PROGRAM MATERIALS
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May 27, 2020

Sovereign and Central Bank Digital Currency - Is Cash Still the King?

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Sovereign and Central Bank Digital Currency

Is Cash Still the King?

May 27, 2020

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Bloomberg

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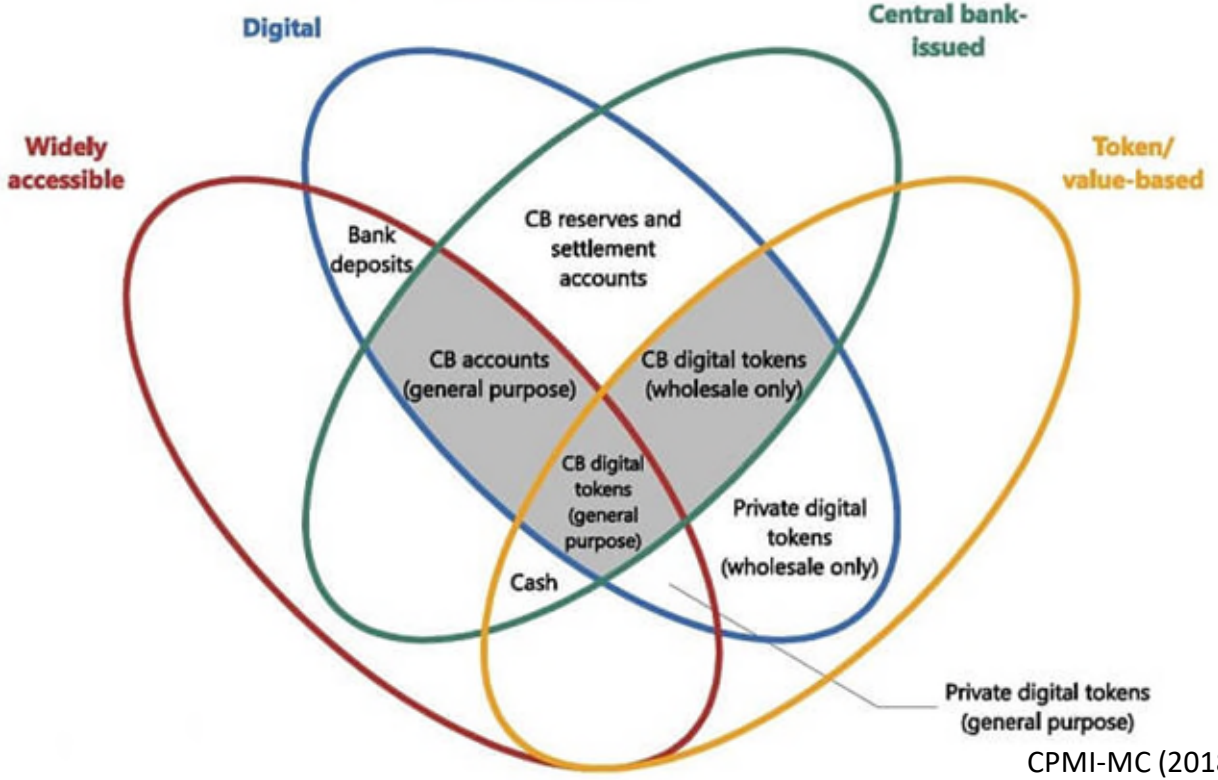
"There is **no country with more to lose** from the disruptive potential of digital currency than the United States."

"This revolves primarily around **U.S. dollar hegemony**. Issuing the global reserve currency and the **medium of exchange for international trade** in commodities, goods, and services conveys **immense advantages**."

– JPMorgan analysists

Evolution of Money

The money flower: a taxonomy of money



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

Central Bank Digital Currencies ("CBDC")

- Central bank liability, like cash
- Digital, like bank money

✓ Backed by full faith and credit of a sovereign nation

✗ Not crypto

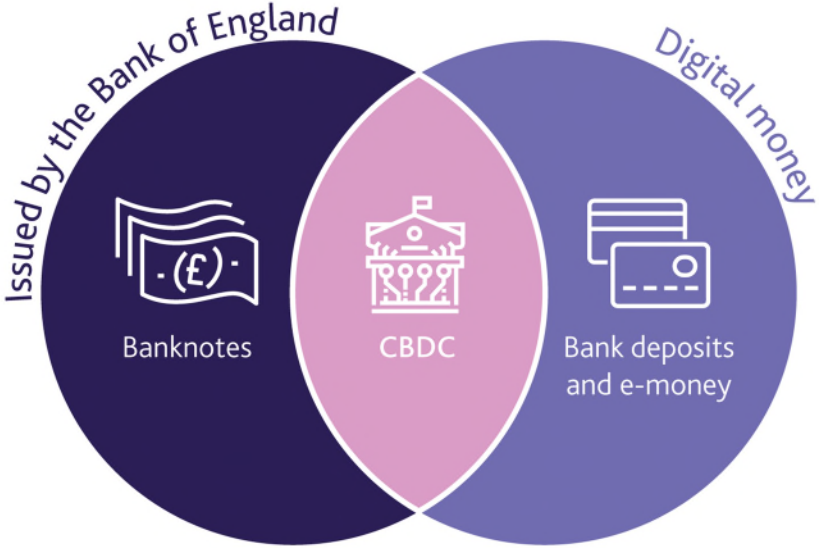
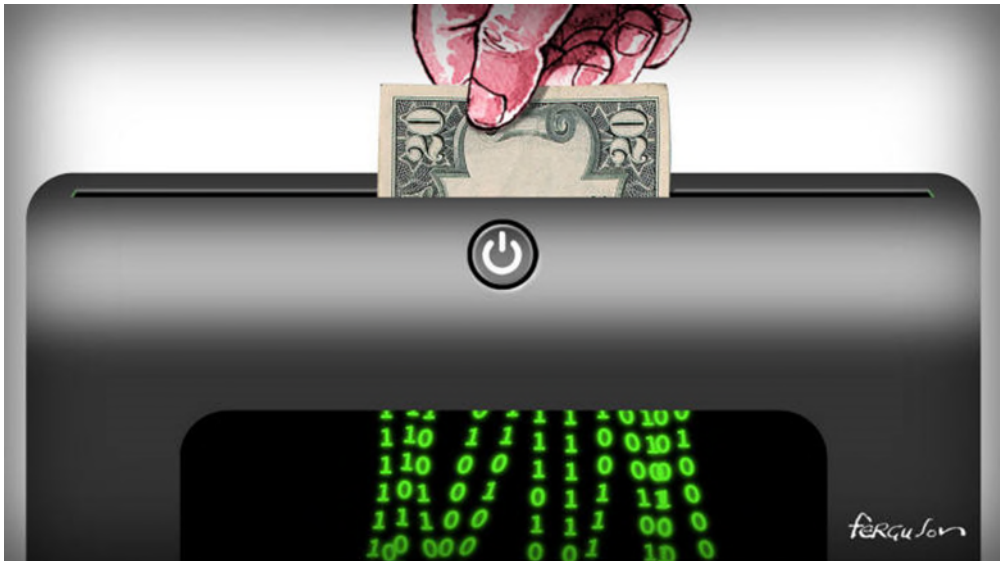


Illustration by the Bank of England

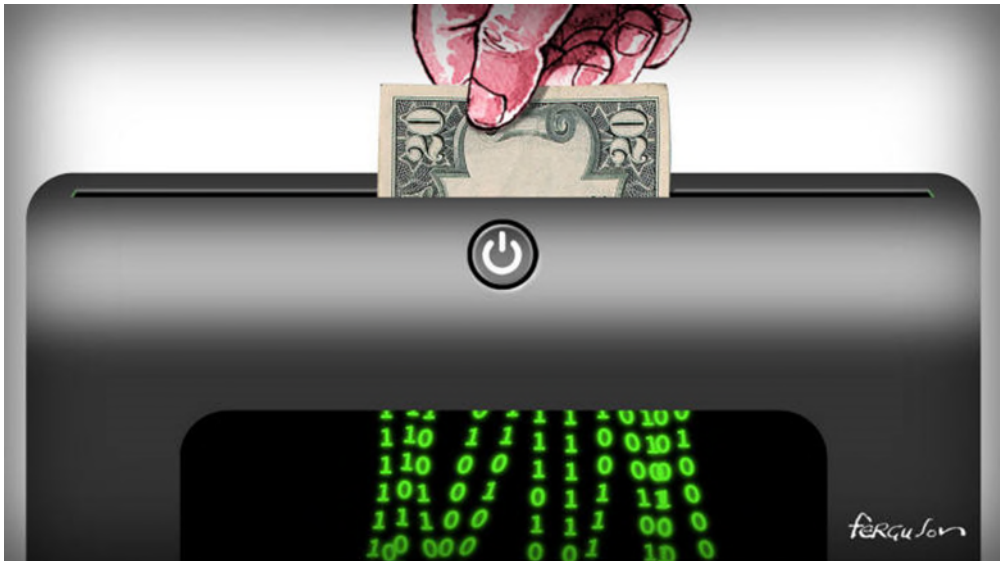
CBDC Design Options

- Account or token based
- Alongside or replace cash
- Access
  - Retail transactions
  - Wholesale – interbank settlements
  - Universal or limited to citizens
- Programmable
  - Identity
  - Privacy
  - Surveillance

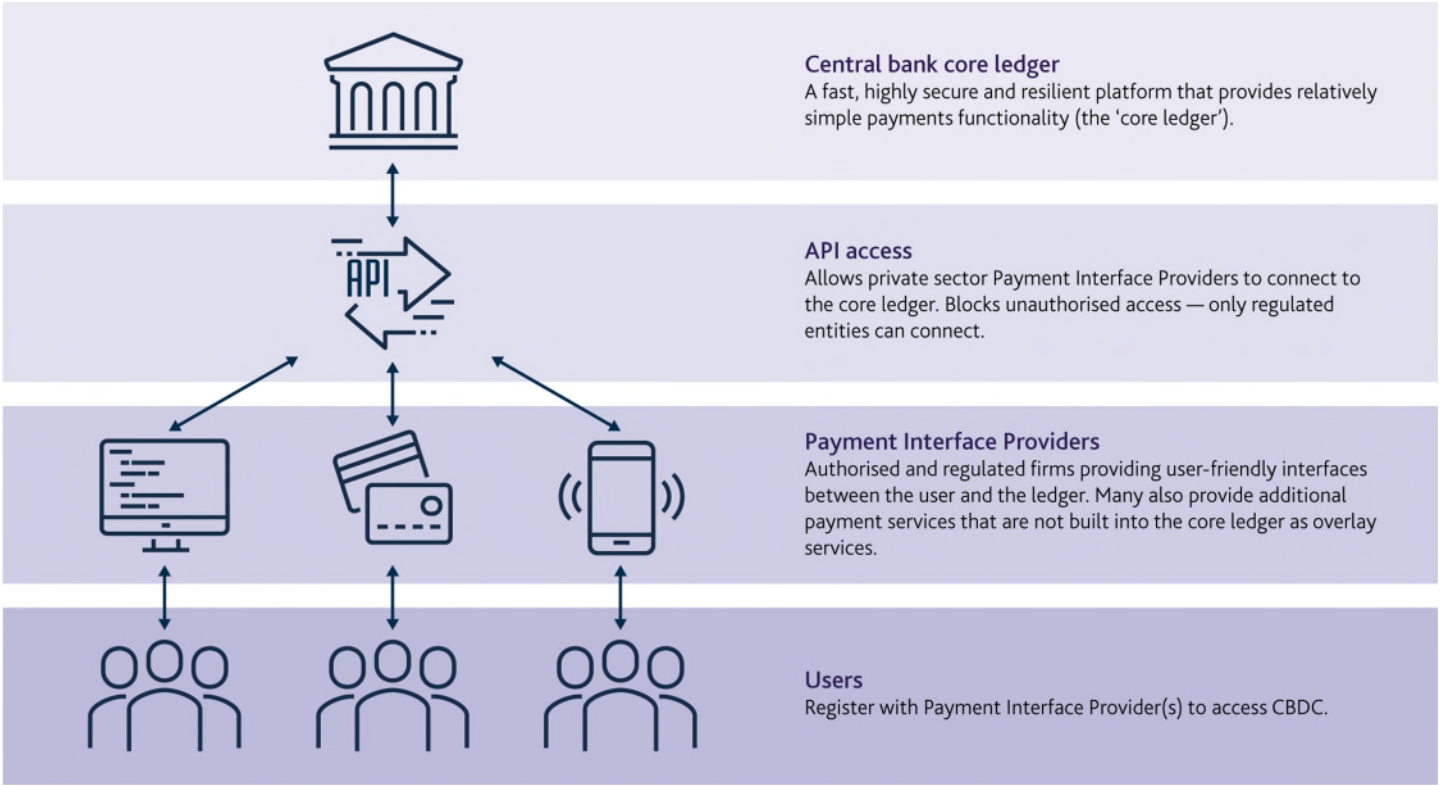


CBDC Design Options (cont.)

- Role of intermediaries
  - Are intermediaries needed?
  - Central Banks not equipped to deal with retail customers, KYC/AML, etc.
  - Impact on macro economy and financial sector
- Interest bearing or not
- Technology
  - Security
  - Interoperability with other CBDCs
  - Blockchain or not



Vision by the Bank of England



Central bank core ledger
A fast, highly secure and resilient platform that provides relatively simple payments functionality (the 'core ledger').

API access
Allows private sector Payment Interface Providers to connect to the core ledger. Blocks unauthorised access — only regulated entities can connect.

Payment Interface Providers
Authorised and regulated firms providing user-friendly interfaces between the user and the ledger. Many also provide additional payment services that are not built into the core ledger as overlay services.

Users
Register with Payment Interface Provider(s) to access CBDC.

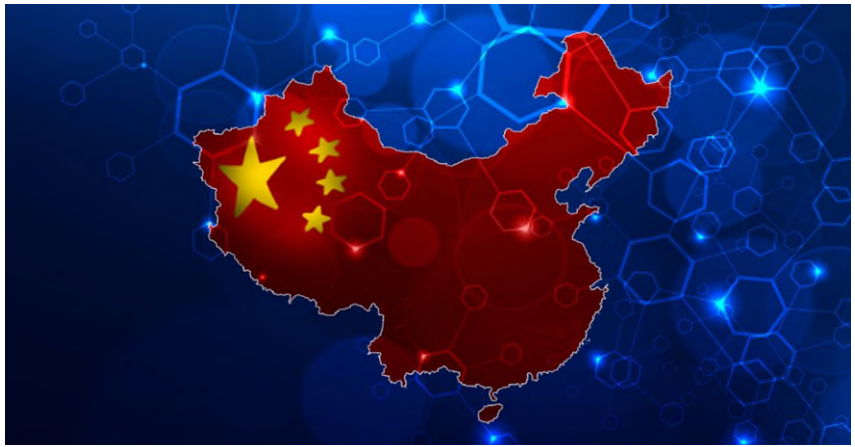
Why introduce a CBDC?

- Avoiding the risks of new forms of private money creation (e.g., the U.K.).
- Privacy concerns due to private payments providers (e.g., China).
- Maintaining cash-like attributes and public access to central bank balance sheet when cash vanishes (e.g., Sweden).
- Limiting cash maintenance costs.
- Financial inclusion.
- Payments efficiency.
  - Especially cross-border if CBDCs are interoperable.
- Better control the growth of monetary supply.

All Major Central Banks Considering

China

- “Digital Currency Electronic Payment” (DCEP).
- Designed to function like cash.
- Intermediaries keep their place in the system.
  - Households or firms may hold DCEP in special digital wallets or in commercial bank accounts, but not at the central bank.
- A centralized database using elements of blockchain and cryptography.
- Bluetooth enabled offline payments without internet.
- Status: pilot; implement by 2021.



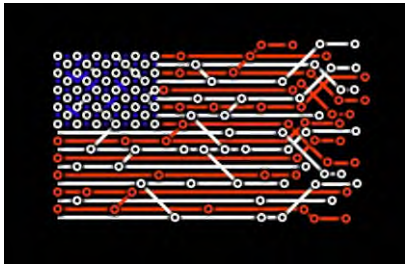
Sweden

- "E-krona."
- The least cash dependent country; estimated that retailers could stop accepting cash by 2023.
  - Problem? If the payment infrastructure is left completely to the private sector, certain groups might be excluded. Also, if people lose the ability to convert their bank deposits into cash backed by the government, it might undermine their faith in the money system.
- E-krona would give the general public access to a digital complement to cash, where the state would guarantee the value of the money.
- Technical solution based on blockchain.
- Status: pilot; no final decision on implementation.

The Marshall Islands

- “SOV.”
- Currently no national currency; uses USD.
- Population of 58,000 people spread out over 1,000 islands.
- Monetary policy coded into the currency smart contract.
- 4% growth; Universal Basic Income to citizens.
- Technical solution based on blockchain.
- Two-tiered onboarding – PreSOV to test systems.
- Status: The Sovereign Currency Act passed in 2018; PreSOV to be introduced 2020.

The United States



- No official plan to implement.
- Covid-19 stimulus draft bill mentioned a “digital dollar.”
- Private Digital Dollar Foundation established to lead discussion on a U.S. CBDC. https://www.digitaldollarproject.org/
- Presently, the U.S. is not officially developing a U.S. CBDC but continues to evaluate costs and benefits.
- The Patriot Act has made it harder to open a bank account, which has led to more unbanked or underbanked citizens and has put the privacy of bank account holders in check.
- U.S. citizens especially alert to security and privacy concerns and surveillance by the state.

European Central Bank ("ECB")

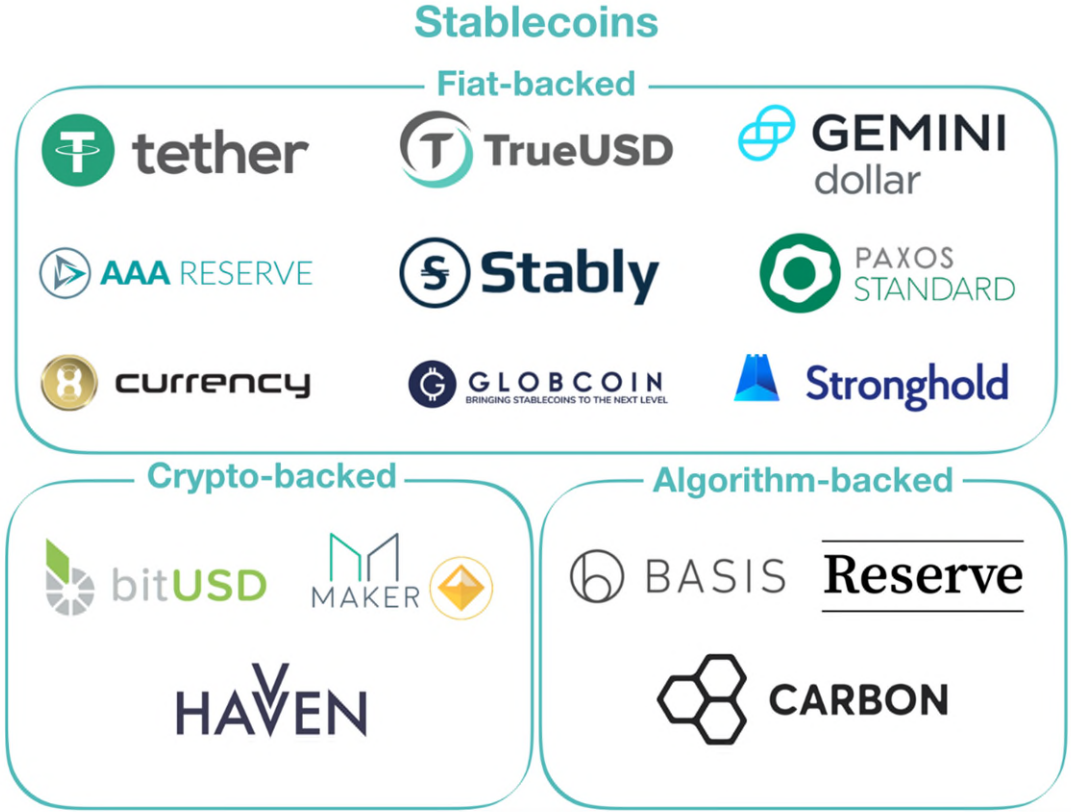
- Working on retail CBDC to ensure access to risk-free central bank money in cashless future.
- Open questions:
  - Legal tender status or not? If yes, would have to be usable at any location and under any condition, possibly even offline.
  - Based on (a) digital tokens that circulate in a decentralized manner without a central ledger allowing for anonymity towards the central bank, similar to cash.
  - Or (b) deposit accounts with the central bank. Increasing the number of current deposit accounts from 10,000 to 300-500 million.
  - Disintermediation: Central Banks might also have to provide loans, launch customer-facing business lines, regulatory compliance like AML, consumer protection and confidentiality.

