



Why are Central Banks Interested in Digital Currency?

May 2020

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Executive Summary

A retail Central Bank Digital Currency (CBDC) would be an electronic and universally accessible form of money issued by the central bank. With a decrease in the use of cash, the objectives pursued by the Central Banks with CBDCs are to anticipate the disappearance of cash, create an efficient and cheap means of payment, and strengthen regulatory controls.

When designing a CBDC, there are natural design choices such as cash-like peer-to-peer functionalities; convenience and speed; and resilience and security. There are also more complex design trade-offs such as volume & speed versus finality; simplicity versus functionality; transaction monitoring versus privacy; and remuneration versus non-remuneration. The challenge for Central Banks is to optimize these design features to achieve their objectives.

There are two main architectures for a CBDC: indirect and direct. The indirect CBDC two-tier model is an extension of the current reserves/bank deposit model, with the exception that new players such as Payment Service Providers and Electronic Money Issuers may have access to the CB. In this model, individuals and corporates will not have an account directly with the CB but with intermediaries. In the direct CBDC one-tier model, Central Banks handle all the activities of the CBDC value chain, positioning the itself in direct competition against commercial banks, and potentially risking financial instability.

In terms of technology, some central banks are testing blockchain/DLT frameworks while others argue that CBDC can be implemented with traditional software. We think that future CBDC solutions will combine design principles of traditional distributed systems with some of the design principles of blockchains, such as the use of Merkle trees and digital "wallets" to store cryptographic keys. It's about creating new communication protocols and the infrastructure to enable the transfer of digital value.

Benefits and drawbacks of CBDCs must be carefully assessed. Compared with physical cash, CBDCs allow new monetary policies and enable the future digital economy. Drawbacks include security, privacy concerns and resiliency challenges (in case of outages). Compared with bank deposits, direct CBDCs must be carefully designed as they would present more benefits but also more drawbacks. Indirect CBDCs present less benefits but also less drawbacks as they are closer to existing electronic money.

The COVID19 crisis may accelerate the transition from cash to CBDC. Notably, it would enable Central Banks to achieve greater stimulus effects by facilitating the distribution of "drone money" for micro-targeting low-income earners.

It is not a matter of "if" but a matter of "when". Central Banks must define the objectives first, then get the design parameters right while carefully assessing the second order effects; and conduct thorough pilots before launching a CBDC.

Why CBDCs are being considered

Digital Payment Trends

The increasing number of mobile phone users and the massive growth of eCommerce have led to the rapid adoption of digital payments all over the world. Cashless payments have become an appealing alternative to many consumers, creating a significant impact on the payments industry.

Asia is leading the charge with companies like Alibaba, Tencent, and Grab leading the fast-growing mobile payment adoption across the region. In China, more than 600 million people already use mobile payments, which is almost half the Chinese population. That figure is expected to rise to 60.5% of the Chinese population by 2023. In terms of volume, the equivalent of \$93T of digital payments were processed in China in Q4 2019, much more than any other country.

The European digital payments industry has also risen by more than 30% in the last three years. According to data gathered by Finanso.se, the European digital payments market is expected to hit a record \$802bn transaction value this year, with a 9.9% year-over-year growth rate. The strong upward trend is set to continue in the following years,

with the market value expected to reach \$1trn by 2023.

Sweden is on track to become almost cashless by early 2023. Cash currently accounts for just 2% of the value of all transactions and is predicted to account for just half a percent by 2020. More than half of the country's banks have stopped allowing customers to withdraw cash or pay in notes and coins over the counter, while shops and other merchants are permitted by law to refuse cash payments.

In the US, the cash usage rate for transactions under \$20 has also dropped from 46% in 2015 to 37% in 2019 according to Square. Moreover, the Federal Reserve has reported that over 80% of transactions are through cashless options such as credit/debit cards, digital wallets, and wearables, among other payment methods.

What is money

In looking at the future of money, it is important to consider which forms of money already exist today. Money is defined as any method to transfer some type of value from one person to the next. A currency is the actual execution of the theoretical concept of money.

There are three main forms of money in our existing payment and banking system: [1] physical cash in the form of notes and coins, [2] digital money (bank deposit, e-money or PSP/EMI deposit, cryptocurrencies) and [3] central bank reserves.

