keep client funds as central bank reserves, and if these are protected from other creditors, then, by proxy, eMoney users can hold, and transact in, a central bank liability. Isn't that the very definition of CBDC?

What's stopping a CBDC from launching now?

There are a number of technological, financial, regulatory and societal challenges that must be overcome before we see a full deployment of a central-bank-issued digital currency. And quite rightly so: changing the global monetary architecture is not a decision to be taken lightly!

Some of the questions that must be answered are:

- **Should the CBDC be token-based or account-based?** The former would create a cash-like instrument in which tokens are not linked to the identity of their holders (thereby respecting user privacy and anonymity), while the latter would create a bank-account-like instrument, where holders of the CBDC would be eponymous (thus making it easier to perform KYC/AML/CTF checks and implement monetary policy actions). Balancing between the two extremes is probably preferable, but also easier said than done.

- **Should it be blockchain-based?** While the nature of CBDCs may favour more centralised designs, it is also important to consider the benefits afforded by decentralised-ledger-based architectures, such as censorship resistance, resilience (no single point of failure), redundancy, etc. Of course, if a blockchain-based architecture is preferred, a myriad more questions should be answered: will the underlying blockchain infrastructure be *permissioned*, *permissionless* or *hybrid*? will the digital currency wallets where CBDCs are stored have to be approved by (and perhaps controlled) by the central bank and/or other custodians? will monetary policy be hardwired on the protocol? who will be responsible for policy decisions and general governance?

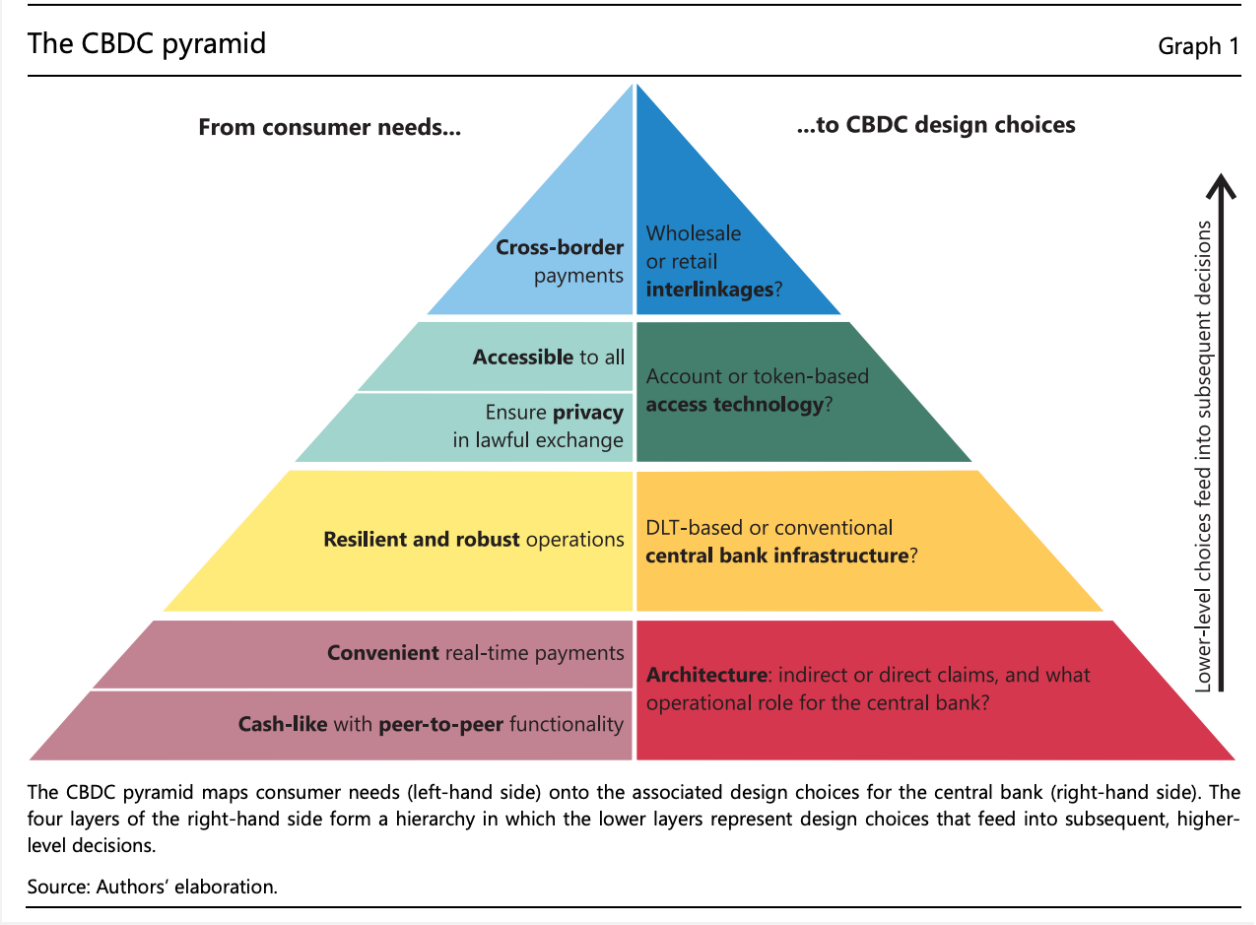
- **What about social inclusiveness?** Needless to say, a national currency should be equally accessible to and usable by all citizens. How can we ensure that no-one is blocked from using CBDCs because of their age, computer literacy level, internet access, socio-economic status, or disability?