Benefits and Related Factors by ECB

Benefit of CBDC	Possible further factors or requirements
A. Efficient retail payments-	
A.1 Making available efficient, secure and modern central bank money to everyone	In particular in economies without high-quality electronic commercial bank money, and/or without a secure and efficient payment system
A.2 Strengthening the resilience, availability and contestability of retail payments	In particular in economies in which banknote demand vanishes and private electronic payments solutions lack competition
B. Overcome use of banknotes for illicit payment and store of value	
B. Better control of illicit payment and saving activities, money laundering, and terrorist financing	Requires (i) discontinuation of banknotes (or at least of larger denominations); (ii) CBDC to not take the form of anonymous token money
C. Strengthen monetary policy	
C.1 Allows overcoming the ZLB as negative interest rates can be applied to CBDC	Requires discontinuation of banknotes (or at least of larger denominations)
C.2 Interest rates on CBDC provide for additional monetary policy instruments, independently of ZLB	
C.3 Easier ability to provide helicopter money	Requires that each citizen has a CBDC account
D. Sovereign money related	
D.1 Improve financial stability and reduce moral hazard of banks by downscaling the role of the banking system in money creation	CBDC takes over to large or full extent sight deposit issuance by banks
D.2 Larger seignorage income to state (and citizens) as state takes back money creation from banks.	CBDC takes over to large or full extent sight deposit issuance by banks

Private Global Stablecoins

- Digital asset, without the status of legal tender.
- Potential to shake the entire international monetary system.
- Risk made real by Libra, proposed by Facebook and others.



Libra

- A globally accessible and low-cost payment system to complement domestic currencies.
- Single-currency stablecoins (e.g., ≋USD, ≋EUR) backed 1:1 by an underlying fiat currency.
- Also, a multi-currency ≋LBR that aggregates single-currency stablecoins using fixed nominal weights (e.g., ≋USD 0.50, ≋EUR 0.18, ≋GBP 0.11, etc.).
- ≋LBR envisioned to be an efficient cross-border settlement coin as well as a low-volatility option for countries without their own single-currency Libra stablecoin.

The Future

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Joel is the chair of Sullivan's Fintech and Blockchain Practice. He is a highly-regarded trailblazer in the fintech, blockchain, and cryptocurrency space. Joel's clients' size and nature vary from governments, top cryptocurrencies, and large enterprises to smaller startups, who describe him as a "very sharp and very experienced partner" who is "super pragmatic" and can "sort through the chaff and get to the nub of things impressively quickly."

His representative client work includes advising the Marshall Islands in creating digital sovereign currencies; helping to launch ndau, a buoyant stablecoin virtual currency; structuring for Gita Holdings/GreatX a structured, principal-protected tokenized investment product allowing investors to obtain upside exposure to hotel room blocks in various hotel properties; as well as providing regulatory advice to prominent blockchain projects including Aeternity, IOTA, NEM, and Celsius.

Joel has been recognized by Chambers and Partners as one of 13 leading Fintech, Blockchain, and Cryptocurrency lawyers in the United States and as one of the six leading Fintech lawyers in the United States by the Legal 500.

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Mari Tomunen is a dual-qualified (New York, Finland) lawyer who advises fintech, blockchain and cryptocurrency companies and governments with legal and regulatory issues, most commonly those related to securities, commodities and corporate law. She has unique experience and industry knowledge from working dedicatedly with several dozens of blockchain ventures helping them to operate through regulatory uncertainty.

Previously, Mari served as a judicial intern to the Honorable Denny Chin of the U.S. Court of Appeals for the Second Circuit, NY. She has also worked as an international corporate tax lawyer at KPMG Oy Ab, Finland, and as a research assistant to former SEC Commissioner Robert J. Jackson, Jr. when he was a Professor at Columbia Law School, NY.

Mari graduated from Fordham University School of Law with magna cum laude, and served as a staff member on *Fordham Journal of Corporate and Financial Law*.

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Attachments

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- Addressing the regulatory, supervisory and oversight challenges raised by “global stablecoin” arrangements: Consultative document, Financial Stability Board, April 2020
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BANK OF ENGLAND

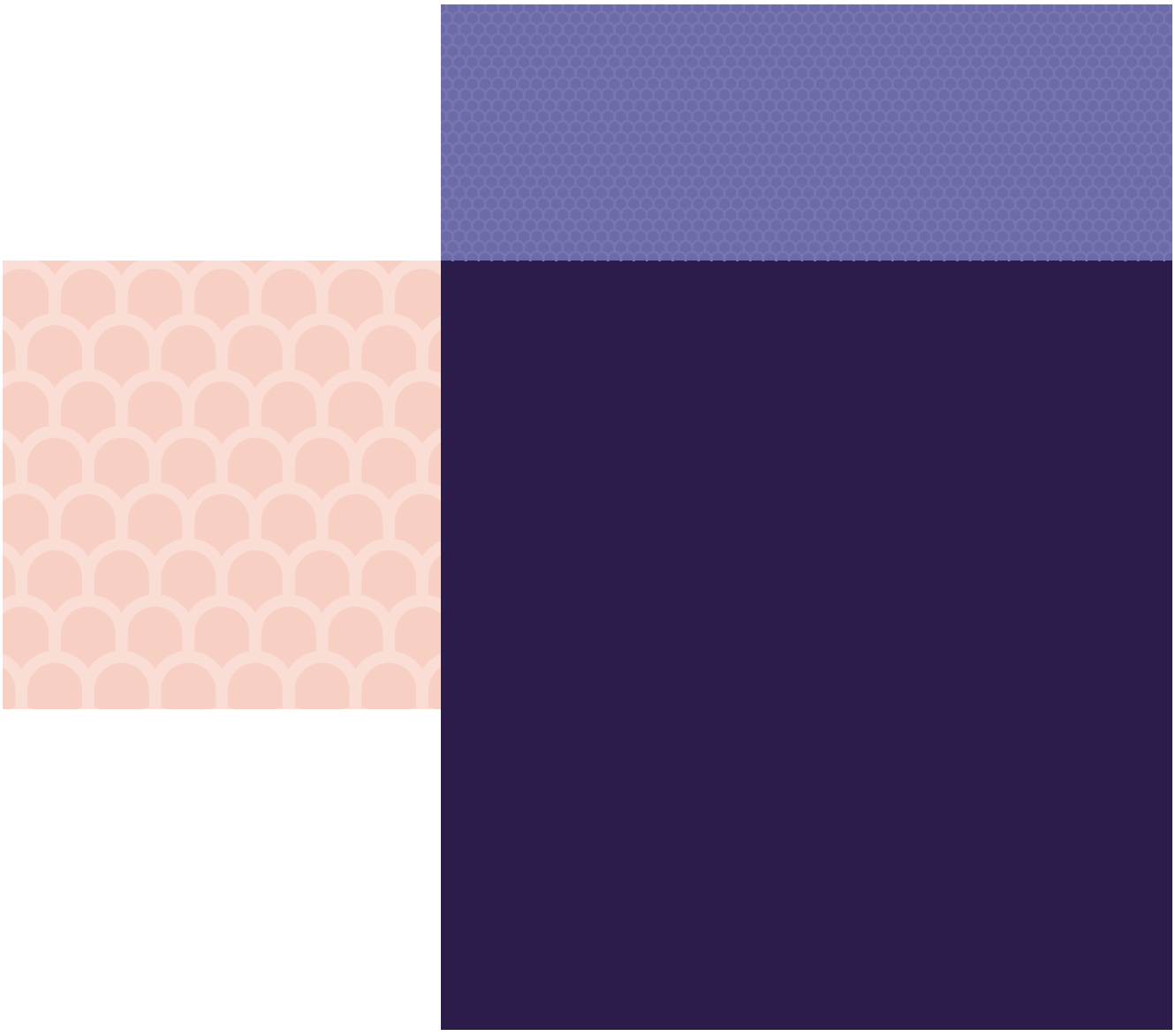
Future of Money

Discussion Paper

Central Bank Digital Currency

Opportunities, challenges and design

March 2020



BANK OF ENGLAND

Discussion Paper:
Central Bank Digital Currency Opportunities, challenges and design

March 2020

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By responding to this discussion paper, you provide personal data to the Bank of England. This may include your name, contact details (including, if provided, details of the organisation you work for), and opinions or details offered in the response itself.

The response will be assessed to inform our work as a regulator and central bank, both in the public interest and in the exercise of our offlcial authority. We may use your details to contact you to clarify any aspects of your response.

The discussion paper will explain if responses will be shared with other organisations (for example, the Financial Conduct Authority). If this is the case, the other organisation will also review the responses and may also contact you to clarify aspects of your response. We will retain all responses for the period that is relevant to supporting ongoing regulatory policy developments and reviews. However, all personal data will be redacted from the responses within flve years of receipt. To flnd out more about how we deal with your personal data, your rights or to get in touch please visit bankofengland.co.uk/legal/privacy.

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Contents

Foreword

For over 325 years, the Bank of England has provided safe money and a risk-free means of payment to households, businesses and the wider flnancial system. This is one of the key ways in which we fulfll our mission — given to us by Parliament — to promote the good of the people of the United Kingdom by maintaining monetary and flnancial stability.

The Bank has always innovated in the form of money and payment services that we provide, most recently by switching our banknotes from paper to safer and stronger polymer notes, and investing heavily in rebuilding our wholesale Real-Time Gross Settlement (RTGS) payment service, which provides high-value and time-critical payment services to flnancial institutions, and ultimately serves as the backbone for every electronic payment in the UK. We are also supporting a number of private-sector initiatives to improve the existing payments landscape.

It is now time to look further ahead, and consider what kind of money and payments will be needed to meet the needs of an increasingly digital economy. We are in the middle of a revolution in payments. Banknotes — the Bank's most accessible form of money — are being used less frequently to make payments. At the same time, flntech flrms have begun to alter the market by offering new forms of money and new ways to pay with it.

These developments create major new opportunities, present some new risks, and raise a number of profound questions for the Bank. This paper considers one of the most important of these questions: as the issuer of the safest and most trusted form of money in the economy, should we innovate to provide the public with electronic money — or Central Bank Digital Currency (CBDC) — as a complement to physical banknotes?

A CBDC could provide households and businesses with a new form of central bank money and a new way to make payments. It could ensure that the public has continued access to a risk-free form of money issued by the central bank, which may be especially important in the future as cash use declines and new forms of privately issued money become more widely used in payments. CBDC could also be designed in a way that contributes to a more resilient, innovative and competitive payment system for UK households and businesses.

While CBDC poses a number of opportunities, it could raise signiflcant challenges for maintaining monetary and flnancial stability. CBDC therefore has relevance to almost everything the Bank does, and would need to be very carefully designed if it were to be introduced.

The Bank has not yet made a decision on whether to introduce CBDC. We need to consider the questions carefully and in good time, alongside Her Majesty's Government. This paper is intended to be the basis for further research and dialogue between the Bank and the payments industry, technology providers, payments users, flnancial institutions, academics, other central banks, and public authorities. I encourage anyone with an interest on these fundamental issues to respond to the Bank on the potential beneflts, risks, and practicality of CBDC.

Mark Carney
Governor

Executive summary

The Bank of England's objectives, as set by Parliament, are to maintain monetary and flnancial stability. To support these objectives, the Bank provides the safest and most trusted form of money to households, businesses and the flnancial system. But the way we pay is changing, with use of banknotes falling, and the use of privately issued money and alternative payment methods rising. In this context, the Bank is exploring the concept of Central Bank Digital Currency (CBDC), as are central banks across the world.(1)

A Central Bank Digital Currency would be an innovation in both the form of money provided to the public and the payments infrastructure on which payments can be made. At the moment, the public can only hold money issued by the Bank in the form of banknotes. Only commercial banks and certain flnancial institutions(2) can hold *electronic* central bank money, in the form of 'reserves' held in the Bank's Real-Time Gross Settlement (RTGS) service. Unlike banknotes, CBDC would be electronic, and unlike reserves, CBDC would be available to households and businesses. CBDC would therefore allow households and businesses to directly make payments and store value using an electronic form of central bank money. For this reason, CBDC is sometimes thought of as equivalent to a digital banknote, although in practice it may have other features depending on its flnal design.

If a CBDC were to be introduced in the UK, it would be denominated in pounds sterling, so £10 of CBDC would always be worth the same as a £10 banknote. Any CBDC would be introduced alongside — rather than replacing — cash and commercial bank deposits.

The Bank has not yet made a decision on whether to introduce CBDC, and intends to engage widely on the beneflts, risks and practicalities of doing so. This discussion paper is part of that process.

CBDC could present a number of opportunities for the way that the Bank of England achieves its objectives of maintaining monetary and flnancial stability. It could support a more resilient payments landscape. It also has the potential to allow households and businesses to make fast, efflcient and reliable payments, and to beneflt from an innovative, competitive and inclusive payment system. It could help to meet future payments needs in a digital economy by enabling the private sector to create services that support greater choice for consumers. It could build on our ambitious renewal of the RTGS service and complement private sector initiatives to improve payments.

CBDC may also provide safer payment services than new forms of privately issued money-like instruments, such as stablecoins. Ensuring that the public has continued access to a risk-free form of money issued by the Bank may be especially important in the future, and help to address some of the consequences of a decline in the use of physical cash. Finally, a domestic CBDC might be an enabler of better cross-border payments in the future.

CBDC would also introduce important policy challenges and risks that need to be carefully considered and managed. If signiflcant deposit balances are moved from commercial banks into CBDC, it could have implications for the balance sheets of commercial banks and the Bank of England, the amount of credit provided by banks to the wider economy, and how the Bank implements monetary policy and supports flnancial stability. Nonetheless, CBDC can be designed in ways that would help mitigate these risks.

This paper outlines an illustrative 'platform' model of CBDC designed to enable households and businesses to make payments and store value. This is not a blueprint for CBDC, nor does it approach a decision to introduce one. Rather, it is intended to illustrate the key issues as a basis for further discussion and exploration of the

(1) Central Bank group to assess potential cases for central bank digital currencies, Bank of England Press release, January 2020.
(2) Reserves can be held at the Bank of England by banks, building societies, PRA-supervised broker-dealers, and central counterparties (CCPs). In addition, some non-bank Payment Service Providers and other Financial Market Infrastructures hold settlement accounts at the Bank of England.

opportunities and challenges that CBDC could pose for payments, the Bank's objectives for monetary and flnancial stability, and the wider economy.

In the 'platform' model, the Bank of England would provide a fast, highly secure and resilient technology infrastructure, which would sit alongside the Bank's RTGS service, and provide the minimum necessary functionality for CBDC payments. This could serve as the platform to which private sector *Payment Interface Providers* would connect in order to provide customer-facing CBDC payment services. Payment Interface Providers could also build 'overlay services' — additional functionality that is not part of the Bank's core infrastructure, but which might be provided as a value-added service for some or all of their users. As well as providing more advanced functionality, these services might meet future payment needs by enabling programmable money, smart contracts and micropayments. Payment Interface Providers would be subject to appropriate regulation and supervision in line with any risks they might pose.

Choices around technology would have a major impact on the extent to which CBDC meets our overall objectives. Although CBDC is often associated with Distributed Ledger Technology (DLT), we do not presume any CBDC must be built using DLT, and there is no inherent reason it could not be built using more conventional centralised technology. However, DLT does include some potentially useful innovations, which may be helpful when considering the design of CBDC. For example, elements of decentralisation might enhance resilience and availability, and the use of smart contract technology may enable the development of programmable money. However, adoption of these features would also come with challenges and trade-offs that must be carefully considered.

The purpose of this discussion paper is to begin a dialogue on the appropriate design of CBDC and an evaluation of whether the beneflts of CBDC outweigh the risks. **Given the wide-ranging implications of CBDC for the Bank's objectives and the wider economy, any eventual decision to introduce a CBDC would involve Her Majesty's Government, Parliament and regulatory authorities, and engagement with society more generally**. We invite feedback and ideas from the public, technology providers, the payments industry, flnancial institutions, academics and other central banks and public authorities, and have outlined our key questions for further research in the flnal chapter.

How to respond

Written responses to any of the questions outlined in Chapter 7, or any other relevant observations, are requested by 12 June 2020.

Please address any comments or enquiries to:
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Threadneedle Street
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1 Our approach to CBDC

Key points

- At the moment, the public can hold central bank money in the form of banknotes, but only banks and certain other flnancial institutions can hold electronic central bank money, in the form of central bank reserves. A Central Bank Digital Currency (CBDC) would be an electronic form of central bank money that could be more widely used by households and businesses to make payments and store value. CBDC is sometimes thought of as equivalent to a digital banknote, although in practice it may have other features that will depend on its flnal design.
- The Bank of England's primary objectives are to maintain monetary and flnancial stability. CBDC should be designed in a way that supports those objectives.
- To develop the illustrative model of CBDC presented in Chapter 4, we have thought through its economic characteristics (as a new form of central bank money), the functionality and technology used to power a CBDC payment system, and the possible roles of the central bank and private sector in providing parts of the CBDC ecosystem.
- CBDC would provide both a new form of central bank money, and a new payments infrastructure. So it is important to consider how CBDC flts into the wider payments landscape, and how it interacts with and complements other initiatives to improve payments.

1.1 What is CBDC?

At the moment, the public can hold money issued by the Bank of England ('central bank money') in the form of banknotes, but only banks and certain other flnancial institutions[(1)] can hold electronic central bank money, in the form of 'reserves' (**Figure 1.1**). A Central Bank Digital Currency (CBDC) would be an electronic form of central bank money that could be used by households and businesses to make payments and store value. This wider access to central bank money could create new opportunities for payments and the way the Bank maintains monetary and flnancial stability.

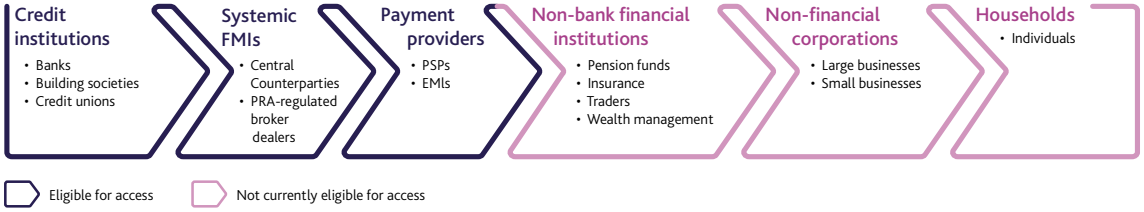
Earlier research has explored how CBDC could provide improved settlement and payments in flnancial markets — this is known as 'wholesale CBDC'.[(2)(3)] However, in this paper we focus exclusively on 'retail CBDC' which would be designed to meet the payments needs of households and businesses outside the flnancial sector. A retail CBDC

(1) Reserves can be held at the Bank of England by banks, building societies, PRA-supervised broker-dealers and Central Counterparties (CCPs). In addition, some non-bank Payment Service Providers and other Financial Market Infrastructures hold settlement accounts at the Bank of England. For further detail see www.bankofengland.co.uk/markets/bank-of-england-market-operations-guide.