[1] By cash, we are referring to the legitimate paper notes and metal coins in circulation in the economy. Cash is accessible to all money users in the economy including private money users, commercial banks, central banks and governments. Though cash is typically printed, minted and supplied by the central bank, some countries such as the UK and the US, only undertake the printing of paper notes whereas the minting of coins is the prerogative of the treasury. Cash is supplied in response to demands from money users, and distributed by commercial banks who exchange bank money for cash.

[2] Digital money only exists in electronic form and is composed of three main types:

- Bank deposits are electronically recorded deposit account liabilities on the ledgers of commercial banks, and represents the assets of money users. Bank money is accessible to all money users in the economy in so far as they have a bank account. Bank money is supplied into the economy when commercial banks credit the deposit accounts of money users as part of the extension of loans to borrowers.
- E-money, Payment Service Provider (PSP) or Electronic Money Institution (EMI) deposits may only be used to facilitate electronic payments and can not be created via credit. Prepaid cards and e-wallets like PayPal allow users to deposit

fiat currency for electronic money. E-money can also be stored on and used via mobile phones, or through payment accounts on the Internet. Most common and widely used mobile subsystems are Google Wallet, Apple pay, etc.

- Cryptocurrencies are internet-based medium of exchanges which use cryptographic functions (hashes, public key cryptography) and consensus protocols among other technology components to facilitate financial transactions. The most notable feature of a cryptocurrency is that it is unregulated. It's decentralized nature makes it theoretically immune to government control and interference. Bitcoin was the first cryptocurrency introduced in 2009 and it remains the most popular. The current Crypto market capitalization is \$215B as of mid-April 2020.

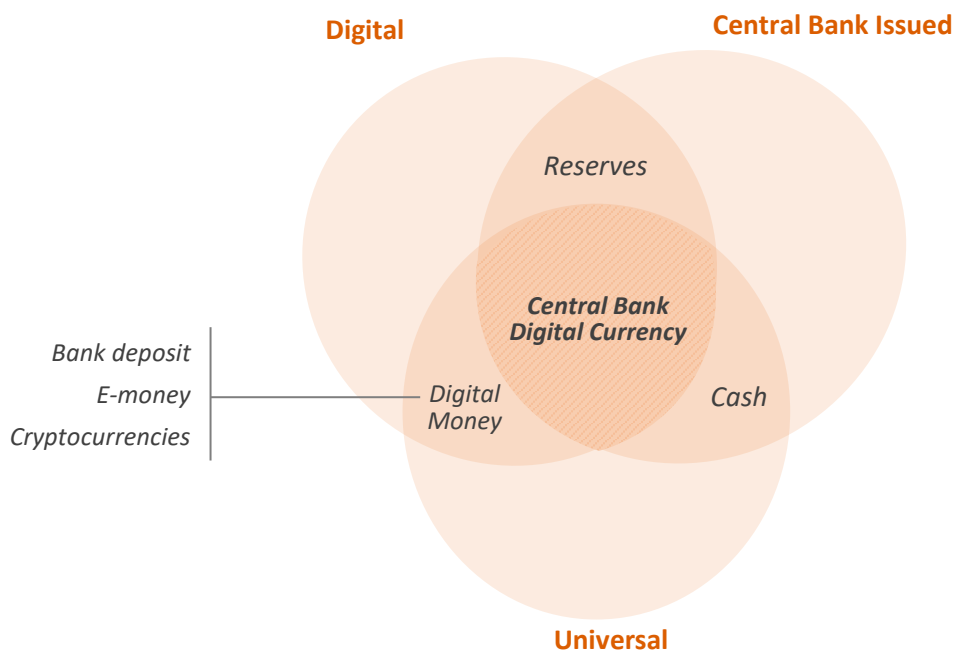
[3] Central bank reserves encompass electronically recorded current account liabilities on the ledgers of central banks. This money is only accessible to users that hold an account directly with the central bank. Central bank account holders typically only include commercial deposit banks, the treasury, and foreign central banks. Central bank reserve money is mainly supplied as credits to the commercial banks' current accounts in exchange for the purchase of governments bonds or other financial securities. Commercial banks may also borrow central bank reserve money from the central bank, which is then credited to their account. Central banks also create reserve money, when they credit the government's account in the central bank as payment of dividends or in exchange for government bonds.