- **What about distribution?** One major challenge is how to actually introduce the new currency to the economy. Given its legal tender status, a CBDC will need to be a legally acceptable form of payment to anyone within the CBDC jurisdiction (for example, a merchant will not be able to refuse being paid in CBDC, no more than they would be able to refuse being paid in cash today). However, it is only natural to expect that many people and businesses might be reluctant or unable to transact in CBDC at first.

- **Will it be remunerated?** Remuneration in this context refers to whether the CBDC will carry interest or not. This goes back to the first question about the CBDC architecture as cash-like (hence, no interest for holders) or account-like (hence, theoretically interest-bearing). Incentivising users through some form of interest or

other remuneration for holders would encourage transition to the CBDC, but needs to be carefully managed so as not to lead to a rushed replacement of physical cash, incentives to hoard (rather than use) the new currency or even a systemic run from other types of interest-bearing deposits.

The BIS has published a report mapping consumer needs to CBDC design choices, summarised in the 'CBDC pyramid'.



The CBDC Pyramid (Source: BIS; full report here)

What's in it for central banks?

There are numerous motivations for a central bank to introduce a CBDC: further to generally modernising/digitising payments, **CBDCs can be instrumental in allowing central banks to fulfil their mission** (i.e. to foster financial and monetary stability) by facilitating monetary policy, promoting financial inclusion, linking payments to identity and so on.

A truly digital retail form of risk-free money will significantly expand the arsenal of central banks. For example, a CBDC would allow its issuer to **manage interest rates** (even negative ones) more efficiently, to **adopt *helicopter money* policies** (in which new money is issued and directly distributed to the public — a practice known as *airdrops* in cryptocurrency jargon), to **inflate or decrease the money supply**, and so on. Moreover, officials will be able to track all digital cash in circulation, making it much harder to launder money or evade taxes.

The central bank could also use **programmability** (see above) to control how the money is used. For example, it would dictate that newly minted money will become usable only after reaching their intended recipient or in a pre-specified amount of time (which can also be dependent on conditions, e.g. the level of inflation).

CBDCs will also provide a more secure and resilient technological infrastructure on which central banks can pursue their objectives. Central banks will be able to managing monetary supply without relying on commercial banks as intermediaries.
This **disintermediation of the monetary value chain** is a fundamental shift away from today's monetary architecture, with far-reaching consequences on how future economies are structured and operate.

What's in it for everybody else?

Benefits from CBDCs will not come automatically to everyone. However, in the long run, we all stand to win from modernising the monetary architecture and removing unnecessary costs and delays from digital payments.

Impact on citizens: CBDCs will allow households and businesses to hold money directly with the central bank. Central banks can thus become a lender of last resort to the whole economic system (not only to commercial banks, as they are today). Within a national economy, this will allow the public to tap into a secure/safe source of money and receive immediate direct liquidity when needed.

Impact on businesses: Businesses will see significant benefits. For example, CBDC will have no credit risk, so it will be preferable for companies to hold some of their liquidity with central banks, rather than (mostly un-guaranteed) bank deposits.

Opportunities will also be created for the technology industry, which will see demand for new apps and services, thus allowing newcomers and start-ups to disrupt competition, gain market share and potentially displace incumbents.

Impact on banks: As noted earlier, a CBDC would allow a central bank to establish a direct banking relationship with the public, thus bypassing (*dis-intermediating*) other FIs. On the one hand, this will have an adverse effect on commercial banks, which may see existing deposits move to CBDCs. Depending on the scale of this transition, this may pose significant risks for economic stability: for example, in the event (or even expectation) of an economic downturn, panicked depositors may move their money to CBDCs *en masse* (a central bank cannot go bankrupt since it can always print new

money, so CBDCs are risk-free, contrary to bank deposits), thereby exacerbating economic problems and putting commercial banks at risk of collapse. On the other hand, new applications and services will be needed in the CBDC era, including custodial and money management services for the public and/or transaction validator services for a decentralised CBDC network, which commercial banks and FIs will obviously rush to provide.

What are the top-five readings to find out more?

#5

Bank of England, *Central Bank Digital Currency: Opportunities, challenges and design* (March 2020). BoE introduces the logic behind the platform model of implementing CBDCs.

#4

R3, *Central Bank Digital Currency: An Innovation in Payments* (April 2020). The makers of the Corda distributed ledger discuss both wholesale and retail CBDCs.

#3

Sveriges Riksbank, *The Riksbank's e-krona project Report 2* (October 2018). The central bank of Sweden makes a compelling case for the design and benefits of e-krona in a society moving fast to cashless.

#2

European Central Bank, *Exploring Anonymity in Central Bank Digital Currencies* (December 2019). ECB focuses on a design that would combine anonymous

cash transactions for small payments with KYC-enabled large-value transfers, through the use of *anonymity vouchers*.

#1

Bank of International Settlements, *The Technology of Retail Central Bank Digital Currency* (March 2020). BIS discusses the design, architectural and technological options behind the design of a national CBDC.