(2) Payments can be broadly split into 'retail' versus 'wholesale', and domestic versus cross-border. 'Retail' in a payments context refers to all payments that involve households and/or small or medium-sized businesses (not just those in a 'retail' or e-commerce context). Wholesale payments are those made between flnancial institutions (eg banks, pension funds, insurance companies) and/or large (often multinational) corporations. (Financial institutions can also make 'retail' payments to households and businesses, for example collecting insurance premiums or paying staff.) However, there is no legal distinction between wholesale and retail payments.

(3) As explored by, for example Project Jasper–Ubin (Monetary Authority of Singapore, Bank of Canada and J.P. Morgan (2019)). See also OMFIF and IBM (2018).

Figure 1.1 Stylised continuum of access to electronic central bank money[a]



(a) Subject to meeting certain criteria — see footnote (1) on page 7.

would be a new form of money that would exist alongside cash and bank deposits (see Box 1), rather than replacing them. A CBDC would be denominated in pounds sterling, just like banknotes, so £10 of CBDC would always be worth the same as a £10 note. CBDC is sometimes thought of as equivalent to a digital banknote, although in practice it may have other features that will depend on its final design.

CBDC would require the creation of *infrastructure* so that it can be used to make payments. This infrastructure includes everything from the database on which CBDC is recorded, through to the applications and point-of-sale devices that are used to initiate payments. CBDC would offer users another way to pay, which might ultimately be faster and more efficient, with new functionality added over time.

Although the term CBDC includes the words 'digital currency', CBDC would be something fundamentally different to 'cryptocurrencies' (or 'cryptoassets'), such as Bitcoin. Many cryptoassets are privately issued and not backed by any central party. They are not considered a currency or money because they do not perform the essential functions of money (see Box 1): they are too volatile to be a reliable store of value, they are not widely accepted as a means of exchange, and they are not used as a unit of account (Carney (2018)). Some privately issued cryptoassets, known as 'stablecoins', aim to overcome these shortcomings and provide stability of value via some form of backing. Depending on the nature of assets backing the 'coin', and how they are held, the stablecoin may be unable to provide stability of value and may come with other risks (as discussed in Chapter 2.4). In contrast, a UK CBDC would be a new risk-free form of (digital) pound sterling, issued by the central bank, and would therefore perform all the essential functions of money.

However, the technological innovations that made cryptoassets possible have evolved into a broad group of technologies often referred to as Distributed Ledger Technology (DLT). While we do not presume CBDC must be built using DLT (and there is no reason CBDC could not be built using centralised technology), some of the individual component innovations of DLT may be useful when applied to CBDC (these are discussed in Chapter 6).

1.2 Our approach to designing CBDC

This paper uses the following approach to structure our thinking and design principles around CBDC. In Chapter 4 we present an illustrative model of CBDC that draws on earlier research by staff at the Bank of England[4] and other central banks. This model is intended as a basis for further discussion and research, to illustrate the choices and the impacts, rather than a blueprint for a design. More detailed analysis would be required before the Bank could make a confident decision on whether to introduce CBDC, and if so, in what form.

Step 1: Understand the opportunities and challenges of CBDC: We need to develop a clear understanding of the opportunities that the introduction of CBDC could pose, and the challenges that would need to be managed (see Chapter 2).

Step 2: Set an overall objective that any design of CBDC would need to meet: This overall objective should follow from the Bank's objectives and mandate, taking into account other public policy objectives, and will inform the **design principles** around which CBDC should be designed. Based on the Bank of England's objectives to maintain monetary and financial stability, we consider it essential that any CBDC must meet the design principles of being reliable and resilient, fast and efficient, and open to innovation and competition (see Chapter 3).

(4) For example, see Broadbent (2016), Barrdear and Kumhof (2016), Meaning *et al* (2018), and Kumhof and Noone (2018).

Box 1
How does CBDC compare to other forms of money?

This box discusses the different types of central bank and commercial bank money that are in use today, and how CBDC would compare.

Functions of money

As discussed in McLeay, Radia and Thomas (2014a) money is fundamentally a special kind of IOU (or promise to pay) that performs certain key roles in society, serving as (a) **a store of value** with which to transfer purchasing power from today to the future; (b) **a medium of exchange** with which to make payments for goods and services, and (c) **a unit of account** with which to measure the value of a particular good, service, savings product or loan. These roles function as a hierarchy and reveal that money is, in essence, a social convention (Carney (2018)).

Money must be a reasonable store of value — it should not lose value substantially in the time between receiving and making payments. There are many assets that act to some degree as stores of value, such as houses, but which are not used as a medium of exchange. An asset can only act as a medium of exchange if at least two people are prepared to treat it as a store of value, at least temporarily. It is also generally more efflcient if the medium of exchange in an economy becomes its unit of account — the unit in which goods and services are priced and debts are denominated. This helps the holders of money assess how many goods and services their money can buy at any point and may make it more acceptable to others as a means of payment.(1)

Current forms of money

There are three forms of money that are widely in use and form the core of the UK monetary system. Each of these are denominated in the pound sterling, which is the unit of account of the United Kingdom.

(1) Banknotes: The vast majority of physical currency used in the UK economy is central bank money — banknotes issued by the Bank of England.(2) Most of those notes are held by households and businesses as a means of payment or store of value. But commercial banks also hold some banknotes at their counters and cash machines in order to meet deposit withdrawals. This is to ensure customers can easily convert their bank deposits into central bank money.

As stated in their inscription, banknotes are a 'promise to pay' the holder of the note, on demand, a specifled sum in terms of the unit of account (for example £5). The Bank of England must ensure that the value of goods and services in terms of the sterling unit of account remains stable in order to retain trust in Bank of England notes and the sterling payment system more generally.

(2) Bank Deposits: In today's economy most of the money used by households and businesses is commercial bank money — electronic bank deposit accounts. Deposits are created when banks issue loans McLeay, Radia and Thomas (2014b). Commercial bank deposits are at the heart of the UK monetary system and account for around 97% of the money held by households and businesses. They are a liability of the banking system — banks stand ready to convert those deposits into central bank money in the form of physical cash or to honour payments customers make with those deposits, which will typically involve a transfer of money to a customer in another bank.(3) So unlike central bank money in the form of banknotes, commercial bank money in the form of deposits is not without credit risk. A customer needing to make a payment relies on their bank to have sufflcient assets to enable a cash withdrawal or enable settlement with another bank. An insolvent bank with insufflcient assets will not be able to honour such commitments. In order to minimise these risks, household deposits up to an amount

(1) If UK shops priced items in US dollars, while still accepting payment only in sterling, customers would have to know the sterling-dollar exchange rate every time they wanted to buy something which would require time and effort on the part of the customers. See also Brunner and Meltzer (1971).
(2) Banknotes make up 94% of physical currency, while coins make up just 6%. Of the banknotes that circulate in the UK economy, nearly 10% are issued by Scottish and Northern Irish commercial banks, but those banknotes themselves are backed by Bank of England notes, UK coins, and funds on deposit at the Bank of England (For further details see www.bankofengland.co.uk/banknotes/scottish-and-northern-ireland-banknotes). In many countries, coins are also issued by the central bank, but in the UK coins are produced by The Royal Mint, and are nominally a liability of the government (HM Treasury (2015)).
(3) A household paying for goods on a debit card from a shop is essentially instructing their bank to debit an amount from their account and pay it into the account held by the shop, which may be held at a different bank.

of £85,000 are protected under the Financial Services Compensation Scheme (FSCS). But large deposits in excess of this amount are not insured and subject to credit risk.

A distinction is often made between 'sight' deposits that are largely used for transactions purposes, typically associated with current (checking) accounts that can be accessed immediately, and 'time' deposits that are made for store of value or savings purposes which typically earn more interest if they are not accessed before a certain date or notice period.

(3) Central bank reserves (commercial banks' deposits at the central bank): Just as households and business hold deposits in accounts at commercial banks, those commercial banks themselves hold accounts at the Bank of England. The deposits in these accounts are known as central bank reserves, and are the asset used by banks when they need to make payments to each other. Like banknotes, reserves are central bank liabilities and are risk free. For this reason, reserves are the ultimate settlement asset used by the banking system.

Convertibility

The Bank of England also stands ready to swap reserves for banknotes should the commercial banks need it, for example to ensure there are banknotes in ATMs before Bank Holiday weekends (when demand for cash usually increases). So, underpinning the current sterling monetary system is the principle that both types of central bank money (reserves and banknotes) are directly convertible into one another, and that households and businesses can convert their deposits into central bank money, in the form of physical cash.

How CBDC compares

A CBDC could in principle perform many of the functions currently offered by both cash and bank deposits. However, to be practical and attractive, CBDC would need to be directly convertible into cash and deposits.

CBDC would be equally safe and free of credit risk as physical cash, but could be more convenient as a means of payment for both households and businesses, particularly for electronic and remote payments. So there may be some shift between cash and CBDC.

Compared to bank deposits held by households, which are insured up to £85,000 under the FSCS, a CBDC would be equally safe and have no credit risk, and similar usefulness as a means of payment to an ordinary current account. But it is not clear that households would necessarily want to substitute from deposits to CBDC given that deposits at a commercial bank offer customers other services, including credit facilities, which would not be offered under a CBDC. However, if flrms providing CBDC-related payment services are able to bundle other useful services with a CBDC account, this may prove attractive to some deposit holders. The incentive to substitute away from bank deposits will also depend on whether the CBDC is remunerated or not (discussed in Chapter 5).

Compared to bank deposits that are not covered by the FSCS, CBDC could play a similar role as a means of payment but would have no credit risk. That may make it attractive to some businesses who typically hold unsecured deposits not covered by the FSCS. But again, holding an account at a commercial bank may offer non-flnancial businesses the use of credit facilities and other beneflts that arise from having a long-standing relationship with that bank.

Overall, the introduction of CBDC will lead to some substitution away from existing forms of money. But the scale of substitution and the implications for monetary and flnancial stability will depend very much on functionality, remuneration and other design features (discussed in detail in Chapter 5).

Step 3: Design CBDC. There would be two main elements to any CBDC: (1) the CBDC itself (ie access to a new form of central bank money) and (2) the CBDC *infrastructure* that allows CBDC to be transferred and used for payments. There are three principal aspects of design to consider, and decisions taken in one area will affect choices that need to be made in other areas:

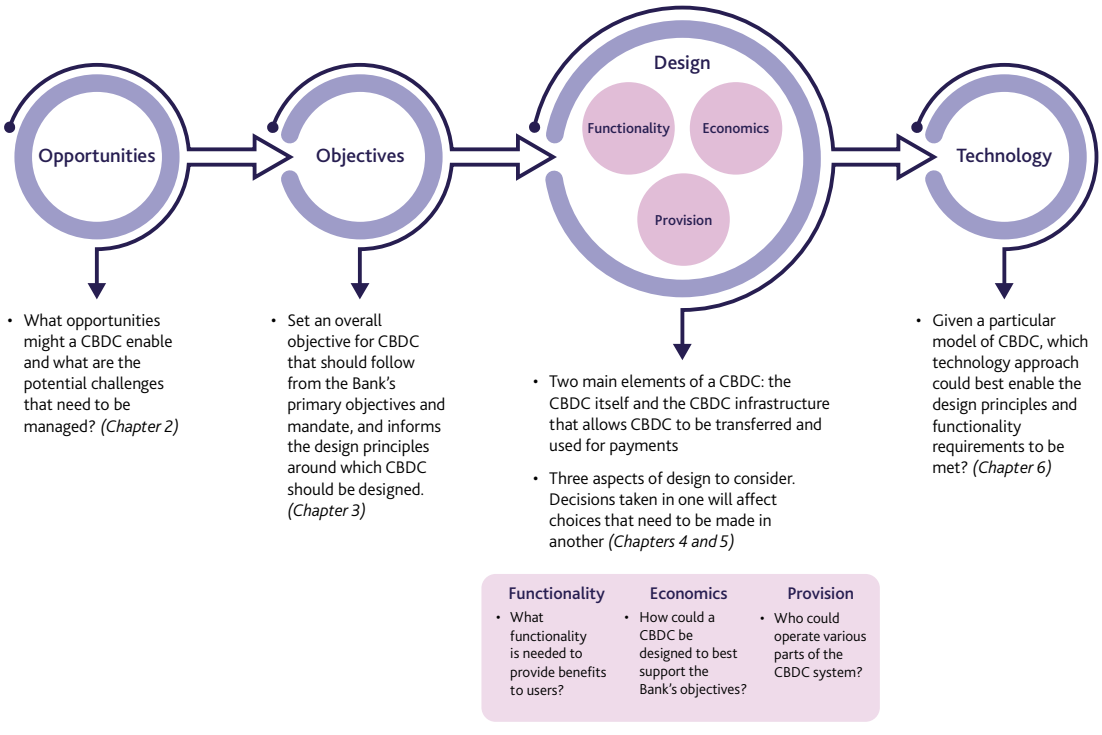
(a) **Provision** concerns choices around *who would do what* in providing CBDC. The responsibilities and functions involved in providing CBDC could be allocated in different ways between the public sector (eg the Bank and other authorities) and the private sector (eg flnancial institutions, payment providers, flntechs and technology flrms). Decisions around provision would have a signiflcant impact on whether CBDC as a whole is resilient, open to competition, interoperable, and designed around the comparative advantages of the private and public sector. There are also signiflcant trade-offs to consider (see Chapter 4.)

(b) **Functional design** is about ensuring that the payments function of CBDC provides a clear beneflt and utility for users. It concerns the types of payments that could be made using CBDC, how users would interact with CBDC, and whether the functionality of CBDC could be extended if payments needs were to change in future. Decisions taken here would have a particular impact on whether CBDC is user-friendly and widely accessible, and on the level of privacy in the system (see Chapter 4).

(c) **Economic design** concerns aspects such as access (who could hold CBDC?), remuneration (should CBDC bear interest?), limits (should there be limits on the amount of CBDC that can be held?), and convertibility (should CBDC be freely convertible for other forms of central bank money, and for bank deposits?). These choices would be particularly important in influencing how CBDC supported the Bank's ability to achieve its mission of maintaining monetary and flnancial stability, and the impact a CBDC would have on other forms of payment and payment systems, and the banking sector (see Chapter 5.)

Step 4: Technology: Given a particular model of CBDC, it is important to assess which technology could best enable the design principles and functionality requirements to be met. We must also think about the technological trade-offs involved between different design principles. Decisions taken here have a particular effect on the extent to which CBDC could be resilient, secure, fast, efflcient, extensible, available and scalable (see Chapter 6). These steps are summarised in **Figure 1.2**.

Figure 1.2 Our approach



1.3 CBDC and the wider payments landscape

CBDC would provide households and businesses with both a new form of money and a new way of making payments, which could exist alongside other forms of money and payment systems, such as physical cash and bank deposits. It is therefore crucial to consider how CBDC might flt into the wider payments landscape, both today and in the future, and whether it could offer additional beneflts that might not be offered by other payment systems or services.

There are many current initiatives to improve payments in the UK and internationally, a number of them being led or overseen by the Bank. Important initiatives include the Bank's own programme to renew its Real-Time Gross Settlement (RTGS) service. This renewal programme will deliver a world-leading service which is flt for the future, through increasing resilience and access, offering wider interoperability, improved user functionality, and strengthened end-to-end risk management of the UK's High-Value Payment System. As part of this initiative the Bank recently expanded access to settlement accounts to non-bank payment service providers and is currently considering whether to provide these flrms with the ability to hold deposits at the Bank overnight. The Bank is also part of the Joint Authorities Cash Strategy Group, which seeks to ensure cash will continue to be accessible, and is contributing to HM Treasury's review of challenges and opportunities from innovation in the payments landscape. Finally, the planned development, by Pay.UK, of the New Payments Architecture for UK retail payments, aims to further enhance the resilience and speed of UK payments. These initiatives are described in detail in the appendix.

The Bank will continue to support these initiatives, recognising the signiflcant beneflts they should provide for UK payments. Our work on CBDC aims to help us understand whether, and how, CBDC could interact with RTGS renewal and these initiatives, and whether CBDC could provide additional beneflts, contributing to a diverse and resilient payment system. As part of this ongoing analysis, the Bank will also consider if the beneflts offered by CBDC could be achieved in other ways, for example by changing policies to support innovation in existing payments systems or to address market failures. In addition, some issues in payments might also be the result of co-ordination problems, where the Bank can play a role in resolving coordination failures rather than building new infrastructure itself.

2 Opportunities for CBDC to support the Bank's objectives

Key points

- CBDC offers a number of opportunities for the way that the Bank of England achieves its objectives of maintaining monetary and flnancial stability.
- CBDC could increase the availability and usability of central bank money, helping to support monetary policy and flnancial stability, and could help to avoid the risks of new forms of private money creation, such as stablecoins. It could support a resilient, innovative and competitive payments landscape, helping to meet future payments needs. It could also help to address the consequences of a decline in the use of cash.(1) Finally, a domestic CBDC could be a means to deliver better cross-border payments in the future.
- Each of these opportunities also comes with implications and challenges that would need to be carefully considered. Depending on its design, CBDC could impact the structure of the banking system (as discussed in detail in Chapter 5) and the way that the Bank achieves its objectives.

2.1 Overview

As set by Parliament, the Bank of England's objectives are to maintain monetary and flnancial stability. CBDC would be an innovation in both the form of money provided to the public, and the payments infrastructure on which payments can be made, and so could have wide-ranging opportunities and implications for both monetary and flnancial stability. The Bank therefore needs to consider both the opportunities and challenges that CBDC presents for the way we achieve our objectives.(2)

This chapter considers seven ways in which CBDC could support the Bank's objectives to maintain monetary and flnancial stability, through the provision of a new form of money and a new payments infrastructure:

- Supporting a resilient payments landscape.
- Avoiding the risks of new forms of private money creation.
- Supporting competition, efflciency and innovation in payments.
- Meeting future payment needs in a digital economy.
- Improving the availability and usability of central bank money.
- Addressing the consequences of a decline in cash.
- As an enabler for better cross-border payments.

These opportunities may also support the government's wider economic policy.

(1) By cash we mean physical banknotes (issued by the central bank) and coins. In the UK coins are issued by the Royal Mint on behalf of HM Treasury, and so are not technically central bank money. In most countries, both coins and banknotes are issued by the central bank.
(2) Motivations for CBDC vary depending on the different conditions in different countries; we have focused on the UK context while recognising that other authorities may be pursuing slightly different goals through their CBDC programmes.

2.2 How the Bank currently achieves its objectives

As described in Chapter 1.1, the Bank of England issues the safest and most trusted forms of money in the UK:

- Commercial banks and selected flnancial institutions hold electronic central bank money in their accounts in the Real-Time Gross Settlement (RTGS) service at the Bank. These balances are known as 'reserves' or 'settlement' balances. Reserves are used to implement monetary policy, and to move money in real time between flnancial institutions, delivering flnal and risk-free settlement. This RTGS service forms the backbone of every electronic payment in the UK.

- The Bank provides banknotes to households and businesses for use as a means of payment and store of value that is free of credit risk. Banknotes can provide an anchor of confldence in the banking system, as households and businesses know that they can convert deposits to central bank money, supporting flnancial stability.(3)

We use reserves to implement monetary policy, supporting monetary stability. We vary the interest rate paid on reserves to influence the interest rates offered and charged by banks, which has an effect on spending and inflation in the economy. This helps to keep the value of money broadly stable in terms of the amount of goods and services it can buy. Reserves also help us meet our flnancial stability objective, by allowing us to provide the highest quality liquidity to the flnancial system, in good times and in bad. This liquidity helps flrms to settle payments in a timely manner, and to guard against unexpected liquidity demands.