Payments can also be broadly split into 'retail' and 'wholesale'. 'Retail' refers to the payments that involve non-financial institutions, such as households and small or medium-sized businesses whereas wholesale payments are those made between financial institutions (e.g. banks, pension funds, insurance companies). Today, the forms of money M1 (cash and current account deposits) and M2 (M1 plus savings accounts and money market accounts) have already been digitalized based on commercial bank accounts. They are already circulated via interbank payment and settlement systems, commercial banks' intra-

bank systems and payment services offered by non-banking payment institutions. When Central Banks study the issuance of a universal CBDC, it is as a replacement of M0, retaining the main characteristics and properties of cash. In the rest of this paper, we will focus exclusively on retail CBDC use.

Compared to the existing forms of money we described earlier, a retail CBDC would be issued by the central bank, be digital and be universally accessible.

Illustration 1: The Features of CBDCs



Source: Bjerg 2017, CH&Co Analysis

Objectives pursued with CBDC

Today, in most countries where fast payments are not available, financial transactions - whether it be the payment of a credit-card bill or mortgage; an online purchase; or the transfer of money to a relative can take 2-3 days. A national digital currency managed on a single network could allow money to change hands almost instantly. According to the Bank International Settlements (BIS), at least 17 CBDC initiatives have been launched to determine whether a digital currency would:

- Offer a convenient payment network to the public at lower cost
- Reduce money laundering and tax evasion
- Help control the money supply and allow for new monetary policies

Anticipate the disappearance of cash

In China, CBDCs already aim to create digital alternatives to cash and coins for retail use.

Sweden assesses that if the current trend continues, it "will find itself in a situation where cash is no longer generally accepted as a means of payment". Similarly, Iceland wishes to address the steady decrease in the use of banknotes and coins.

The South Africa Reserve Bank stated that the objective of their Electronic Legal Tender (ELT) project is also to offer a complement to cash. It wants to go down this route for financial inclusion, as the current banking landscape tends to leave many citizens without access to financial services.

Create an efficient and cost-effective means of payment

For the ECB, a CBDC with a status of legal tender could guarantee that all users have access to a cheap and easy means of payment.

Brazil is looking to improve the efficiency of the monetary functions, payments systems, financial inclusion and user experience.

In the Eastern Caribbean, a pilot has been implemented and aims to address the high cost of current payment instruments and banking services.

In Cambodia, the NBC has been researching a blockchain-based payment platform since 2017 to provide "smooth, efficient, safe and affordable interbank transactions". The main goal is to bring all players in Cambodia's payment space under one roof, making it easy for end-users to pay each other regardless of the institutions they bank with.

Improve Control and Regulation

For the Bahamas, the main goal is to reduce the size of legitimate but unrecorded economic activities, strengthen national defenses against money laundering and other illicit ends and deliver governments services through digital channels, improving tax administration and increasing the efficiency of spending.

Uruguay declared they could be interested in digital bills that aim to have the same functions and uses as physical bills, preventing double-spending and falsification through creating unique traceable bills, while securing e-Pesos even if users lose their phones or the password for their digital wallet.

Design and Architecture choices for CBDC

Design choices for CBDC

In this section, we present design choices for CBDC. We will start with natural design choices, and from there explore trade-offs that need to be carefully fine-tuned.

General design features

Cash-like with peer-to-peer functionality and convenient real-time payment

CBDC design choices around architecture come from two consumer needs: (1) the CBDC must be convenient for real-time payments and (2) ensure a cash-like functionality for peer-to-peer transactions.

Compatibility with e-commerce infrastructure

Businesses should be provided with payment interfaces that accept CBDC payments, either in person at the point-of-sale (PoS) or remotely (ie on a website). Newer PoS devices that feature the ability to integrate new payment services should be considered for retail, and CBDC would need to be designed to be compatible with these PoS systems.

Resilient and robust operations

CBDC must be designed to be as resilient as possible. CBDC should be able to handle peak demand, connectivity breaks, hardware and

software failures, and develop offline payments functionality in case there is a large-scale outage of electricity and data networks.

Some papers make a distinction between Token-based and Account-based CBDC. In line with the Bank of England, we think that distinction does not matter much from an operational perspective, as eventually the money issuance, KYC and AML controls will apply the same way.

Design trade-offs

Some design choices are non-obvious and require trade-offs:

Volume & Speed versus Finality

Card payment systems handle high volumes of low-value payments and prioritize the speed of payment authorization. In contrast, the high-value payment systems used by banks and financial institutions prioritize liquidity efficiency and the speed with which the funds are transferred with no possibility of the payment being reversed ('finality of settlement'). The CBDC platform must arbitrate within the two.

Resilience versus Functionality

In the platform model outlined in the Bank of England's report, the Bank's core ledger would have the minimum necessary functionality, because limiting the functionality reduces the number of potential bugs and increases the resilience of the system. However, limiting the core functionality too much would limit the ability of service providers to build new services on top of the CBDC payment system.

Security Vs Usability

Cryptographic features may be used to enable different types of security functionality, including the use of public key cryptography to verify that someone sending a payment instruction is entitled to do so, or the use of cryptographic proofs to assert that a particular transaction has occurred. However, it needs to be carefully designed to avoid having a negative impact on usability or performance.

Transaction monitoring versus Privacy

The CBDC system must be carefully designed to protect user's privacy while at the same time complying with all the relevant regulations, including know your customer and anti-money laundering requirements.

Remuneration versus non-remuneration

A key design decision for CBDC would be whether to remunerate, i.e. pay interest on

CBDC balances. A CBDC could be non-remunerated (non-interest bearing) like banknotes, or remunerated (interest bearing) like central bank reserves, bank deposits and many other financial assets.

Architecture choices for CBDC

Two main architectures are being considered by Central Banks: indirect and direct. The indirect CBDC two-tier model is an extension of the current reserves/bank deposit model, except that there will be new players as the PSPs and EMIs may have access to it. Individuals and corporates will not have an account directly opened with the CB. In the direct CBDC one-tier model, the Central Bank handles all the activities of the issuance value chain and is the only institution handling payment services. The CB will be in direct competition against banks, but will still need service providers to manage its operations.

To better understand the differences, hereafter is the decomposition of the ownership of the activities along the money issuance chain. In this table, "Delegated" means that the service is performed by an independent financial intermediary and that the control is done by the CB through regulatory supervision, and "Outsourced" means that the service provider is hired by the CB who remains directly accountable:

Table 1: Ownership of the activities along the money issuance chain

Activities	Indirect (2-tier)	Direct (1-tier)
Governance and Oversight	CB	CB
Regulatory Policies and Guidelines	CB	CB
System design (requirements)	CB	CB
Rules and control of money issuance	CB	CB
KYC, Account creation and management	Delegated	Outsourced
Client development & maintenance (wallet)	Delegated	Outsourced
Infrastructure development & maintenance	Outsourced	Outsourced
Transaction monitoring / AML controls	Delegated	Outsourced
Help Desk (requests, complaints, questions)	Delegated	Outsourced
Financial services delivery (lending, investing)	Delegated or N/A*	Outsourced or N/A*

**the N/A scenario is when the CBDC is not remunerated and can only be issued against payments, and not against promises to pay in the future.*

In both models, the CB is responsible for the governance, regulatory supervision, system design and defines the rules of the money issuance. In the Indirect model, intermediaries will do the onboarding (KYC), the transaction monitoring, the AML controls and Help Desk services. Using a cryptocurrency analogy, it is akin to going through Coinbase, who will perform the KYC, account opening and management before you can buy a bitcoin. On the ledger, your bitcoins may be mixed with many other bitcoins into a Coinbase wallet. All existing regulations will apply to this indirect model. It is an extension of the current reserves/bank deposit model where PSPs and EMIs have access to the CB. It will therefore increase the competition among financial

institutions. In this model, the central bank leverages 'market forces' to optimize related systems through close co-operation with commercial banks and other organizations. This would facilitate resource integration, synergistic collaborations and innovation. Furthermore, as the public is accustomed to using commercial institutions for financial transactions, a two-tier model could also boost the public's acceptance of a CBDC.

In the direct model, the Central Bank handles all the activities of the money issuance value chain. It provides the ledger, the process to get access, the wallet software to access the ledger, and performs AML controls and fraud investigations. In practice, the CB will

outsource these services due to a lack of resources. In this architecture, the Central Bank may be in direct competition with commercial banks, but it will still need service providers to manage its operations.

Combinations between these two architectures are possible. The whole purpose of designing a CBDC is to find the right balance between the two models, and to optimize the expected benefits depending on the design objectives.

To blockchain or not to blockchain

The debate about whether a blockchain or a distributed ledger could be leveraged to issue and manage CBDCs is a difficult one to have because of semantics. There is no consensus on the definition of those terms. For instance, the R3 solution Corda is called a blockchain, even though its technical whitepaper states that it does not utilize a chain of blocks to record transactions (page 5: "There is no block chain"). It is worth noting that Libra is also called a blockchain, even though it does not use one per its technical whitepaper (page 8: "Unlike previous blockchain projects, which view the blockchain as a collection of blocks of transactions, the Libra Blockchain will be a single data structure").