In providing electronic money to banks and selected flnancial institutions, and banknotes to the public, the Bank supports all types of payments in the economy. This ensures that we have stable and resilient payment systems and underpins the Bank of England's primary objectives for monetary and flnancial stability.

However, by volume, the majority of payments made today by households and businesses are not made in cash or reserves, but by transfers of bank deposits through retail interbank payment systems and card networks. Disruption to payment systems can pose risks to flnancial stability, and so the Bank has responsibility for ensuring that systemically important payment systems are stable and resilient, and that people and businesses can make the critical payments upon which they rely. This is why the Bank's Financial Policy Committee (FPC) — the body charged with safeguarding flnancial stability in the United Kingdom — considers the provision of payment and settlement services as one of the vital functions that the flnancial system as a whole performs in our economy.(4) Furthermore, the Bank is responsible for protecting and enhancing the stability of the flnancial system, including banks. This secures the monetary stability of deposits *vis-à-vis* central bank money.

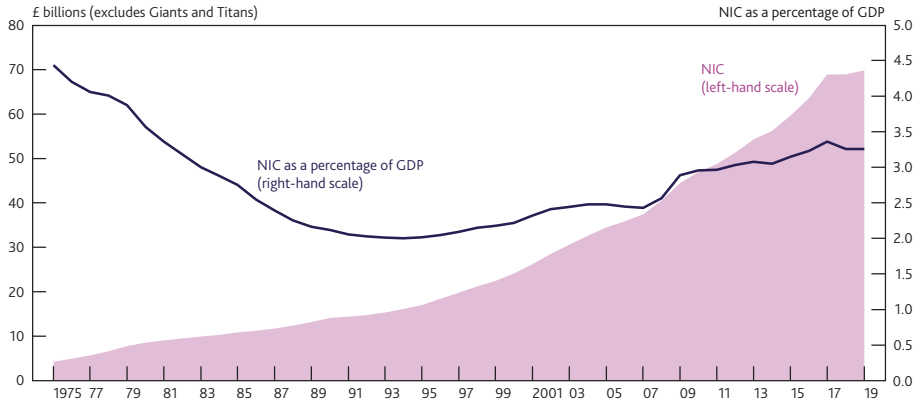
The Bank is also committed to supporting wider innovation and improvements in payments. One reason for this is that better payments can boost economic activity,(5) supporting the government's wider economic objectives.

2.3 The changing payments landscape

The way we pay is changing. For over 300 years, banknotes have been the only way in which households and non-bank businesses can directly use central bank money to make payments. However, although the total value of banknotes in the economy remains near an all-time high (**Chart 2.1**), people are making fewer payments in cash. Whereas 60% of payments (by volume) were made using banknotes in 2008, this fell to 28% of payments by 2018 (**Chart 2.2**), and is predicted to fall to just 9% of payments by 2028 (UK Finance, (2019)). Countries like Sweden and Norway are further along in this trend: in Sweden, over half of retailers expect to stop accepting cash payments by 2025 (Erlandsson and Guibourg (2018)).

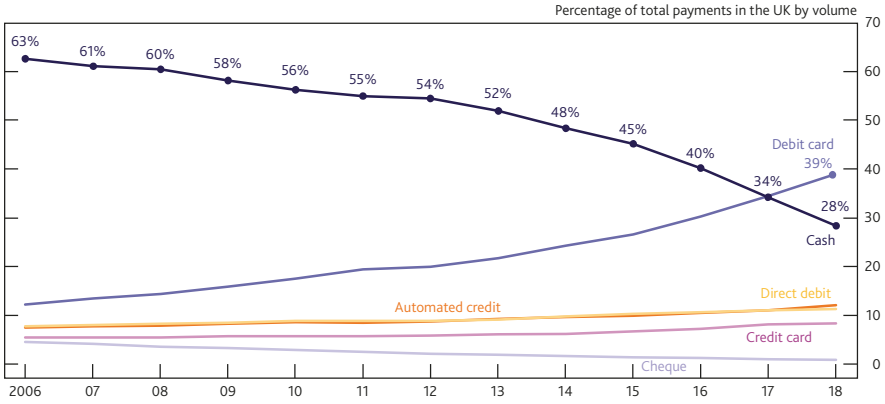
(3) This is a motivating factor for the Riksbank's e-krona project (Sveriges Riksbank (2018).
(4) The FPC's response to HM Treasury's annual remit letter states 'the purpose of preserving stability is to contribute to avoiding serious interruptions in the vital functions which the flnancial system as a whole performs in our economy: notably, the provision of payment and settlement services…'.
(5) See, for example, Hasan, De Renzis and Schmiedel (2013).

Chart 2.1 UK notes in circulation (NIC)



Source: Bank of England.

Chart 2.2 Decline of cash as a means of payment



Source: UK Finance 2019.

This decline in the use of cash as a means of payment means that the majority of payments in the UK are now made by transfers of bank deposits through retail payment systems, such as Faster Payments, Bacs, Cheque Imaging, and credit or debit cards. Most payments that were previously made in cash are now made by card (debit and credit); nearly half of all payments were made with credit and debit cards in 2018 (UK Finance (2019)).

New forms of money and payments are also emerging, such as stablecoins (cryptoassets[6] whose value is linked to another asset). Whereas existing payment systems transfer value that is created by other entities — central banks or commercial banks — stablecoins propose to *create* the digital tokens which aim to represent and store value, as well as the platform on which those tokens can be transferred. As discussed below, this creation of money-like instruments poses potential risks that go beyond those usually associated with existing payment systems (Bank of England (2019b)).

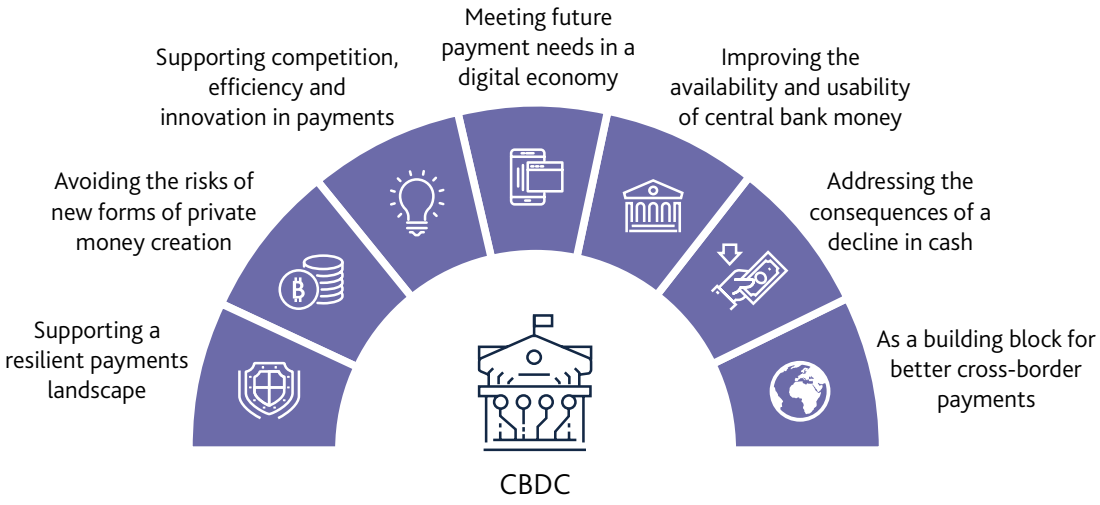
The changing nature of money and payments is critical to the Bank. Central bank money in the form of banknotes and reserves are central to our ability to achieve monetary and flnancial stability today. Therefore, as people's use of money and payments evolves, and different forms of privately issued money increasingly dominate the payments landscape, it is appropriate for the Bank (along with other central banks) to consider whether it should issue a new form of central bank money to households and businesses. CBDC, as a new form of publicly issued central bank money, could complement privately issued money and could enhance the Bank's ability to achieve its objectives in the future.

(6) The Financial Stability Board (FSB) deflnes cryptoassets as 'a type of private asset that depends primarily on cryptography and distributed ledger or similar technology as part of their perceived or inherent value'.

2.4 Opportunities for CBDC to support monetary and financial stability

There are a number of ways in which CBDC could support the Bank's objectives to maintain monetary and financial stability, through the provision of a new form of money and a new payments infrastructure. These are summarised in **Figure 2.1**.

Figure 2.1 Opportunities for CBDC to support monetary and financial stability



Supporting a resilient payment landscape

UK electronic payment systems are already highly resilient and secure. However, the continued shift from cash to electronic payments increases the reliance on electronic payment systems, which has implications for the diversity and resilience of the payments landscape. Cards and cash are typically the only two options for point-of-sale transactions, with cards usually the only option for e-commerce.(7) Consequently, the operational resilience of the cards network is increasingly critical, and this increasing reliance on a single electronic payment method could reduce the resilience of the payments landscape.

Cash currently provides a useful contingency to electronic payment systems in the event there is disruption to card payment networks. However, as the use of cash in payments declines, the ability to use it as a contingency payment system will also decline.

CBDC could therefore enhance financial stability by contributing to resilience in payments and providing some core payment services outside of the commercial banking system. By providing a new way to make payments, it could diversify the range of payment options, particularly for e-commerce (where cash cannot be used). It is less likely that both card networks and a CBDC network would suffer outages at the same time, and so CBDC could serve as a substitute. CBDC must be designed from the ground up to be as resilient as possible, for example this might include applying some aspects of decentralisation (discussed in Chapter 6.3) to enhance operational resilience, and avoiding reliance on legacy systems. The structure of the CBDC ecosystem could also be designed to avoid some of the vulnerabilities in payment systems that have evolved over time, complementing ongoing work to enhance resilience in existing payment systems. However, CBDC would still be vulnerable to a large-scale outage of electricity and data networks, unless some kind of offline payments functionality is developed (discussed in Chapter 4.3). In addition, CBDC would only serve as a useful contingency if, at the time of any outage, people already held CBDC and knew how to make CBDC payments, and it was widely accepted by merchants.

(7) Although the UK has Faster Payments which allows users to instantly transfer a deposit between the buyer and seller's bank accounts, there is no retail interface that allows this infrastructure to be used at the 'bricks and mortar' or online point of sale (unlike in other countries) that has any meaningful level of adoption by banks and merchants.

The introduction of CBDC would also pose some risks to payments. A very successful CBDC could displace existing payment systems and ultimately *reduce* diversity of payment options, creating a new form of concentration risk. The prospect of the introduction of CBDC could potentially discourage innovation in existing payment systems, potentially delaying other initiatives that could enhance resilience, speed and efflciency. These risks would need to be carefully managed.

Avoiding the risks of new forms of private money creation

Existing payment systems transfer money that has been created either by the Bank of England or by commercial banks (see Box 1). While the commercial bank money used in existing payment systems is not risk free — for example, commercial banks can, and do, fail — the Bank's prudential regulation and supervision helps to ensure that these failures happen rarely and in an orderly way, and deposit insurance protects households in the event of a failure. Consequently, users of existing payment systems can have conflдence that the money they send will reliably retain its value, both while it is being used to make a payment, and while it is being held over time.

This safety and conflдence may not exist to the same degree for new payment systems that have been proposed by a number of flrms, including new entrants and existing technology companies. These proposed payment systems include cryptoassets known as 'stablecoins' intended for use in transactions currently processed by retail or wholesale payment systems. Stablecoins propose to *create* the digital tokens or 'coins' that they transfer. Stablecoins vary widely in their design features, but most seek to provide stability of value via some form of backing. Depending on the nature of assets backing the 'coin', and how they are held, the stablecoin may be unable to provide stability of value and redeemability at par back into commercial or central bank money. Uncertainty about, or large fluctuations in, the value of stablecoins could give rise to similar risks to flnancial stability associated with the operational or flnancial failure of the payment system itself. These could include risks to the users' ability to manage their liquidity or to meet payment obligations, or the risk of such fluctuations causing a collapse in conflдence with potential contagion risks for the system. Stablecoins may also not be interoperable with each other and with other payment systems, creating closed loops and inefflciencies.

Consequently, this creation of private money (or money-like instruments) for transactional purposes poses potential risks that go beyond those usually associated with existing payment systems. This is why the FPC recently outlined its expectations for stablecoins used for payments.[8]

Stablecoins will only be widely adopted if they provide functionality and efflciency beneflts over existing payment systems. But given the risks they could pose, it may be worth asking if CBDC can be designed to better meet those needs. CBDC may be able to provide better payment services, backed by risk-free central bank money, and reduce the demand for new privately issued money-like instruments.

Supporting competition, efflciency and innovation in payments

While the safety and resilience of payment systems is essential, a safe payment system is only beneflcial if people use it. Users therefore need fast, efflcient, user-friendly and inclusive services, and innovation, driven by competition, is important in the payments landscape.

There are opportunities for improvements to address potential market failures in existing payment services. For example, while card payments appear near instantaneous to the user, the merchant can wait up to three days to receive funds. There are signiflcant efforts underway to further improve existing payment systems (detailed in the appendix) but to the extent these initiatives do not fully resolve such issues, a CBDC could possibly help to enhance the speed and efflciency of UK payments. This could be both directly — through offering a fast and efflcient payment service to users — but also indirectly through creating a more competitive payments landscape.

A well-designed, robust, open, CBDC platform could enable a wide range of flrms to compete to offer CBDC-related payment services, and importantly to innovate in the payment services they provide to consumers,

(8) The FPC recently announced that the current regulatory framework may need adjustment in order to accommodate innovation in the payments sector (of which CBDC is one potential example). (*Financial Stability Report*, Bank of England (2019c)). The Bank is also a member of the Cryptoassets Taskforce, which was announced in March 2018 by the Chancellor of the Exchequer as part of the government's FinTech Sector Strategy. The Taskforce consists of HM Treasury, the Financial Conduct Authority and the Bank of England, and is working to develop a response to cryptoassets, stablecoins and distributed ledger technology.

and the ways in which these are integrated into the digital economy. In doing so, the introduction of CBDC could support competition on both cost and quality of payments services.

Increased competition and innovation could have beneflts for the wider economy. Changes in payments behaviour shows that consumers will adopt the methods that are most convenient, such as cards, even though these methods might have a higher cost for businesses. Since payment costs will ultimately be passed on to consumers, there would be net beneflts for consumers and businesses if CBDC were able to provide greater convenience at lower cost.

Meeting future payments needs in a digital economy

The next generation of payments will need to support a more digital economy and allow for seamless connections between different services used by households and businesses. As a new system, CBDC could be designed with this in mind, supporting the wider economy.

For example, CBDC could facilitate 'programmable money' (discussed in Chapter 6.4), by enabling transactions to occur according to certain conditions, rules or events.(9) There will be many potential applications of this functionality, including integration with physical devices or Internet-of-Things (IoT) applications. Examples might include the automatic routing of tax payments to tax authorities at point of sale, shares automatically paying dividends directly to shareholders, or electricity meters paying suppliers directly based on power usage. CBDC might also enable the use of micropayments (payments for very small amounts — discussed in Chapter 4.3) if it allows small transactions to happen at lower cost than happens today. This may increase the volume and frequency of these payments leading to the development of new services that can leverage this capability. This could enable new business models, for things like paying for digital media (eg paying a few pence each time to read individual news articles, rather than needing to sign up to a monthly subscription).

Improving the availability and usability of central bank money

As discussed in Chapter 1.1, currently households and (non-flnancial) businesses are only able to use central bank money in the form of banknotes. CBDC would also enable them to hold central bank money in electronic form, and use it to make payments. This would increase the availability and utility of central bank money, allowing it to be used in a much wider range of situations than physical cash. Central bank money (whether cash, central bank reserves or potentially CBDC) plays a fundamental role in supporting monetary and flnancial stability by acting as a risk-free form of money that provides the ultimate means of settlement for all sterling payments in the economy. This means that the introduction of CBDC could enhance the way the Bank maintains monetary and flnancial stability, through providing a new form of central bank money and a new payments infrastructure. This could have a range of beneflts, including strengthening the pass-through of monetary policy changes to the wider economy (discussed in Chapter 5), and increasing the resilience of the payment system.

This increased availability of central bank money also poses risks. The initial introduction of CBDC is likely to lead to some substitution away from the forms of money currently used by households and businesses (ie cash and bank deposits). If this substitution was very large, it could reduce commercial bank funding, with potentially harmful impacts on the level of credit that banks could provide. Consequently, CBDC needs to be carefully designed to manage the impact on monetary policy and flnancial stability. These considerations are discussed in depth in Chapter 5.

Addressing the consequences of a decline in cash

Physical cash has certain unique characteristics that would be lost if it were to fall out of general use. For example, cash offers a level of privacy in transactions that is not always available with existing electronic payment systems. Cash also has an important role in flnancial inclusion. In a world where cash becomes less widely used, there is no guarantee that the current private sector provision of the retail payment systems may meet the needs of all users, leaving underbanked groups of society particularly at risk (Sveriges Riksbank (2018)).

(9) See Ali and Narula (2019) who describe how this could be used to enable 'atomic cross chain transactions' to reduce counterparty risk and potentially lower transaction costs and improve flnancial stability.

Although privacy and financial inclusion do not fall directly within the Bank's remit, they are important issues for society as a whole, which the Bank must take into account. For example, CBDC could be designed in a way that protects users' privacy to a greater extent than some existing payment systems, subject to being fully compliant with all relevant regulations, particularly anti-money laundering requirements (see Chapter 4.6). A well-designed CBDC may also help to boost financial inclusion in an increasingly digital world by being accessible to a broader range of people, potentially in different formats, than private sector solutions.[10]

Because of these different characteristics, CBDC would not be a perfect substitute for physical cash. As long as demand for cash remains, the Bank is committed to meeting this demand. For those in society who value the physical nature of cash, the introduction of CBDC is unlikely to affect their payment behaviour, and so we consider that CBDC would likely act as a complement to cash rather than a substitute.

As an enabler for better cross-border payments

For many users, cross-border payments are expensive, slow, and opaque (senders may be unable to know when the payment will be settled, and recipients will not know the charges that will be deducted on an incoming credit) (CPMI (2018)).

One recent proposal to address these issues is the creation of stablecoins. If well designed, stablecoins may be able to meet a clear need for better cross-border payments. But they also introduce risks, as highlighted by the FPC (Bank of England (2019b)) and the G7 Working Group on Stablecoins (2019). Consequently, CBDC may offer a safer way to provide better cross-border payments. For example, central banks may be able to work together to link domestic CBDCs in a way that enables fast and efficient cross-border payments. Individual domestic CBDCs could be designed around a common set of standards intended to support interoperability. This might enable 'atomic' transactions between CBDC systems: where the transfer of CBDC in one currency is linked with a transfer of CBDC in another currency, in a way that ensures each transfer occurs if — and only if — the other does.

The Bank is also actively working with other central banks and finance ministries to consider public and private actions to improve the existing cross-border payment system. For example, the Bank is involved in the CPMI's Cross-border Payments Task Force, and will feed into G20 work on enhancing cross-border payments.

(10) Financial inclusion is a prominent argument for CBDC in developing countries where the banking and payments system are underdeveloped. In these countries, the provision of basic accounts and an electronic payment system by the central bank could make a significant difference to financial inclusion. The UK has a relatively high level of financial inclusion, with 98% of adults in possession of a bank account in 2018. (Calculated from figures in McKay, Rowlingson and Overton (2019)).