It is also worth noting that Ecuador created the first CBDC in 2014 using a traditional architecture (physically distributed and functionally centralized). It was later decommissioned in 2018 due to the lack of adoption by Ecuadorians.

After some first experimentations, some Central banks stated that a CBDC does not require a blockchain/DLT:

- Canada, Netherlands and Ukraine stated that blockchain was unnecessary for digital fiat. More specifically, the Central Bank of Canada observed that "The case for a blockchain approach is not clear since its value is most evident in situations where there is no commonly trusted party, whereas in the case of a CBDC, the Bank of Canada would be a trusted party";
- The Chinese CBDC, also called DCEP for Digital Currency Electronic Payment, will not use a blockchain/DLT. Ironically, that will allow actual peer-to-peer payments to be made as people will be able to pay each other offline via NFC, when no network is available, by positioning their phones close together.

That being said, many central banks across the world continue to experiment different blockchain/DLT frameworks, the most popular ones being R3 Corda (Sweden, Thailand), Hyperledger Fabric or Iroha (Cambodia, Japan), Ethereum (Australia, Brazil) and JPM Quorum (South Africa).

At Chappuis Halder & Co., we think that this labelling debate should be transcended. It is not an "or" but an "and" question; future CBDC solutions will combine design principles of traditional distributed systems and some of the design principles of blockchains, such as the use of Merkle trees and digital "wallets" to store cryptographic keys. It is about creating new communication protocols and the infrastructure enabling the transfer of digital value.

Benefits and drawbacks of CBDC

Central banks must perform a full analysis of the impacts - benefits and drawbacks - of introducing a digital equivalent to fiat before

launching one. In this section, we will compare CBDC against both bank deposits and cash

CBDC Vs Physical cash

Table 2: The benefits and drawbacks of selecting CBDCs over Cash

Benefits of CBDC Over Cash

- Allows for new monetary policies
- Easier / more efficient AML controls
- Less expensive to produce and maintain
- Can be used online
- Could pave the way for a future digital economy

Benefits

Allows for new monetary policies

One benefit presented by CBDCs is the provision of fiat currency directly from the Central Bank to consumers. Being able to directly distribute money to consumers via central bank accounts could help streamline quantitative easing, induce spending more quickly within the economy and expand monetary policy options.

Drawbacks of CBDC Over Cash

- Anonymity / privacy concerns
- Need internet and a device to work
- Need electricity to work
- Security concerns

Easier / more efficient AML controls

The introduction of a digital fiat currency could allow for easier and cheaper AML/CFT controls. Specifically, the execution of digital payments using CBDCs will require the creation and implementation of new AML monitoring systems within central banks. Once one-off costs are incurred to build this digital infrastructure, both marginal costs and time taken to conduct AML/CFT activities will decrease. Furthermore, the level of traceability

of CBDCs in comparison to physical cash will make it easier to perform AML controls and will help CBDCs meet AML/CFT requirements.

Less expensive to produce and maintain

It is expected that CBDCs will be cheaper to produce and maintain in comparison with physical cash.

Can be used online

Another advantage of CBDCs is their design. Specifically, the ability to use CBDCs online and through devices enhances convenience for consumers in terms of both storage and use of money. For example, CBDCs can also be used in a wider range of instances compared to physical cash, such as for online purchases, payments and cross-border transfers.

Could pave the way / be an enabler for a future digital economy

In today's world, consumers are increasingly opting to use digital payment systems as opposed to physical cash. According to the Bank of England, while approximately 60% of payments were executed using banknotes in 2008, only 28% payments were made using cash in 2018 in the UK. Thus, the introduction of CBDCs could prove to be an attractive alternative to meet consumers' evolving needs for digital payments, while helping to support the creation of a native digital infrastructure that will serve the needs of the digital economy overall.

Drawbacks

Anonymity / privacy concerns

While a non-anonymous CBDC has benefit in that it can address AML/CFT concerns and requirements through its traceability, this lack

of anonymity poses privacy concerns for businesses and consumers. Thus, the "appropriate degree of privacy" would need to be assessed by a central bank before implementation.