3 Objectives and design principles

Key points

- Any CBDC payment system would need to be designed with a clear use case in mind. For this paper, we focus on domestic retail payments — payments that involve households and/or small or medium-sized businesses, in sterling, within the UK. Work is taking place elsewhere to address wholesale and cross-border payments.
- Our overall objective for CBDC payments is that households and businesses should be able to make fast, efflcient and reliable payments, and beneflt from a resilient, inclusive, innovative, and competitive payment system. This overall objective sets our design principles, which in turn determine our choices around economic design, functionality, provision and technology.
- An approach to CBDC where the Bank of England does everything, with no private sector involvement, is unlikely to meet most of our design principles. Such a CBDC may be resilient, fast and reliable. But it would not be open to competition, may not support innovation, and would not be designed around the respective strengths of the Bank and private sector. For this reason, and in order to more likely meet these principles, we consider a model which has both central bank and private sector involvement, as presented in Chapter 4.

3.1 Objective for CBDC payments

The Bank's monetary and flnancial stability objectives require that any CBDC payment system would be reliable, resilient and secure. But a safe payment system is only useful if people use it, which means CBDC would also need to enable fast, efflcient, user-friendly and inclusive services. This in turn requires that a CBDC payment system would be open to innovation and competition, and built around the comparative advantage (relative strengths) of the Bank and the private sector. Consequently, for the purpose of this paper we have taken the following broad objective for CBDC payments:

> *Households and businesses should be able to make fast, efficient and reliable payments, and benefit from an inclusive, innovative, competitive and resilient payment system.*

Types of payments in scope

Different users need to make different types of payments, so it would be challenging, if not impossible, to build a single payment method that meets the needs of all users in an optimal way. For example, households making small value payments in shops have different needs to a large corporate paying a company in a different country for an order worth millions of pounds. This is why we have chosen to focus this paper on *retail* CBDC, covering payments which are: domestic (within the UK), retail (made by households and businesses — CBDC 'users') and in one currency (sterling). **Table 3.A** shows the types of payments that would fall within this scope. Our focus on domestic retail payments means that domestic wholesale and all cross-border payments are outside the scope of this paper. However, the Bank is engaged in a range of other initiatives to enhance the functioning of these payment types — see Box 2 overleaf.

Table 3.A Example types of payments in scope

From	To	For	Current payment methods available
Households	Businesses	Goods and services, in shop or online	Cash or debit/credit cards
Households	Businesses	Recurring bills	Direct debit/standing order
Households	Households	Gifts, rent etc.	Cash or faster payments
Businesses	Households	Wages to employees	Faster payments or Bacs
Businesses (small to medium)	Businesses (small to medium)	Goods and services from suppliers	Faster payments or debit/credit cards

Box 2
Types of payments out of scope

Domestic wholesale payments

In the UK these payments are usually handled by CHAPS, the high-value payment system provided by the Bank of England. Users of wholesale payments have very specifiic requirements, such as the need for banks making those payments to manage their liquidity (ie holdings of central bank money) as effiiciently as possible. Improvements in existing high-value payments are being addressed by the Bank's RTGS Renewal Programme, which will rebuild the Real-Time Gross Settlement System that underpins CHAPS and other UK payment systems. This programme will implement a range of enhancements seeking to strengthen resilience and flexibility to respond to emerging threats. This will facilitate greater direct access to central bank money settlement for fiinancial institutions and infrastructures. Furthermore, it will promote harmonisation and convergence with critical domestic and international payment systems.

The Bank is also separately considering how alternative high-value payment systems, which are sometimes described as 'wholesale CBDC', could be supported, and will consult on this shortly.

Cross-border payments (retail and wholesale)

Although CBDCs may ultimately enable new ways to make cross-border payments, this type of payment is signifiicantly more complex than domestic payments. Cross-border payments and payments involving certain jurisdictions may have a higher risk profiile for the purposes of anti-money laundering and sanctions legislation. Additional frictions for cross-border payments include lack of overlap of opening hours of payment systems across the world, liquidity ineffiiciencies, lack of harmonised messaging and different access requirements to payment systems.

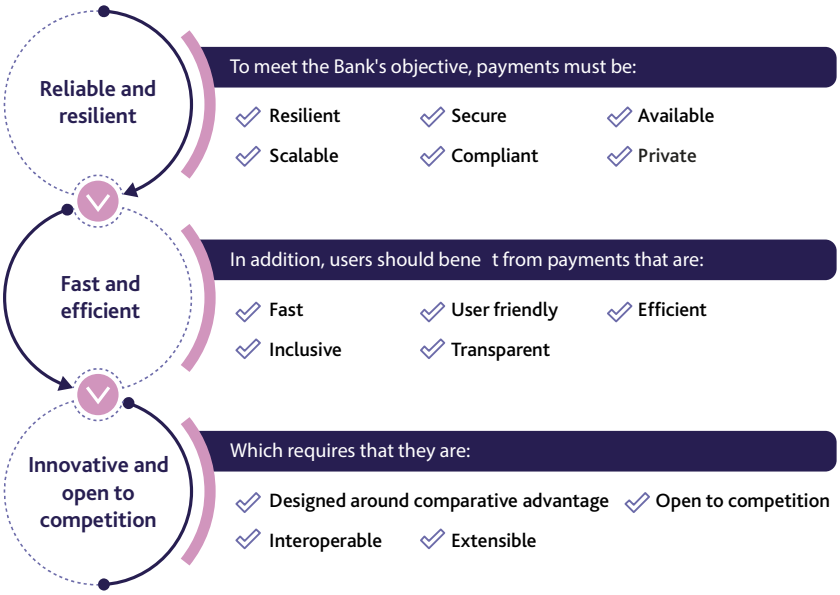
Removing these frictions will require international co-ordination between central banks, commercial banks and other payment providers. Work to improve the existing cross-border payment system is a part of the Bank's Future of Finance initiative,(1) and a key deliverable of the G20 agenda. In co-ordination with the Committee on Payment and Market Infrastructures (CPMI), the Financial Stability Board (FSB) will develop and deliver to the G20 a roadmap for how to enhance global cross-border payments. The Bank is closely involved in both the FSB's work and the CPMI's Cross-Border Payments Task Force.

(1) The Bank has also worked with Bank of Canada and the Monetary Authority of Singapore to explore ways to improve cross-border payments (Bank of Canada *et al* (2019)).

3.2 Design principles

Our overall objective can be split into the following design principles. For each, we have a described an ideal case. However, in the real world there will be trade-offs between different principles, making it impossible to achieve the best outcome for every principle. Consequently, if we were to issue CBDC, we would need to make careful choices about which principles to prioritise, and the optimal trade-offs between them.

Figure 3.1 Design principles for retail payments



Reliable and resilient

The Bank's primary objectives require that any CBDC payment system must be reliable and resilient. This requires that any CBDC should need to be:

- **Resilient:** any CBDC payment system must be able to recover from operational disruption, for example from hardware or software failures. It is also important to minimise any credit and liquidity risk arising in the wider CBDC ecosystem.
- **Secure:** CBDC should follow the highest standards of cyber-security against fraud and cyber-attacks. There would need to be clear policies around who is responsible for redress in the case of fraudulent payments.
- **Available:** CBDC should provide 24/7 payments with no planned downtime.
- **Scalable:** the technology powering CBDC payments should be able to handle increased volumes if demand for CBDC payments increases signiflcantly.
- **Compliant:** CBDC should be compliant with regulations around anti-money laundering (AML), the countering the flnancing of terrorism (CFT), and sanctions.
- **Private:** CBDC should be compatible with the General Data Protection Regulation (GDPR).

Fast and efflcient

This consideration is about ensuring that users beneflt from using CBDC. This means that CBDC payments would need to be:

- **Fast:** the process from the payer (sender) initiating a payment to the payee (recipient) receiving the funds, should complete as quickly as possible, with certainty over completion.

- **User friendly:** users should be able to make a payment intuitively, in the minimum number of steps, with a minimum required level of technical literacy.

- **Efflcient:** the payment should happen in the simplest way, to ensure that the cost of CBDC payments would be as low as possible (subject to the need to ensure the system is resilient and secure).

- **Transparent:** the costs of making payments in CBDC should be clear to all users.

- **Inclusive:** CBDC payment systems should be designed to minimise barriers to use from (a) technical literacy, (b) disabilities, and (c) access to hardware (eg avoiding reliance on latest smartphones) or (d) access to mobile data networks (eg in rural areas).

Innovation and open to competition

This consideration is about ensuring that the CBDC system as a whole remains open to innovation and competition, and evolves with changing user needs. This means that any CBDC would need to be:

- **Designed around comparative advantage:** the structure of a CBDC should build on the Bank and private sector's respective strengths and expertise, so long as it does not compromise resilience, security or confer unfair commercial advantage.

- **Open to competition:** the structure of a CBDC should facilitate a competitive market for providers of CBDC-related payment services. This requires an appropriate regulatory structure that protects consumers while minimising barriers to entry. The design of CBDC should also ensure that there are no structural factors that would lead to a winner take all market dynamic in the provision of CBDC-related services.

- **Interoperable:** CBDC should be designed to avoid creating closed-loop payment systems, in which payments can only be made between users of the same payments provider. Instead, CBDC payments should be interoperable, allowing payments between users of different providers, and between users of CBDC and users of deposit accounts. Furthermore, CBDC should also be designed to interoperate with other countries' CBDC payment systems (to support future cross-border payments in CBDC). CBDC should also avoid tying providers into specifIc technologies or technology providers.

- **Extensible:** it should be possible for private sector innovators to build additional services on top of the CBDC platform, and support innovative use cases that we cannot currently foresee. The design of CBDC should not limit the range of services that can be provided in the future, and recognise that the functionality and infrastructure will need to evolve over time.

3.3 The beneflts of private sector involvement

In one possible CBDC model, the Bank would exclusively provide all CBDC-related services. It would need to provide the entire core technology that records CBDC accounts and transactions. In addition, the Bank would also need to provide all customer-facing services, including the user interface and point-of-sale integrations, so that people could pay with CBDC in shops and online.

However, an approach where the Bank exclusively provides all CBDC-related services is less likely to achieve our overall objectives or meet our design principles than an approach that involves both the Bank and the private sector:

- Exclusive central bank provision would not be open to competition, because there is no role for any participant other than the Bank to provide CBDC-related services.

- This approach may not support innovation, because any new features or functionality would have to be implemented by the Bank. This would also means that this model would not extensible.

- This approach does not play to the Bank's comparative advantage, as it involves building services for large numbers of retail customers rather than for flnancial institutions. Building user-friendly services for the general public is a strength of the UK private sector, which can also build on this experience to ensure they provide inclusive services.

- This approach also raises considerations about privacy, because all data on users' identities and transactions would need to be stored by the Bank.

This approach may be appropriate in countries with low flnancial inclusion, where the private sector is unable or unwilling to provide CBDC-related payments infrastructure or services. But we do not think this model would be appropriate for a country like the UK, with a high level of flnancial inclusion and an innovative private payments sector. Therefore, we will not further develop this model of CBDC, where the Bank exclusively provides all CBDC-related services, in this paper.

4 A platform model of CBDC

Key points

- Based on our design principles, we have set out an illustrative CBDC model as a basis for further discussion and research.
- In this model, CBDC would serve as a payments platform on which the private sector could innovate. The are two key elements of the platform: (1) a core ledger, provided by the Bank, would record CBDC and process payments, and (2) private sector 'Payment Interface Providers' would handle the interaction with end-users of CBDC and provide additional payments functionality through overlay services.
- Payment Interface Providers would need to meet criteria set by the Bank and relevant regulators before they start to offer CBDC-related services. Furthermore, they should be supervised on an ongoing basis, in order to ensure consumer protection and the resilience of the CBDC system. The CBDC system as whole would be designed to be compliant with anti-money laundering and data protection regulations.
- This platform model has the potential to meet many of our design principles, depending on its flnal design.

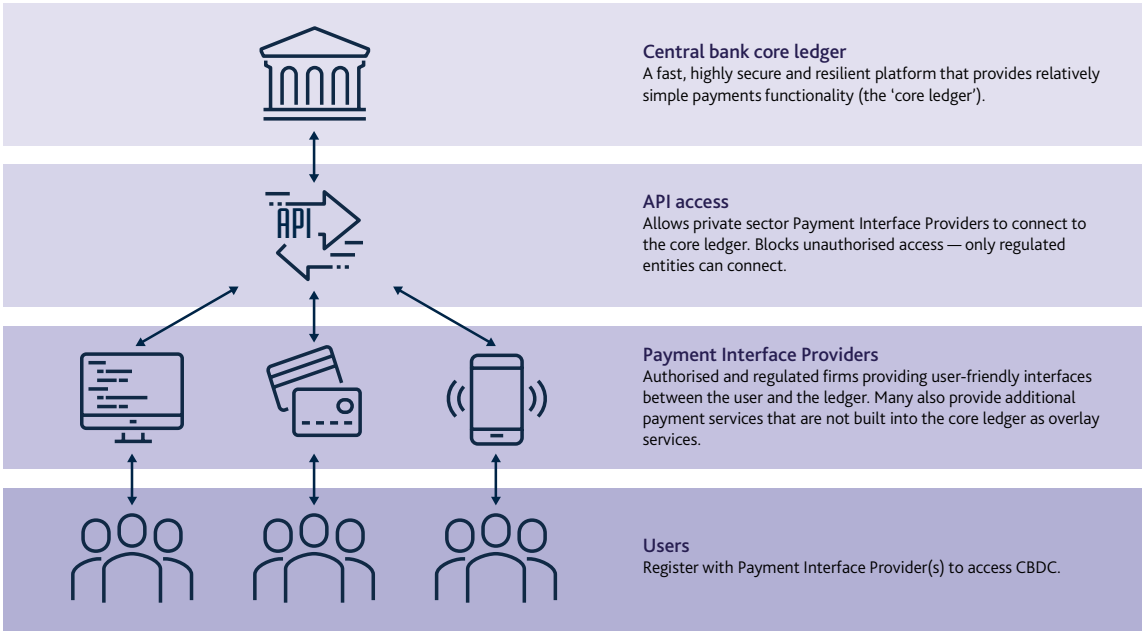
4.1 Overview

There would be two main elements to any CBDC: (1) the CBDC itself (ie access to a new form of central bank money) and (2) the CBDC infrastructure that allows CBDC to be transferred and used for payments. This chapter focuses on infrastructure, and presents a hypothetical model of CBDC as a public-private payment *platform*. This model has been built around the design principles we outlined in Chapter 3, and is intended as a basis for further discussion and research, rather than a proposal for a CBDC. Outlining an illustrative model helps us explore the practicalities, opportunities and implications of introducing CBDC, and allows us to evaluate at a high level how well a particular design of CBDC might meet our objectives. The model will also provoke discussion by stakeholders of the beneflts, challenges and design choices involved.

In this *platform* model (**Figure 4.1**), the Bank would build a *fast*, highly *secure* and *resilient* technology platform — the '*core ledger*' — which would provide the minimum necessary functionality for CBDC payments. This would serve as the platform on which private sector flrms, called *Payment Interface Providers*,(1) could connect in order to provide customer-facing CBDC payment services. These flrms might also build '*overlay services*' — additional functionality that is not part of the Bank's core ledger, but which could be provided as a value-added service for some, or all, of their users. The Bank could impose *standards* for these overlay services, alongside wider regulation, to ensure that they were secure, resilient and interoperable with the wider CBDC payment system. The Bank would otherwise allow the private sector to innovate payment services for speciflc use cases.

(1) The term *Payment Interface Provider* is not intended to have the same meaning as a 'Payment Initiation Service Provider' under the Payment Services Directive 2015. Further engagement would need to be undertaken on the regulatory classiflcation of flrms participating in a CBDC system. Regulatory considerations are covered in Chapter 4.5.

Figure 4.1 Platform model of CBDC



This 'layered architecture' approach to technology infrastructure is becoming a common approach in payments, as it can help facilitate competition, innovation and extensibility. Similar approaches have been taken by the New Payments Platform in Australia, Payments Canada's Modernization programme, and it is also the model proposed in Pay.UK's New Payments Architecture Programme in the UK (see appendix).

There are complex considerations in each area of CBDC design, and many open questions that require further research. The platform model is not the only way that CBDC could be structured, so we may choose to explore other models in the future.

4.2 Key components

(a) Central bank core ledger

The centre of the CBDC payment system would be a *core ledger* (database) that records CBDC value itself, and processes the payments (transactions) made using CBDC. In this illustrative model, the functionality of the core ledger could be limited to the essential features required to enable CBDC payments. For example, it could provide push payments ie payments initiated by the payer (sender) and the ability to query latest balances or transaction history. Limiting the range of functionality to the essential features could make it easier to build a system that is simple, fast and resilient, and could allow most of the innovation in CBDC payment functionality to happen in the private sector through overlay services (discussed below).

In this model, the core ledger would be accompanied by an *API* (Application Programming Interface) to allow third-party Payment Interface Providers to securely send payment instructions and ask for updates from the ledger. To ensure resilience, security and integrity, only entities approved by the Bank, such as Payment Interface Providers,(2) would be able to connect to the core ledger (See also Chapter 6).

Although the Bank could operate the core ledger itself, there is also the possibility of distributing or decentralising aspects of the maintenance of the ledger and processing of transactions. Chapter 6 considers the technology beneflts, costs and trade-offs involved in adding degrees of distribution and decentralisation to a CBDC payment system. Whatever technology approach is used, it is essential that only the Bank can 'create' or 'destroy' CBDC.

(2) Regulatory considerations are explored in Chapter 4.5.

(b) Payment Interface Providers

In the platform model, *Payment Interface Providers* would be private sector flrms that would manage all the interaction with users of CBDC and provide overlay services that extend the functionality of CBDC. In practical terms, they could:

- Provide a user-friendly interface, such as a mobile application or website, to allow the user to initiate payments and manage their CBDC.
- Apply Know Your Customer checks to verify the identity of users (or commission a third-party service to do this).
- Register one or more accounts for the user in the core ledger. This account could be pseudonymous on the core ledger, meaning that the core ledger would not need to record identity information. However, the Payment Interface Provider would record the identity of the user on its own systems, and would know which pseudonymous account(s) the user holds at the Bank.
- Authenticate the user when they initiate payments, to protect them against fraud (eg if the user's phone has been stolen), protect their personal data and ensure cyber-resilience.
- Apply anti-money laundering and sanctions checks to relevant payments (or commission a third-party service to do this).
- Develop overlay services (see below) to provide additional functionality.
- Some Payment Interface Providers might also want to provide 'merchant services' to enable retailers and businesses to take CBDC payments from consumers.

In the basic model above, Payment Interface Providers would maintain an individual account in the core ledger for every user. Payments between users would be processed through the core ledger even if both users have the same Payment Interface Provider. An alternative model could be for each Payment Interface Provider to maintain a single 'pooled' account in the ledger, which holds all of their users' CBDC. The Payment Interface Provider would record how the funds in the pooled account are divided between its users. Payments between two users of the same Payment Interface Provider could then be processed within the Payment Interface Provider's own systems, rather than through the core ledger. However, payments between a user of the Payment Interface Provider and any other Payment Interface Provider would still need to go through the core ledger.

Although some Payment Interface Providers would be payments-focused flrms, other types of flrms may also want to provide CBDC-related services, if this enhances the service they provide, makes their services more 'sticky', or serves as a loss-leader to attract customers for other services. For example, websites that provide marketplaces for retailers may be able to integrate CBDC payments for those retailers. Some online accounting platforms for businesses may want to become Payment Interface Providers, as they could monitor incoming payments, reconcile them into the flrm's flnancial accounts, and also initiate outgoing payments for invoices and salary payments.

(c) Overlay services

By design, the core ledger would have relatively simple functionality in this model, but Payment Interface Providers could develop 'overlay' services to provide additional functionality. This means that Payment Interface Providers could build new services, for example, those that are only needed by a subset of users, or which meet new use cases that emerge in the future (as discussed below). The standards and expectations set by the Bank and relevant regulators could be important here to ensure that overlay services are secure, resilient, open to competition, interoperable, and meet society's expectations of conflldence and trust in money.

New use cases will emerge that we cannot foresee. Therefore, it is important to ensure the core ledger provided the minimum functionality or building blocks to enable Payment Interface Providers to develop new services. Furthermore, it is important that the system as a whole was extensible and open to innovation.

4.3 CBDC payments functionality

In this model, all CBDC payments would be settled immediately ('real time') in central bank money. Payments would be settled 'gross'.[3] This means that CBDC would provide flnality of settlement: when the payment is made, it is settled immediately. The money would then belong to the recipient and the payment would be irrevocable (although returns and refunds could of course be made by initiating a payment in the opposite direction).

Basic payments

The core ledger could provide the basic functionality for one-off 'push' payments, where the payment is initiated by the payer, via their Payment Interface Provider. Payment Interface Providers could then develop the full range of payment types as overlay services. For example, these could include push payments (initiated by the payer), pull payments (initiated by the payee) and recurring payments.

Point-of-sale payments for businesses

Some Payment Interface Providers might want to provide merchant services that allow businesses to accept CBDC payments, either in person at the point-of-sale (PoS) or remotely (ie on a website). For shops and in-person sales, many traditional cash registers have been replaced by newer PoS devices that feature the ability to integrate new payment services. CBDC would need to be designed to be compatible with these PoS systems. For smaller businesses with older or more basic tills, even a low-end smartphone should serve as a terminal to accept CBDC payments.

Offline payments

Most CBDC payments would need to connect to the core ledger, which means that there would need to be a working data connection between the payer, payee and core ledger. This may not always be possible. For example, mobile data connections may be weak or non-existent in some instances. This would limit the usability and usefulness of CBDC, and so there may need to be a simple way for payments to be made, without immediate 'online' reference to the core ledger. The challenge is flnding a way to enable offline payments without exposing either the buyer, seller, or Bank of England to the risk that the payment may not ultimately be settled. Another challenge is to build offline payments functionality in a way that it cannot be abused by fraudsters.

Existing card payments already allow some 'offline' payments, where the card terminal does not (or cannot) connect for an authorisation, for example when using contactless cards to pay for a journey on the transport network.[4] But these payments require the merchant to bear the risk that the payer does not actually have the necessary funds to fulfll the transaction, and so these payments are generally only allowed below a certain value limit. Work is underway in some central banks and in the private sector to flnd solutions that allow this kind of offline device-to-device payments in CBDC in a way that does not create any credit risk, but this technology is still very experimental.

Bulk payments

Large companies often need to send (or request) multiple payments at the same time, for example making payroll payments to hundreds or thousands of employees, or requesting bill payments from thousands or even millions of customers. These bulk payments are not usually time critical, although they may need to be made within a certain window (eg midnight and 6am on pay day). It may be beneflcial to incentivise Payment Interface Providers to

(3) Most retail payment systems use a settlement model known as 'deferred net settlement' (DNS), where the underlying settlement obligations between customers of different payment providers are netted against each other. This creates net obligations between banks, which are settled by larger payments in central bank money. This model signiflcantly reduces the amount of funds that must be transferred between the payment providers. However, it only reduces liquidity needs when there are a large number of offsetting payments between a small number of participants. In a CBDC context, there are a large number of participants, with each participant making relatively few payments, and few of those payments can be offset against payments coming in the opposite direction. Consequently, this model is not applicable to CBDC.

(4) Processing Card Transactions, The UK Cards Association.

queue these types of bulk payments and send them when they know the core ledger will be signiflcantly below peak demand for 'immediate' payments.

Micropayments

CBDC could enable micropayments — payments for very small amounts — supporting the development of Internet-of-Things (IoT) applications, which connect networks of physical devices, like smartphones, vehicles, homes, and home appliances. Micropayments could also support alternative revenue models for digital media (for example shifting away from current subscription and ad-supported models). This is particularly the case as, for many existing payment systems, the cost to process a micropayment may be greater than the value of the payment itself.

Programmability

As discussed in Chapter 2.4, CBDC might facilitate 'programmable money', where payments occur according to specifled conditions, rules or events. This programmability could be implemented via the use of 'smart contracts', which are discussed in Chapter 6.4. This functionality could also enable 'atomic' transactions, where the transfer of CBDC with another asset is linked in such a way as to ensure that the transfer of CBDC occurs if and only if the transfer of the other asset also occurs. If multiple different national CBDCs existed, the other asset might be a CBDC transaction in another currency, enabling Payment-versus-Payment (PvP) for cross-currency transactions. Or the other asset could be a physical or flnancial asset (eg a parcel, or a security), enabling Delivery-versus-Payment (DvP).

4.4 Incentives for private sector involvement

In Chapter 3.3 we concluded that a model which relied exclusively on the Bank to provide all CBDC-related services would be unlikely to meet most of our design principles. This means that there would need to be a signiflcant role for the private sector, and incentives for private sector operators to undertake the services described above. These flrms would need to ensure that they had viable opportunities to develop value-add services and generate revenues from functions beyond those offered by the core ledger.

The Bank would also incur costs in building and running the core ledger, and these would need to be recovered, possibly by small transaction fees charged to Payment Interface Providers. The Payment Interface Providers themselves would incur costs in getting established and building and maintaining their own systems, applications and so on.

It is not for central banks to decide the revenue model for private sector flrms, but some possibilities are demonstrated by existing payment service providers. Firms could generate revenue directly from providing CBDC payment services, for example by charging transaction fees or monthly account fees. Some flrms might seek to provide CBDC-related services at cost or even as loss leader if it reduces third party payment costs in their core business, attracts new customers, enhances the usefulness of other products they offer or has synergies with their wider business model. In all cases, the way that Payment Interface Providers charge — or otherwise generate revenue on the services they provide — should be transparent to users.

4.5 Regulatory framework

To ensure flnancial stability, the Bank of England regulates and supervises systemically important payment systems (the core infrastructure that undertakes the activities of authorisation, clearing and settlement) and designated critical providers to them. In addition, to ensure consumer protection and resilience, payment service providers are subject to regulation by the Financial Conduct Authority (FCA). The Payment Systems Regulator (PSR) is the economic regulator for the payment systems and their participants in the UK. The Bank of England's Financial Policy Committee (FPC) has recently announced that the current regulatory framework may need adjustment in order to accommodate innovation in the payments sector (of which CBDC is one potential example). The FPC outlined three principles that payments regulation should aim to achieve, which UK authorities are currently considering, including as part of HM Treasury's review of the payments landscape:

i. Reflect the financial stability risk, rather than the legal form, of payment activities;

ii. Ensure end-to-end operational and financial resilience across payment chains that are critical for the smooth functioning of the economy; and

iii. Ensure that sufficient information is available to monitor payment activities so that emerging risks to financial stability can be identified and addressed appropriately.

Payment Interface Providers would need to meet these and any other criteria set by the Bank and relevant regulators before they start to offer CBDC-related services. This would include a requirement that entities have the appropriate regulatory authorisation(s), and would be supervised on an ongoing basis. There would need to be consideration of how any CBDC-related regulation might sit alongside, or within existing regulation and oversight, which participants may be subject to. There would need to be an agreed approach across relevant regulators regarding the criteria for authorisation and the precise requirements placed on Payment Interface Providers undertaking payment activities using the CBDC infrastructure.

Under any revised regulatory framework, Payment Interface Providers (and any other firms in the CBDC ecosystem) would need to be subject to appropriate regulation, according to the risks they pose, and would need to achieve equivalent standards to current payment firms. This would include ensuring that all firms in the CBDC ecosystem are subject to the relevant standards of operational and financial resilience in order to mitigate risks that their operational or financial failure could pose to the end-to-end payments chain. As noted by the FPC, 'firms that are systemically important should be subject to standards of operational and financial resilience that reflect the risks they pose', and this would apply to firms involved in CBDC provision. They would also need to conform to the conduct and other standards set by the FCA and other relevant regulators.

Setting standards and requirements

The Bank (and relevant regulators) would also need to set standards to ensure that the CBDC payments system was resilient and reliable, open and interoperable. However, the standards should not dictate how CBDC-related services should be built, or what technology Payment Interface Providers or overlay services would need to use. These standards and requirements collectively make up the payment scheme that would apply to CBDC, and could define:

- Standards for interoperability between different Payment Interface Providers, including how payments can be made between different customers of different Payment Interface Providers, and how a customer can transfer their service to another Payment Interface Provider.

- Standards or expectations for Payment Interface Providers and overlay payment services they provide, potentially including minimum standards for security and identity. This would ensure resilience, interoperability and appropriate levels of consumer protection.

- Guidelines and principles for CBDC Payment Initiators' user interfaces (eg applications).

- Messaging standards used in CBDC payments (such as adopting the ISO 20022 data standard) and mandating the use of identifiers like the Legal Entity Identifier (LEI). These measures could support interoperability, extensibility and security of CBDC.

- Rules about who bears responsibility when CBDC payments go wrong, including in cases of fraud, failed transactions, cyber-risks and privacy.

Box 3
Other approaches to providing CBDC

An alternative to CBDC would be for private sector flrms to issue liabilities which were fully backed by funds held at the central bank. These flrms would act as intermediaries between the central bank and the end-users. Providing that the regulatory framework ensures that these flrms' liabilities were always fully backed by funds at the central bank, these liabilities could share many of the characteristics of a CBDC that is directly issued by the central bank. However these liabilities would not be central bank money, as holders would not hold a direct claim on the central bank.

Such an approach has been suggested by some stablecoin proposals. It has also been described by some researchers as 'synthetic CBDC' (Adrian and Mancini-Griffoli (2019)).

In line with the Financial Policy Committee's principles for regulation of payments and expectations relating to stablecoins, such an approach would require appropriate regulation and supervision to ensure that equivalent standards apply as with existing forms of private money.

4.6 Compliance with anti-money laundering (AML), combating the flnancing of terrorism (CFT) and sanctions

A CBDC payment system would need to be compliant with AML and CFT regulations and requirements. This means the identity of CBDC users would need to be known to at least some authority or institution in the wider CBDC network who can validate the legitimacy of their transaction. In the platform model, one possibility is that the core ledger only stores pseudonymous accounts and balances, but that each account in the core ledger is linked to a Payment Interface Provider who knows the identity of each user. Payment Interface Providers would be responsible for applying AML checks to users, and for reporting suspicious transactions to the authorities.

This arrangement means that the Bank would not hold granular personal data on any user, reducing the privacy concerns that could arise in connection with holding personal user data, but AML requirements could still be met by the CBDC system as a whole.

AML responsibilities could be handled entirely by the Payment Interface Providers. However, it is also possible that new business models could emerge with dedicated flrms that verify users' identity and use new techniques to identify suspicious activity. The fleld of digital identity is currently experiencing signiflcant developments. Therefore, the current model, where payment providers apply AML using their own systems, does not have to be the only model in use if CBDC is eventually introduced.

4.7 Privacy and data protection

It will be essential to consider how privacy is respected and how data is protected in a CBDC system. Privacy and data protection is an issue that is of concern to policymakers in government and other authorities[5] and should be considered carefully when designing CBDC.

Any CBDC system would need to be compatible with privacy regulations, such as the 2018 General Data Protection Regulation (GDPR), which would apply to the Bank of England, Payment Interface Providers and any other flrms providing CBDC-related services. In simple terms, this means that users should have control over how their data is used and who it is shared with. Any third-party processing data will need to observe applicable data protection legislation.

(5) In the UK, this would include the Department for Digital, Culture, Media and Sport (DCMS) and the Information Commissioners' Offlce (ICO).

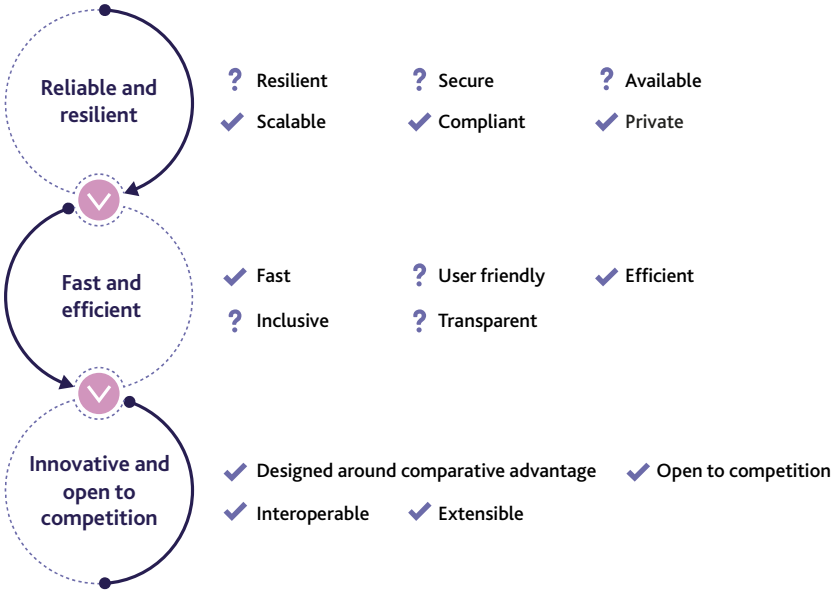
The appropriate degree of anonymity in a CBDC system is a political and social question, rather than a narrow technical question. As discussed above, CBDC would need to be compliant with AML regulations, which rules out truly anonymous payments. However, CBDC could be designed to protect privacy and give users control over who they share data with, even if CBDC payments are not truly anonymous (or secret). For example, a user may legitimately want to make a payment to a supermarket without sharing their identity with the supermarket, as this would allow the supermarket to build a picture of their shopping habits. In most cases, the payer should be able to pay without revealing their identity to the payee. In this sense, they could have anonymity with regards to other users, without having anonymity with regards to law enforcement.

Some discussions of CBDC assume that CBDC is equivalent to cash and so should offer the same degree of anonymity in payments. When a payer hands over cash to a payee, for example in a shop, the payee does not receive any data about the identity of the payer, and there is no digital record that links the payer and payee.(6) But the fact that an in-person cash payment provides an anonymous means of payment is a result of the nature of this payment method. The Bank does not have a specifiic mandate to provide untraceable or anonymous payment methods.

4.8 How the platform model measures against our design principles

The platform model of CBDC has the potential to meet many of the objectives and design principles that we outlined in Chapter 3.2. However, as shown in **Figure 4.2**, the ultimate outcome is not certain and will depend on the flnal design of CBDC, and the choices made about trade-offs between different design principles.

Figure 4.2 How the platform model may meet our design principles



Resilient and reliable

- **Scalable:** because the core ledger would have relatively simple functionality, it should be possible to scale its capacity as demand varies.
- **Compliant:** the CBDC system would be designed to be compliant with AML requirements.
- **Private:** The CBDC system would be designed to be compliant with GDPR.

(6) In some circumstances, there may be identiflcation requirements even where cash is used, such as for high-value purchases.

Fast and efflcient

- **Fast:** the system could provide instant real-time payments in central bank money, so payers (including merchants) can receive funds instantly.

- **Efflcient:** the core ledger could be built with relatively simple functionality, so that it would be as efflcient and cost-effective as possible. Additional functionality that would only be used by a subset of users could be provided by Payment Interface Providers through overlay services. This would ensure that the cost of providing for more complex user needs falls on the users of those services, rather than being distributed across all users.

Innovative and open to competition

- **Designed around comparative advantage:** the platform model allows the Bank and the private sector to focus on their respective strengths. The Bank could focus on building a highly resilient infrastructure (the core ledger), while the private sector Payment Interface Providers could focus on the user experience, by providing customer services, and building user-friendly services.

- **Open to competition:** flrms could compete to provide CBDC-related services. An appropriate regulatory structure could protect consumers while minimising barriers to entry.

- **Interoperable:** the Bank could set requirements to ensure that any CBDC account should be able to pay any other CBDC account, regardless of the Payment Interface Provider associated with each account. This will ensure that the CBDC payments network does not fragment into closed loops (which would reduce the usefulness of CBDC overall, and could lead to the emergence of one or two dominant Payment Interface Providers).

- **Extensible:** Payment Interface Providers can develop innovative overlay services to provide functionality that is not built into the core ledger, to enable CBDC to meet payment needs as they evolve.

Design principles that may not be met by the platform model

However, some of our design principles are not automatically met by the platform model of CBDC. Additional standards or policy interventions would be needed to ensure that the following design principles are met:

- **Resilient and available:** although the core ledger could be highly resilient and available 24/7, Payment Interface Providers' own systems may be vulnerable to disruption, which would possibly prevent users making payments. Therefore, the Bank would need to set minimum standards for operational resilience.

- **Secure:** the Bank should also set minimum standards for cyber-security and user authentication.

- **Transparent:** policies for other authorities would be needed to ensure that the cost of CBDC was transparent.

- **User-friendly:** private sector Payment Interface Providers could design the user interface for CBDC payment systems, with the most user-friendly services likely to have a competitive advantage.

- **Inclusive:** the Bank and relevant regulators would need to set standards to ensure that Payment Interface Providers build systems that support inclusion and avoid barriers that arise as a result of technical literacy, disabilities or reliance on more expensive hardware (such as smartphones).

5 Economic design and impacts on monetary and financial stability

Key points

- CBDC would be a new form of money, which would for the first time allow households and businesses to directly make electronic payments using central bank money. This change could impact the structure of the banking system and the way that the Bank achieves its primary objectives to maintain monetary and financial stability.
- There are potential benefits and risks of CBDC for monetary policy. For instance, it may support more effective transmission of monetary policy through some channels. But these benefits would have to be weighed against risks, such as the potential effects of disintermediation of the banking sector on credit provision.
- CBDC would only have benefits if households and businesses hold it and use it to make payments. This means they must switch some of their funds out of banknotes and commercial bank deposits and into central bank money in the form of CBDC, so some disintermediation would be inevitable. But a very large or rapid shift from deposits to CBDC could have significant implications for the amount and cost of credit that the banking sector could provide to the economy and the way the Bank achieves its objectives.
- There would be new tools available to the Bank to influence the attractiveness and use of CBDC, and therefore manage the trade-off between benefits and risks. The Bank's existing macro and microprudential tools, alongside the role of deposit insurance, could also help to manage risks.

5.1 Overview

CBDC would be a new form of money, which would for the first time allow households and businesses to directly make *electronic* payments using *central bank* money. While this may seem like a small change, it could have material benefits for households and businesses and could impact the structure of the banking system and the way that the Bank achieves its objectives to maintain monetary and financial stability. For instance, CBDC could, for some transmission channels, increase the speed and extent to which changes in the Bank's policy rate are passed on to households and businesses, and it could alter the amount and cost of credit provided to the economy by the banking sector. For these reasons, CBDC would need to be carefully designed to ensure that the potential benefits for monetary and financial stability, as well as the wider benefits of introducing CBDC for the public, could be realised without jeopardising the Bank's objectives and the financial sector's ability to provide credit and other services to the wider economy.

This chapter discusses how introducing CBDC could affect the balance sheets of the Bank of England and the commercial banking system.[1] It then shows how the introduction of CBDC could affect monetary policy, flnancial stability and the role of the Bank of England. Finally, it explains how the economic design of CBDC could have important effects on the rate of adoption of CBDC and therefore the extent of these wider impacts. In particular, it focuses on the important design issue of remuneration: whether or not CBDC should pay interest.

5.2 Impact of disintermediation (switching from deposits to CBDC)

CBDC would only have beneflts if households and businesses hold it and use it to make payments. This means they must switch some of their funds out of banknotes and commercial bank deposits and into central bank money in the form of CBDC. But this switching from deposits to CBDC can have potentially signiflcant implications on the banking system, monetary policy and flnancial stability. To understand these implications, it is important to understand the impact of a switch from deposits to CBDC on the balance sheets of the Bank of England and commercial banks.