Need internet and a device to work

One challenge to be addressed in the design and implementation of a CBDC is the ability for CBDCs to be accessible in non-Wi-Fi environments and through means other than a smart phone or device. The inability of a CBDC's technological infrastructure to provide these features could significantly limit its usership and result in the financial exclusion of the poor and the less technologically savvy in general.

Need electricity to work

Similarly, CBDCs will not be resilient to power outages, given that they will most likely be distributed via devices and supported only in Wi-Fi environments. Thus, instances or areas that are prone to electricity outages will serve as an implementation challenge and must be taken to account in the design of a CBDC.

Security concerns

Digital fiat currencies are susceptible to theft both physically and electronically. For example, CBDCs could be subject to theft in instances of aggravated robbery where perpetrators could simply retrieve the user's wallet (stored on a device) and the associated key by force, or using social engineering and phishing techniques. Hosting CBDCs on electronic platforms makes them further susceptible to electronic means of theft such as hacking, whereas cash can only be stolen physically.

CBDC Vs Bank deposit

Table 3: The benefits and drawbacks of direct and indirect CBDCs over bank deposits

Type of CBDC	Benefits Vs Bank deposits	Drawbacks vs Bank deposits
Direct CBDC	<ul style="list-style-type: none"> • Direct control over money creation and liquidity • Increased safety in case of a crisis • Direct control over KYC due diligence and AML monitoring • More seigniorages for the CB • Prevent emergence of potential monopolies of private digital cash 	<ul style="list-style-type: none"> • Financial stability • Complex to implement • Inefficiencies
Indirect CBDC	<ul style="list-style-type: none"> • Better control upon money creation and liquidity on top of existing regulations • Prevent emergence of potential monopolies of private digital cash 	<ul style="list-style-type: none"> • n/a

Benefits

Direct control over money creation and liquidity

While central banks currently limit and control money creation by commercial banks through regulation, introducing either a direct or indirect CBDC would allow them to have a tighter control over the money supply. Furthermore, being able to distribute money directly through digital means equips central banks with the ability to more easily provide liquidity to end consumers than relying on commercial banks.

Increased safety in case of a crisis

CBDCs have the potential to enhance safety of money in comparison to bank deposits in the

event of a crisis. From a commercial bank perspective, though deposits are currently guaranteed up to \$250,000 per account, which suffices as protection for most consumers, central banks face a lower risk of bankruptcy and default and are thus able to provide consumers with access to relatively safer money.

Direct control over KYC due diligence and AML monitoring

A CBDC can provide central banks with greater control over their KYC due diligence activities and AML monitoring over bank deposits. The direct provision of a digital fiat currency from the central bank to the consumer provides central banks with greater visibility of

transactions than they would be privy to when bank deposits are used.

More seigniorages for the CB

As the central bank regains control over the creation of money, the share of seigniorages currently allocated towards commercial banks will decrease, while increasing the central banks economic profits (as long as the cost of producing the currency is lower than its value).

Prevent emergence of potential monopolies of private digital cash

One point of concern for governments is the introduction of digital money by large private companies. The Libra Association, for example, is recently reported to be working towards "regulatory compliant global payment network" designs that will accept multiple coins, including those that are government issued. Thus, it may be in the interest of central banks to introduce either a direct or indirect CBDC in order to preemptively curb the undermining of government-issued fiat currency by massive companies seeking to monopolize the digital cash economy.

Drawbacks

Financial stability

Introducing direct CBDCs could create financial instability due to the current structure of the financial system. Specifically, as consumers begin to exchange commercial bank deposits for CBDCs, commercial banks' access to liquidity could decrease dramatically, resultantly limiting banks' ability to provide lending services.

Complex to implement

An evident drawback for direct CBDCs in comparison to commercial bank deposits is the inevitable implementation challenge. Providing fiat currency directly to consumers would force central banks into a completely new role within the financial system and would require profound change in terms of the relationship between central banks and commercial banks, laws and regulation and systems infrastructure.

Inefficiencies

It is typical for public institutions to experience more inefficiencies and bureaucracy when delivering services that more agile, private institutions can also provide. Typical inefficiencies could pose a challenge to central banks in their provision of direct CBDCs, in comparison to private commercial banks. As demonstrated in the case of Ecuador when attempting to introduce a new digital currency, fears of bureaucracy and inefficiency convinced the Ecuadorian public that central bank electronic money accounts may in fact possess a higher risk of default than deposit accounts at private commercial banks, leading to a lack of trust and eventual decommissioning of the new digital currency.

For some countries, the risks of issuing a CBDC still outweigh the potential benefits

Denmark stated that the "potential benefits of introducing CBDC are not assessed to match the considerable challenges that the introduction would present".

The Central Bank of Canada stated in Feb. 2020 that the "expected benefits [of CBDC], however, might be small or are unlikely to be realized in practice", and concluded "that there is not a compelling case to issue a CBDC at this time.

Canadians will continue to be well-served by the existing payment ecosystem, provided it is modernized and remains fit for purpose”.

For Israel, CBDCs would help in the struggle against unreported transactions and contribute to the high-tech sector. However, the implementation team involved in Israel's CBDC efforts “does not recommend that the Bank of Israel issue digital currency (e-shekel) in the near future”.

Switzerland examined the opportunities and risks of introducing a Cryptofranc (e-franc) and concluded that “additional benefits are currently low and outweighed by risks”.

In Japan, Deputy Governor Masayoshi Amamiya argued that a Digital Yen would provide minimal benefits to the country when addressing the Bank of International Settlements at their Future of Payments Forum. Specifically, Amamiya explained that the costs of introducing a CBDC would significantly outweigh the benefits for countries with more mature payment infrastructures. One of Amamiya's key claims is that, while merchants would likely prefer the widespread distribution of CBDCs due to the lower operating and running costs they would pose in comparison to private payment systems, introducing CBDCs could suppress business and discourage innovation within the private sector. Furthermore, the Deputy Governor discussed how the introduction of CBDC and eventual elimination of physical cash could inevitably position the Bank of Japan as the sole repository for Japan's payment and transaction information, and highlighted the corresponding

public concerns that this would pose with regards to the storage of personal financial data.

In Sweden, as they are exploring the potential design, implementation and benefits of an e-Krona are ongoing, there is also an increasing trend towards returning to physical cash. For example, a new law enacted by the Swedish government instructs all banking institutions to remain fully capable of providing cash to Swedish residents and companies. The new law further states that all people must be able to withdraw cash within less than 15 miles distance from their place of residence. In enacting this law, the government aims to allow people the freedom to exercise their preferences in terms of payments, while protecting poorer, older and disabled subsections of the population from the financial exclusion that could arise when solely providing digital currency as a means of payment. The government has also expressed concerns related to cybersecurity, fearing that introducing CBDCs could open the opportunity for increased cyber-attacks on the financial system.

Despite the reluctance of some countries to adopt CBDC, it will be interesting to assess how their stances may change in the future. Given the current climate of COVID-19, where a large section of the world's population has been forced into isolation, we may see countries re-visit CBDC implementation efforts.

The impact of COVID19 on CBDC

As the world teeters on a recession, we can only wonder how deep it will be, and if it will be combined with a debt crisis. As Taleb (2020) notes, "global connectivity is at an all-time high, with China one of the most globally connected societies", and with high connectivity in any system comes a higher probability of systemic threats i.e. the rate of contagion of financial crises is higher than ever.

All bets are off the table for what paradigm shift this next recession will have on central banking and economic theory. There is a lot at stake: corporate debt defaults, EM sovereign debt defaults, rampant unemployment, pension fund shortfalls, USD dominance, and the presidency of the United States are all entangled the prevailing status quo.

A changing paradigm for reserve banking?

The evolution of fiat money towards central bank digital currency should also be seen in the perspective of economic history. For decades we have been operating in a neo-classical paradigm (aka 'Monetarist') which views the role of money, and thus the role of credit/debt, as insignificant in the functioning of the economy - as opposed to Keynesian or Austrian schools in which money plays a central part of the macroeconomic theory.

The prevailing theory has focused almost exclusively on monetary policy to stimulate growth through adjusting interest rates and targeting inflation. However, with interest rates around the world at 0%, it appears this strategy is exhausted, and we are heading towards an era of more fiscal policy, including the once unthinkable 'helicopter money' and Universal Basic Income. Spain has in fact reportedly moved towards rolling out permanent UBI to its citizens, something akin to a People's Quantitative Easing.

While we will not likely to return to a gold standard, there are alternatives to the current system which have been in the background for years. One example is 'The Chicago Plan', which essentially proposes to outlaw the creation of private bank-created credit-money and give a monopoly of money creation to the central bank. It was developed by leading economists as a response to the Great Depression during Roosevelt's New Deal banking reform. The Plan proposes the separation of two types of private banks: money banks, which would keep the deposits and provide services for fees, and credit investment trusts, which would still be able to provide loans. This could be implemented today, as suggested in CBDC frameworks, by making digital money on deposit with private banks.