CBDC would represent a new form of central bank money, which would be issued by the Bank of England. Central bank money, whether cash, central bank reserves (explained in Chapter 1.1) or potentially CBDC, plays a fundamental role in supporting monetary and flnancial stability by providing the ultimate means of settlement for all sterling payments in the economy.

Like other forms of central bank money, CBDC would be recorded as a liability on the Bank of England's balance sheet (just like banknotes and reserves), and 'backed' (matched) by assets held by the Bank. At present, the majority of these assets are bonds issued by the government, but other backing assets include loans to the banking sector through schemes like the Term Funding Scheme, as well as the Bank's routine liquidity facilities.

In contrast, commercial bank deposits are issued by commercial banks and form an important part of the banking sector's funding. A commercial bank's deposits are recorded as liabilities on its balance sheet, and are backed by its assets, which typically consist of central bank reserves, bonds, loans (such as mortgages), and other flnancial assets.

If CBDC were introduced, some of the households and businesses that currently hold commercial bank deposits might wish to exchange these deposits for CBDC. This process of converting deposits to CBDC is described in detail in Box 4 but the result is that, absent any other action, commercial banks lose both deposits and assets in equal amounts, and so end up with a smaller balance sheet.

This shrinking of the banking sector's balance sheet is known as 'disintermediation'.[2] Some degree of disintermediation is an inevitable consequence of a successful CBDC. However, this disintermediation would result in a lower total volume of funding for banks. Banks would need to consider how to react to a prospective loss of deposit funding, and the impact it would have on their ability to provide lending to the wider economy. They could react by paying a higher interest rate on deposits in order to limit any further outflows to CBDC,[3] or they could seek to replace lost deposit funding with alternatives, such as longer-term deposits or wholesale funding. However, both of these options may raise their overall cost of funding, which — if banks seek to maintain their proflt margins — could prompt banks to increase the cost of the credit they provide to the economy. In turn, that could result in a lower volume of lending by banks, all else being equal.

If disintermediation were to occur on a large scale, that would either imply a large fall in lending or would require banks to seek to borrow signiflcantly more from the Bank of England. This could have profound implications for the structure of the banking system and the Bank's balance sheet.

(1) Other models and implementations of CBDC are possible, but would have their own economic consequences that depended on their design and are not discussed here.
(2) See also Broadbent (2016), Mancini-Griffoli *et al* (2018), Andolfatto (2018), Kumhof and Noone (2018), Meaning *et al* (2018), and Chiu *et al* (2019), among others.
(3) A corollary of higher deposit funding costs would be higher rates of return for depositors.

Box 4
The balance sheet impact of a switch from cash or deposits to CBDC

Switching from cash to CBDC: Banknotes and CBDC are just two different types of central bank liability, so a switch from banknotes to CBDC affects the composition — but not the size — of household and central bank balance sheets. The household swaps one asset (cash) for another asset (CBDC) and the central bank swaps one liability (cash) for another liability (CBDC). Although banks may facilitate this conversion from cash to CBDC, the process has no impact on the size of the banking sector's balance sheet.

Switching from deposits to CBDC: A shift from deposits into CBDC has the same impact on bank balance sheets as a withdrawal of banknotes from an ATM or bank branch, reducing both the assets and liabilities of the bank and shrinking the bank's balance sheet. This means that net shifts from deposits to CBDC (partially) disintermediate the banking sector. For example, if a household wants to convert £10 of deposits to CBDC:

- The household tells its bank to make a £10 payment from its deposit account to its CBDC account (in effect, 'withdrawing' CBDC just like with cash).
    - The bank debits (ie reduces the value of) the household's account by £10.
- The bank tells the central bank to transfer £10 from its reserves account to the household's CBDC account.
    - The central bank debits (reduces the value of) the bank's reserves account, and credits (increases the value of) the household's CBDC account, by £10.
- The composition of the household's assets changes, because it now holds £10 less in deposits and £10 more in CBDC. But there is no change in the overall size of the household's balance sheet.
- The composition of the central bank's liabilities changes: it now has £10 less in reserve liabilities and £10 more in CBDC liabilities. But there is no immediate change in the size of the central bank's balance sheet.
- However, the commercial bank has lost both £10 of reserves (an asset) and £10 of deposits (a liability). Its balance sheet has contracted by £10.

A flow from deposits to CBDC results in commercial banks as a whole holding fewer reserves. If they end up holding fewer reserves than they need to meet their own or supervisory liquidity risk measures, they may wish to acquire more reserves from the central bank. If the central bank chooses to meet this demand by issuing new reserves, then the central bank's balance sheet will expand by the amount of newly issued reserves.

These potential costs of disintermediation mean it is important to design CBDC in a way that makes the demand for CBDC, *vis-à-vis* bank deposits, manageable. However, gauging the likely shift from deposits into CBDC is challenging because to date no major economy central bank has introduced a CBDC. Important lessons can be learned from previous flnancial reforms in the UK that have had implications for bank intermediation,[4] but signiflcant further research is needed.

5.3 The impact of CBDC on the Bank's monetary and flnancial stability objectives

Impact on monetary policy

By acting as an additional, digital alternative to bank deposits, CBDC could mean that any changes in Bank Rate would be passed on faster and more fully to the rates faced by households and companies (Meaning *et al* (2018)).

(4) For instance, both Competition and Credit Control in 1971 and the flnancial liberalisation reforms of the 1980s had large effects on the demand for bank deposits and bank lending and major implications for monetary and flnancial policy at the time.

However, if CBDC became more attractive relative to deposits, the extent of disintermediation of the banking sector would likely be greater. An associated reduction in the availability, and/or an increase in the cost, of credit from the banking sector would be likely to have important consequences for both aggregate supply and demand in the economy. Any fall in the total amount of bank lending would also lessen the importance of bank lending in the overall transmission of monetary policy, meaning that other channels of transmission would become relatively more important.

A shift from deposits to CBDC could result in banks drawing down on their stock of reserves (which must be paid across to CBDC accounts). Banks may need to replace some of these reserves, for example to meet their own risk appetite or regulatory liquidity requirements. While the stock of reserves is currently ample in the UK as a result of quantitative easing, this may not always be the case. In 2018, the Bank explained that, once it begins to unwind quantitative easing, it intends to meet banks' demand for reserves by lending at Bank Rate against high-quality collateral.[5] However, a large-scale shift into CBDC may mean that banks would not have sufflcient amounts of the right quality collateral to obtain the reserves they need. Aside from the flnancial stability implications of a shortage of liquid assets, this could result in market rates moving out of alignment with the policy rate, or necessitate adjustments to the Bank's monetary policy implementation framework — including to consider supplying reserves against a wider range of collateral. Given this, the design of CBDC would have to consider the effects on how the Bank implements monetary policy.

Impact on flnancial stability

As discussed in Chapter 2, a well-designed CBDC could have the potential to enhance flnancial stability by supporting a resilient payment system and averting some of the risks of new forms of privately created money.

First, if a universally accessible payment system such as CBDC were to be established and actively used, it could reduce systemic risk by providing some core payment services that are outside of, and not reliant on, the banking system. Second, disintermediation of the banking sector is already happening as a result of developments in payments. CBDC could give the Bank more opportunity to manage these risks and, depending on its design parameters, may not result in greater disintermediation than is expected regardless of the introduction of CBDC.

But CBDC could also introduce risks for flnancial stability, offsetting some of these beneflts. In a transition to CBDC, the shrinking of banks' balance sheets could affect the availability of credit, which may have an impact on flnancial stability. While over time the banking system would be expected to flnd a new equilibrium, a rapid flow into CBDC from bank deposits (from a single bank or from multiple banks) could be destabilising. If, during a period of stress or flnancial uncertainty, households and businesses saw CBDC as less risky than commercial bank deposits (notwithstanding that retail depositors enjoy FSCS protections), that rush to safety could trigger broader systemic instability. In that sense, a period of rapid substitution from deposits to CBDC would be equivalent to a run on the banking system. This could in principle happen today through a run from deposits to cash, but runs to cash are limited by the practical frictions and costs involved in withdrawing and storing large amounts of cash. In contrast, the cost and frictions of running to CBDC would likely be much lower (although this would depend on its flnal design). This may incentivise banks to take steps to protect themselves, for instance through a tendency to 'hoard' reserves in a period of stress. That behaviour would impact further on the functioning of money markets.

However, the Bank would still be able to use its existing macro and microprudential tools, including its ability to supply reserves and liquidity to the system, to limit the incentive for runs to CBDC in the flrst place.[6]

In the most extreme scenario, where a CBDC fully replaced transactional sight deposits at commercial banks, those banks — if they were not to reduce lending — would be reliant entirely on other sources of funding. To the extent that this included an increased reliance on existing central bank facilities, or if shortages of private market funding prompted central banks to adjust the extent to which funding is offered, this would have signiflcant implications for the role of the central bank, including in influencing the cost of credit. Any expansion of the central bank balance sheet to support bank funding would raise the question of what assets would match the additional liabilities, and how they would be supplied. In this scenario there may be a shortage of high-quality

(5) Bank of England (2018).
(6) Villaverde *et al* (2020).

assets to back an enlarged central bank balance sheet, and therefore the central bank may have to broaden the range of assets purchased or lent against.

5.4 Managing the risks through economic design of CBDC

Three possible tools to manage these risks, discussed below, are remuneration of CBDC, the tiering and structure of that remuneration, and limits on the amount of CBDC that could be held.

While the central bank would have direct control over these economic design choices, it would have to be aware that it might have only indirect control of features offered by Payment Interface Providers that could also affect the flnal attractiveness of CBDC. For instance, user-friendly design, loyalty schemes or other flnancial products being bundled with CBDC could make holding CBDC more attractive to the public.

Design choice 1: Remuneration

The most important design decision for CBDC would be whether to remunerate, ie pay interest on CBDC balances. A CBDC could be unremunerated (non-interest bearing) like banknotes, or remunerated (interest bearing) like central bank reserves, bank deposits and many other flnancial assets. In stable economic conditions, the rate of remuneration would be a key determinant of how attractive CBDC would be relative to other forms of money, how widely it would be adopted, the extent of any disintermediation it might cause, and how it might impact monetary and flnancial stability.

Unremunerated CBDC

An unremunerated CBDC would essentially be a digital version of banknotes. While potentially an attractive risk-free form of money and a useful means of payment, there would be less incentive, relative to a remunerated option, for households and business to make a signiflcant movement away from bank deposits (at least beyond balances they currently hold for payments-related purposes). There would also be a lower impact on the banking system's ability to provide credit. However, in the current low interest rate environment the interest paid on bank deposits might not be sufflcient to disincentivise moves to an unremunerated CBDC.

An unremunerated CBDC would not directly transmit changes in Bank Rate to holders, nor would it be likely to have large effects on money market interest rates. But an unremunerated CBDC could still have important implications for monetary policy. In particular, it could reinforce the lower bound on interest rates. The lower bound exists because if interest rates fell signiflcantly below zero depositors could withdraw and hold banknotes. But doing so comes with some costs, particularly for large amounts, because banknotes must be stored securely and cannot be used for payments that are not face-to-face. This makes the effective return on cash holdings slightly negative and has enabled some central banks to set policy rates below the zero rate paid on cash. CBDC would probably have negligible storage costs, making it easier to hold unremunerated CBDC when other interest rates drop below zero, signiflcantly reducing the extent to which rates could go into negative territory. Although the Bank's current assessment is that the lower bound is slightly above zero, due to the structure of the flnancial system, this assessment could change in the future as the flnancial system evolves.

How would this be different for a remunerated CBDC?

Remuneration could have a number of implications for the monetary transmission mechanism. A remunerated CBDC, which would be a closer substitute for bank deposits, could lead to faster and fuller transmission of monetary policy to deposit rates. The rate paid on a remunerated CBDC would set the lower limit of the return households and businesses were prepared to accept on their money holdings. This may mean that as the rate paid on CBDC varied, banks might adjust the deposit rates offered to households and companies to avoid a change in the relative attractiveness of CBDC to deposits. A remunerated CBDC would also mean the public received interest on their CBDC balances. This would increase the proportion of money linked directly to monetary policy choices, and have an impact on the monetary transmission mechanism. As interest rates changed, the effect on the interest income received by deposit and CBDC holders would be more pronounced (an effect known as the 'cash-flow' channel). Ultimately, the impact would depend on the relative changes to interest rates on both saving and borrowing.

On the other hand, remuneration increases the potential for greater disintermediation of the banking system by increasing the incentive for households and businesses to shift larger amounts of money into CBDC. Households' deposits tend to be relatively 'sticky', ie they tend to stay with one bank, meaning that households and businesses may continue to hold their sight deposits at banks even if a remunerated CBDC were introduced. Other attractions to holding deposits, such as overdrafts and the associated beneflts of a banking relationship, may also limit conversion to CBDC.[7] But the stickiness of deposits may change with or without the introduction of CBDC, as initiatives such as Open Banking and the Second Payment Services Directive (PSD2) (see Annex) make it easier for users to switch, and move money between, bank accounts in the UK.

There may also be beneflts from remuneration for unconventional monetary policy. If interest rates are, and continue to be, low then central banks are likely to be constrained by the lower bound more frequently than historically was the case.[8] A CBDC that could be remunerated at a *negative* rate could be used to relax that constraint, to the extent that the constraint was caused by the fact that cash pays zero interest (Bordo and Levin (2019)). This could, theoretically, widen the policy options available and avoid the economic costs of having monetary policy hit the effective lower bound, potentially improving economic outcomes. However, the wider effect of setting a negative interest rate on CBDC could be limited if cash use remains prevalent in the economy and cash storage costs are not excessive. And for this beneflt to be realised the issues related to the structure of the flnancial system, which determine the current effective lower bound for Bank Rate, would need to have changed.

Design choice 2: Structure and tiering of remuneration

If the Bank were to decide to remunerate CBDC, but was worried about the impact on bank intermediation and credit, it might be possible to alter the *structure* of any possible remuneration in addition to setting the headline interest rate. For instance, it need not pay the same rate of interest on CBDC as is paid on the reserves held by banks (Bank Rate), as was implicitly assumed above. The CBDC rate could be set lower than Bank Rate, which would allow deposit rates to go some way below Bank Rate.

Alternatively, if policymakers intended CBDC to be used primarily for transactions, rather than as a large-scale store of value, remuneration could be *tiered* such that balances above a certain level pay a lower interest rate or no interest at all (Bindseil (2020)). The Bank could also introduce the potential for remuneration by initially 'remunerating' CBDC at zero but leaving open the possibility of applying a non-zero interest rate in the future.

Design choice 3: Limits

To address the concern that CBDC could lead to a degree of deposit outflow from the banking sector and into CBDC, the central bank may also wish to impose some limits on the amount that could be held by each individual or business. Setting aside the practicalities of this, limits on individual holdings of CBDC could help ensure that CBDC was used primarily for payments balances and not for large savings, reducing the extent of disintermediation of the banking system.

A *hard* limit would specify the total amount of CBDC that each type of user could hold (perhaps with a different limit for businesses and individuals). Such a limit would pose some practical challenges. For example, if a user reached its CBDC limit, would incoming payments to that account be blocked? In addition, if users could hold multiple CBDC accounts with multiple Payment Interface Providers, there would need to be a way to calculate each user's total CBDC holdings across all accounts. This would not be impossible, but would require careful technological design.

If CBDC were to be remunerated, then soft limits, such as the tiered remuneration schedule discussed above, may be preferable to hard limits. Soft limits could provide an economic incentive for users to limit their holdings of CBDC by making it less attractive to hold balances above a given level.

(7) Chiu and Hill (2015).
(8) Carney (2020).

If CBDC were introduced, limits could also be used as a precautionary tool for an initial period. The central bank would be able to observe demand for CBDC and its determinants, and could over time gradually change limits based on experience.

Another form of restriction would be to limit the rate of conversion by limiting maximum transfers over a certain time period. This could be done either by requiring a notice period for large amounts, or by imposing a ceiling on individuals' daily transfers.

More research and analysis is needed on the viability of limits, and the trade-offs between limiting the speed of possible bank runs to CBDC and reducing the usefulness of CBDC in normal times.

6 Technology design

Key points

- The technology used to power CBDC should be chosen on the basis of our design principles. There are trade-offs between different design principles, so we would have to strike the right balance in order to achieve the Bank's policy objectives.
- We do not presume that CBDC must be built using Distributed Ledger Technology (DLT), and there is no inherent reason it could not be built using more conventional centralised technology. However, some of DLT's individual component innovations may be useful.
- Distribution and decentralisation (as used in DLT) may enhance resilience and availability, but could have a negative impact on aspects such as performance, privacy and security.
- CBDC may be able to provide 'programmable money' through smart contracts. There would be a range of options for how this might be delivered, including: building the functionality into the core ledger; providing the functionality via a separate 'module'; or enabling the functionality to be provided by third parties.
- Cryptography should be used to increase the security of the CBDC platform, but this needs to be carefully designed to avoid having a negative impact on usability or performance.

6.1 Overview

Technology choices would have a bearing on the extent to which CBDC is resilient, secure, fast, efflcient, extensible, available and scalable, and so these decisions would be crucial to meeting the overall objectives for CBDC. For this reason, it would be essential to choose a technological approach that best meets these design principles.

This chapter focuses on the core CBDC ledger in the illustrative model described in Chapter 4, which would be operated by the Bank. However, much of the technology in a CBDC system would be provided by Payment Interface Providers, including the software and hardware that powers their own systems, and the interfaces used by users of CBDC.

Although CBDC is often associated with Distributed Ledger Technology (DLT — see Box 5), we do not presume CBDC must be built using DLT. Most existing payment systems are run on centralised technology stacks, and there is no reason CBDC could not also be built this way. However, DLT includes a number of potentially highly useful innovations, which can potentially be adopted independently of each other, allowing us to use the speciflc features of DLT which are most relevant and appropriate, without using DLT in its entirety. This chapter considers which of those innovations could be useful in a CBDC context.

Box 5
Relevant elements of Distributed Ledger Technology (DLT)

Since the advent of Bitcoin over a decade ago, the term 'DLT' has come to refer to a wide range of technologies, many of which take quite different design choices — as such there is no single implementation of DLT. However, there are several common features of the technology — the core 'building blocks'[1] — which can be deployed to varying degrees in different implementations (**Figure 6.1**). These building blocks include:

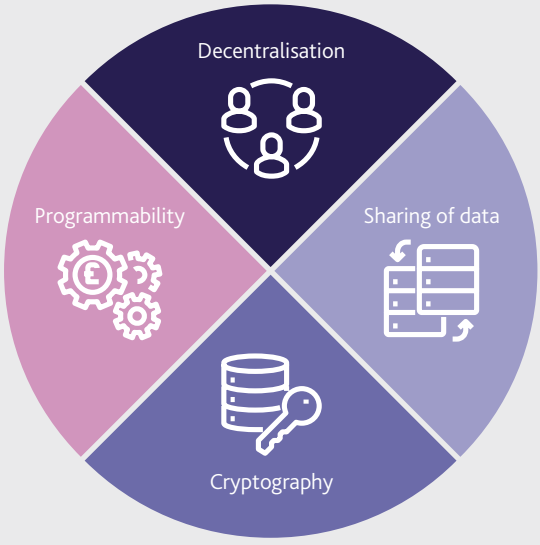
- **Decentralisation:** where a number of third parties are involved in maintaining copies of the ledger and processing updates to the ledger (such as transactions). This requires a 'consensus process' to ensure that all copies of the ledger are synchronised and store the same information.
- **Sharing of data:** visibility of the ledger, including providing access to a wider group of participants to 'read' data on the ledger, and/or the right to update ('write') data on the ledger.
- **Use of cryptography:** the range of cryptographic features which can be used to enable different type of 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 facts about the ledger (eg that a particular transaction has occurred).
- **Programmability:** the creation of so-called 'smart contracts' which can be used to automatically execute terms of an agreement, and initiate related transactions, without human intervention.