QE and Helicopter money: What's different this time?

One significant misconception about QE is that it provided banks with free 'cash' to lend out to the public. However, as highlighted by the Bank of England, banks cannot lend out their reserves; reserves can only be lent between banks, since consumers do not have access to reserve accounts at the central bank.

During QE, the long-term bonds that the central bank bought from the private sector in exchange for extra reserves at the central bank only changed the form of the assets on bank books but did not create any new money. This time, however, central banks are looking to expand their monetary toolkit aided by the removal of cash and the initiation of CBDC.

The alternative to QE to stimulate an economy proposed as far back Milton Friedman is to put money directly into people's hands/accounts, dubbed "helicopter money", in order to induce spending and lift the velocity of money. This could be executed even more effectively today if consumers have an account directly with the reserve bank through a form of CBDC, or if the digital currency already in people's retail accounts was converted to legal tender. This is one possible reason why an initial COVID stimulus bill included the creation of a digital US dollar.

On top of helicopter money, the benefit of this CBDC "drone money" is that it could micro-target low-income earners with more money, thus having a greater stimulus effect as it will be spent rather than saved if distributed indiscriminately (Rogoff, 2016).

Removing Cash

Although negative interest rates and the removal of cash might seem like an unthinkable dramatic change in monetary policy, it is not a new idea.

The influential US economist Kenneth Rogoff has been a proponent for the removal of cash for decades (2016, *The Curse of Cash*.) and notes that negative interest rates were advocated during the Great Depression by contemporary luminaries John Maynard Keynes and Irving Fisher. Back in the 1930s, as now, short-term interest rates were also at the zero-lower bound.

Unlike then, policymakers today are staring into the unknown with years of absent inflation and many countries' rates already at the zero lower-bound at the onset of a global recession of totally unpredictable consequences. Acknowledging the gravity of this situation, the IMF in a 2018 paper titled *Monetary Policy with Negative Interest Rates: Decoupling Cash from Electronic Money*, advises central banks to remove cash and replace it with a form of CBDC to make interest rates effective as low as -4%. The IMF recommends introducing a dual-currency system of a central bank digital currency and cash, where cash on deposit has a decaying value relative to the CBDC.

Not only are there measures to remove cash for money laundering and terrorism, but there is added impetus with COVID-19. China at one stage was literally disinfecting its cash, which is notorious for gathering bacteria.

Demand for alternative to USD global reserve currency

Since the USD was de-pegged from gold in 1971, the world has been flooded with dollars (and Eurodollars), and the Federal Reserve has grown in importance to become the world's de facto central bank.

Major nations are aware of the exorbitant privilege the US commands as the world's reserve now more than ever, as it can issue debt in its own currency and print more to pay it off.

In recent years, both China and Europe have overtly expressed, both in words and actions, their dissatisfaction with the "USD hegemony", and a desire to change the status quo.

Most recently, Bank of England Governor Mark Carney expressed his desire to create a digital "Synthetic Hegemonic Currency", a digital basket of fiat currencies similar to an SDR and sympathized with Facebook's Libra proposal. He said there is "a de-stabilizing asymmetry at the heart of the international monetary system. While the world economy is being reordered, the US dollar remains as important as when Bretton Woods collapsed". This movement towards CBDC, in whatever form it turns out, is as much about historical precedent as it is about technology.

Conclusion

The literature on CBDC is growing, but this is still a new topic of investigation and a lot of additional questions remain to be explored. This research paper has investigated the possible architecture, benefits and drawbacks of CBDC. Forming a clear understanding of all the designing options at stake is crucial and will have implications for the optimal design of CBDC.

Concerning the direct CBDC model for instance, future research should explore how CBDC can be properly introduced, without having a destabilizing impact on the banking sector. Mechanisms shall be designed in a way that the financial stability risks of CBDC can be

reduced. Under a universally accessible CBDC, monetary policy could operate similar to how it does now, and this model could even allow for new monetary policies.

All the functional and technological bricks to build a retail CBDC are available today. There will not be one single model, but probably a range of CBDC models. It is a matter of defining the exact objectives first, then getting the design parameters right, carefully assessing the second order effects and conducting pilots. It is not a matter of "if" but a matter of "when".

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