These elements can potentially be adopted independently of each other — for example, the programmability features of smart contracts can be deployed over a ledger created using more traditional centralised database technology.

Some important questions in the context of CBDC are (a) which of these elements can helpfully support our objectives for CBDC, and (b) what are the implications and trade-offs of adopting different features?

Figure 6.1 Elements of DLT

Each of these elements can potentially be adopted independently of each other



(1) Building blocks: the useful elements of blockchain, Simon Scorer (2019).

6.2 Our requirements for the core ledger

Any form of CBDC would require a ledger, to keep a record of CBDC transactions, and to maintain the overall stock and supply of CBDC. One reason for this is to prevent users being able to 'double-spend' CBDC by sending the same units to different recipients. There are considerations, discussed later in this chapter, around whether the ledger is centralised or decentralised, and whether it uses an account-based or token-based data structure but, in all of these scenarios, a ledger is required.

The core ledger must be optimised around the following design principles:

- **Resilient:** because CBDC would likely serve as a critical piece of national infrastructure, it would need to be able to handle hardware and software failures in parts of the CBDC system, or telecom network failures, while sustaining continuity of operations and without having a single point of failure that could break the system. It must also be resilient to, and able to adapt to, peaks in demand.

- **Secure:** in particular, CBDC would need to maintain data integrity and be protected from data loss, data theft and cyber vulnerabilities. It must be possible to upgrade the security model as threats evolve.

- **Available:** CBDC payments would need to be available 24/7, and so the core ledger should also operate 24/7, with no planned downtime.

- **Scalable:** it must be possible to increase the capacity of the core ledger as demand increases over time.

- **Fast:** because CBDC would be used for retail payments, the ledger must be able to process and conflrm transactions very quickly.

- **Efflcient:** the processes should be optimised around the functionality that will be used by most or all users. More complex functionality that would only be used by a smaller subset of users should be left for overlay services, where possible, to avoid adding complexity or reducing the speed of the core ledger.

- **Extensible:** the core ledger would need to be able to provide the necessary functionality to enable a range of overlay services which can meet new use cases and evolving demands. It must be possible to update and upgrade the platform as demand changes.

Building a payment system requires making trade-offs and striking the right balance between different design principles. Consequently, in designing a CBDC it will be impossible to maximise the outcome on every design consideration. For example, some common trade-offs in payment systems include:

- **Transaction throughput versus speed of settlement.** Card payment systems handle high volumes of low value payments, and prioritise the speed of payment authorisation when a customer is standing at the checkout counter, even though the merchant may not receive the funds for a number of days. In contrast, the high-value payment systems used by banks and flnancial institutions handle lower volumes of payments and prioritise liquidity efflciency and the speed with which the payee receives the funds with no possibility of the payment being reversed (known as 'flnality of settlement').

- **Simplicity versus functionality.** In the platform model outlined in Chapter 4, the Bank's core ledger would have the minimum necessary functionality, because limiting the functionality reduces the number of possible flaws, or bugs, in software (boosting the resilience of the system) and limits the 'attack surface' for hostile actors (boosting the security of the system). However, if we limit the core functionality too much, it may limit the ability of Payment Interface Providers to build useful overlay services, thereby limiting the extensibility and level of innovation in the CBDC payment system.

The use case for CBDC in this paper is focused on retail payments (between households and businesses), and so we would need to consider the needs of these groups when prioritising certain design choices.

6.3 Decentralisation and resilience of the core ledger

Many existing technology platforms, including payments, social media, video streaming and search engines, require very high levels of resilience. This is often achieved through the duplication of data and processes. Duplicating data and processes across multiple servers in different locations makes it signiflcantly less likely that the data will ever be lost and ensures that the system as a whole can continue to operate even if part of the system fails or is cut-off from the rest of the network. The same applies to the processing of transactions. The use of these techniques would be an essential part of ensuring that any CBDC core ledger is resilient and available.

Duplication typically involves one entity that controls all of the duplicated components (eg servers, data centres etc), such as the central bank in the case of Real Time Gross Settlement systems. Decentralisation involves going further to involve multiple different entities, such as different companies, in storing copies of the ledger and processing updates to that data (ie transactions). This requires a 'consensus process' to ensure that all copies of the ledger are synchronised and store the same information. In the context of CBDC, it might be possible to involve Payment Interface Providers or other trusted technology providers in the process of maintaining the core ledger, processing transactions and storing data for the CBDC system as a whole, rather than just for their own customers. Alternatively, if multiple central banks provided CBDC, they could possibly partner with each other and operate 'nodes' in each other's CBDC networks.

A decentralised approach could add further resilience to a CBDC system. Differences in geographical locations, and approaches to implementation can create more diversity in the system as a whole, which means that problems that affect one type of hardware, or one software version, are unlikely to affect all parts of the network simultaneously.

However, a decentralised approach also comes with a number of signiflcant trade-offs, including:

- **Performance:** the consensus process in the decentralisation of data requires transmitting a high number of messages between participants for each transaction. As a result, many DLT platforms to date have struggled to match the performance of more 'centralised' payment platforms in respect to aspects such as throughput and speed.

- **Data privacy:** involving third parties in the processing of transactions ('transaction validators') may require the sharing of private data with them. There are approaches to mitigate this, but these come with their own challenges.(1) One approach involves segregating the data so that each individual transaction validator only has visibility of a subset of the ledger. Alternative approaches involve using advanced cryptographic techniques (for example those based on zero-knowledge proofs)(2) to hide details, such as the counterparties or the value of the transaction, from the transaction validators. However, these are currently computationally intensive and currently have a negative impact on performance.

- **Security:** involving multiple parties in the operation of the system may provide more targets for potential cyber-attackers, particularly in relation to data theft. However, the use of multi-party consensus could also make a system more secure against attackers that are attempting to manipulate data, for example to steal funds. The overall security of any system as a whole depends on the 'weakest link' – the entity that has the weakest security standards. This may represent a greater challenge if many parties are involved.

Consequently, decentralisation comes with challenges. Systems with no duplication at all will have lower resilience, but systems that are extremely decentralised are likely to be slow, inefflcient and difflcult to scale. An important area of technology research is to identify the appropriate and optimal level of distribution or decentralisation for the CBDC core ledger, achieving the best combination of resilience, speed, efflciency and scalability.

(1) Stella: Balancing conflidentiality and auditability in a distributed ledger environment, European Central Bank and Bank of Japan (2020).
(2) A zero-knowledge proof is a cryptographic method which allows one party to prove to another party that they possess certain information, without disclosing the information itself.

Whatever degree of duplication and decentralisation is used, the Bank would need to retain overall control of the CBDC network. This means it would always need to be a 'permissioned' system, with the Bank granting access to the network. It is likely that only regulated Payment Interface Providers would be allowed to connect to the core ledger, a restriction that adds a layer of security to the core ledger. If a DLT approach is used, the Bank could also control which entities are allowed to operate a node in the network (processing transactions for the network as a whole). In all arrangements, the Bank must have exclusive control of the creation (issuance) of new CBDC, and the technology design must ensure that this remains the case.

6.4 Programmable money

One of the most interesting features that has emerged through developments in DLT is the potential to create 'programmable money'. This can be implemented via the use of 'smart contracts' — pieces of code which are able to self-execute payments based on some pre-deflned criteria. In simple terms, these contracts are statements that say 'If X happens, then pay Y to Z'. An example would be a forward-dated payment: 'If today's date is X, then transfer £100 from account Y to account Z'. More advanced smart contracts could be used (for example) to automatically initiate payments on the conflrmed receipt of goods, or routing tax payments directly to the tax authorities at point of sale. Transactions could also be integrated with physical devices, or the 'Internet of Things', for example code could be written to say 'when £X is transferred to account Y, switch on device Z'.

Smart contract functionality can be (and is being) decoupled from DLT. It is possible to implement smart contracts over a variety of types of ledger, including centralised databases. It is also possible to restrict the range of functionality available within a smart contract programming language, which may be desirable for both security and efflciency reasons.

Smart contracts are more complex to process than a simple push payment, so their use could have a negative impact on performance and scalability.(3) Smart contracts may also have a negative impact on the security of the system; signiflcant funds have already been lost or stolen as a result of vulnerabilities in smart contract platforms.(4)

If CBDC were to support programmable money functionality, we see three broad potential approaches: building the functionality into the core ledger; providing the functionality via a separate 'module'; or enabling the functionality to be provided by Payment Interface Providers.

Providing full programmable money functionality on the core ledger would come with signiflcant trade-offs. Requiring the core ledger to perform the more complex computations associated with smart contracts would have an impact on its performance, potentially slowing down individual transactions whether they were associated with a smart contract or not. However, this approach may be necessary to realise the full extent of the beneflts associated with programmable money.

An alternative approach would be for the Bank to develop an additional 'module', separate to the core ledger, to manage and process smart contracts. This module would be responsible for processing smart contract code, and would then instruct the core ledger when a payment is needed. This approach could mitigate the negative impact on the performance of the system, while still leveraging the Bank's position as a trusted party. The module would require the appropriate authority to move users' funds, as well as a process for users to control and approve this functionality. This approach would require careful consideration around aspects including the process for user authentication.

A third option is to restrict the smart contract related functionality provided by the Bank to the minimum necessary to enable Payment Interface Providers to provide a more complete range of programmable functionality to users. This minimum functionality might include the ability to cryptographically lock funds in an

(3) In some DLT platforms, high demand to use popular smart contracts has caused the entire network to hit capacity constraints and become congested, for example see CryptoKitties craze slows down transactions on Ethereum, BBC News (2017).
(4) See Understanding the DAO attack, David Siegel (2016).

effective escrow service.[5] In this approach there would also be a role for the Bank in setting standards for smart contract functionality. These standards would ensure interoperability between providers and set minimum security standards, but would not dictate how the services are provided.

Each of these potential approaches to supporting programmable money functionality would need signiflcant further evaluation, in order to understand the potential advantages and implications, and to determine an optimal approach.

6.5 Security and use of cryptography

The instant nature of CBDC payments means that the system could be an attractive target for hackers or fraudsters who wish to steal funds. In addition, the CBDC payments system may become a target for hostile attacks with the aim of disrupting the system and, potentially, the wider economy. For these reasons, the security of the CBDC payments system must be of the highest standard.

There are two aspects of security that we need to consider in particular: user security and security of the payment infrastructure.

Building user security requires thinking carefully about how payments are initiated, how users are authenticated, and what happens if users lose credentials or private keys (discussed below), or are tricked into making payments to the wrong recipient. A lot of this user security will be handled by Payment Interface Providers themselves, but the Bank would need to set minimum security standards. There may also be a trade-off between user security and the extent to which the platform is user-friendly as a whole, although there are ways to provide a user-friendly interface on the back of a very secure system.

The need for security of the payment infrastructure would apply to the core ledger, the Payment Interface Providers, the overlay services they provide, and the network connecting them. These services would need to be resilient to cyber-attacks and avoid having single points of failure that can be targeted. The system should be able to recover quickly from an attack. The CBDC core ledger and wider network would need to be designed with a security model that can be constantly upgraded to protect against evolving threats.

A common aspect of most DLT platforms is the use of cryptography to validate the accuracy of a copy of the ledger, to lock-up funds for a period of time or until a specifled event has happened, or to validate the correct owner of speciflc funds. Use of cryptography can enhance security, but also comes with some challenges. For example, if private keys are used to authenticate payment instructions, but a user's private key is lost or stolen, the funds may be lost forever. Therefore, high security around the storage of private keys would be required, and a mechanism to 'freeze' and reissue CBDC where the corresponding private key has been lost.

Cryptographic security is constantly evolving, and individual cryptographic functions can weaken over time as technology advances, making them vulnerable to attackers. It would be vital that any cryptographic functions deployed in a CBDC continue to be secure as technology advances; this is likely to require the ability to change and upgrade the speciflc cryptographic techniques used by the system over time.

6.6 Account-based versus token-based approaches

The literature around CBDC and DLT often discusses 'token'[6] and 'account' based models, and there are a range of differing interpretations of these terms. The terms are often used as shorthand for a wide range of independent design choices that are not necessarily directly linked to either of these two concepts.

(5) More advanced techniques, such as Hash Time-Locked Contracts (HTLC) have been explored by other central banks as a way of enabling 'atomic' transactions between different ledgers. See Monetary Authority of Singapore, Bank of Canada and JP Morgan (2019) or ECB and BoJ (2018). To enable the use of HTLC, in addition to the ability to lock funds, the ledger would also need to support a timeout mechanism to release the lock, and certain cryptographic features to disclose secret information.

(6) Note that the term 'tokenisation' also has a different meaning in the context of data security. This relates to the process of protecting sensitive data by replacing it with a non-sensitive equivalent, referred to as a 'token'. This process is commonly used in payments, for example to replace a 16-digit card number with a single-use unique token, allowing payments to be processed and the token to be passed through a network, without exposing the actual account details.

In our view, the core difference between token-based and account-based systems relates to the underlying data structure and the related process for moving funds:

- An **account**-based system records the state of the system as a list of accounts, each of which has a corresponding balance. When funds are transferred, the record is updated by increasing and decreasing the balances in the relevant accounts. In order to initiate a transfer, the holder of an account is required to demonstrate their authority to do so, either by proving their identity as the account holder, or providing that they hold some information (eg password or private key) that only the account holder should know.

- By contrast, a **token**-based system records the state of the system as a list of individual assets (or 'tokens'), each of which has a corresponding 'owner' who can control the asset. Each of these tokens has a speciflc value (eg £15), which does not change. In order to initiate a transfer, the holder of a token is required to prove they control the token, usually by signing a payment instruction with the private key associated with that token. Individual tokens cannot be partially spent — instead, the token being transferred is generally 'destroyed' and replaced with two newly created smaller tokens (with the same total value), with one going to the recipient and the other being returned to the sender as 'change'.

We do not see any inherent reason that token-based systems would automatically provide anonymity. Both account-based systems and token-based systems can be conflgured with various identity solutions, ranging from fully anonymous to pseudonymous and to a fully transparent, identiflable solution. As discussed (Chapter 4.6), any CBDC would need to be compatible with AML obligations, ruling out truly anonymous payments. In Chapter 4.2 we assume that the core ledger could use pseudonymous accounts (with Payment Interface Providers managing identiflcation), although other models would also be feasible.

In digital form, neither an account-based approach nor a token-based approach would enable cash-like transfers, where a payment can be made without reference to any third party or intermediary. In an account-based system, the accounts of the payer and payee need to be debited and credited by the operator(s) of the ledger. And in a token-based system, in order to prevent double-spending, ownership of tokens needs to be recorded in a ledger, which will need to be updated to reflect any changes in ownership.

So, from an operational perspective, either a token or account-based approach might be able to provide the necessary range of functionality for a CBDC. However, there may be certain use cases or overlay services which are better supported by one of these data structures, and there may also be important legal implications.

7 Next steps and priorities for further research

7.1 Overview

It is clear that the introduction of a Central Bank Digital Currency (CBDC) in the UK would pose both opportunities and challenges for monetary policy, flnancial stability and payments. Before any decision could be taken on whether to introduce a retail CBDC, the Bank would need to be clear that the net beneflt for payments users, the flnancial system, and society as a whole would outweigh any risks.

The illustrative model of CBDC set out in this paper is intended as a basis for further discussion and research, rather than as a blueprint for a flnal design of CBDC. Our work so far has highlighted a number of ways that CBDC could be designed to maximise the beneflts and mitigate the risks. But there are still many questions that need careful consideration. Our ongoing work on CBDC will focus on the following areas:

- **Impact on payments:** Understanding the beneflts that CBDC could provide for payments users and for the economy more widely, taking into account that payments needs are changing as the economy becomes increasingly digital. This includes understanding how CBDC could complement or facilitate other initiatives to improve payments, particularly the signiflcant improvement initiatives currently underway in the UK (see the appendix).

- **Impact on monetary and flnancial stability:** Quantifying the beneflts and implications of CBDC on monetary policy and flnancial stability, and identifying ways to mitigate any risks. This includes understanding the impact on the Bank's own balance sheet and operations.

- **Functionality and provision of CBDC:** Developing the design of CBDC to maximise beneflts and minimise risks, and identifying the appropriate role of the public and private sector.

- **Technology:** Understanding the technology that would be most appropriate to power a CBDC, including how the Bank could build a CBDC that enables signiflcant further innovation in payments.

More detailed questions on each of these areas are listed below. We plan to draw on the widest possible expertise, and we invite ideas and feedback from technology providers, the payments industry, flnancial institutions, academics, other central banks, and public authorities.

We do not expect written responses to address all questions, and observations on other aspects are also welcome. Details on how to respond can be found on page 6.

7.2 Understanding the impact of CBDC on payments

CBDC poses a number of potential opportunities for improving the payments landscape in the UK, as discussed in Chapter 2.4. However, each of these opportunities also come with challenges that require careful consideration.

1 How could CBDC be designed to support a more resilient payments landscape in the UK?

2 How could CBDC be designed in a way that improves the efflciency and speed of payments, while also facilitating competition and innovation?

3 How could CBDC be designed to meet future payment needs? How might future innovations and evolutions in technology (eg the Internet of Things) change these needs?

4 As usage of cash as a means of payment declines, is it important to preserve access to central bank money for households and businesses?

5 Does CBDC pose other opportunities or challenges with respect to the payments landscape that we have not discussed?

6 What factors would determine the level of adoption of CBDC as a means of payment in the UK?

7 Are the design principles described in Chapter 3.2 comprehensive? What are the most signiflcant trade-offs between some of these design principles?

There are signiflcant initiatives underway in the UK to facilitate improvements in both electronic and cash payments. These initiatives are outlined in the appendix. The Bank will continue to fully support these initiatives, recognising the signiflcant beneflts they could provide for the UK payments landscape. It is essential to understand how CBDC would work alongside these existing initiatives, and how CBDC flts into the wider payments landscape.

8 How could CBDC be designed to complement other public and private sector initiatives to improve payments in the UK?

9 Could CBDC provide unique beneflts, over and above existing initiatives, to improve UK payments?

10 Could the potential beneflts of CBDC alternatively be achieved with policy levers to (a) influence the private sector to deliver a better payments landscape, or (b) address market failures or co-ordination problems in the private sector?

11 Could the potential beneflts of CBDC be alternatively achieved by enabling new innovative private sector arrangements (eg stablecoins) to develop?

7.3 Understanding the impact of CBDC on monetary and flnancial stability

As discussed in Chapter 5, CBDC could impact the structure of the banking system and the way that the Bank achieves its primary objectives to maintain monetary and flnancial stability. It is important to fully understand these impacts, and ways to mitigate any risks through the design of CBDC.

12 What opportunities could CBDC provide to enhance monetary or flnancial stability?

13 How much demand would there be to hold CBDC? How would that demand vary depending on the economic design choices outlined in this paper?

14 To what extent might CBDC lead to disintermediation of the banking system? How would the degree of disintermediation vary with different economic, functional and technological design options outlined in this paper? How would different degrees of disintermediation affect the stability of banks and the rest of the flnancial system?

15 How would CBDC affect the monetary transmission mechanism and policy setting under existing monetary policy frameworks? What overarching analytical frameworks could be used for modelling how CBDC would affect the macroeconomy and monetary policy?

16 What are the most signiflcant risks to monetary policy implementation, and how could those risks be addressed?

17 How could CBDC affect the portfolio of unconventional monetary policy tools available to the central bank? How effective would a remunerated CBDC be in relaxing the effective lower bound on monetary policy?

18 How would increasing the efflciency of payment systems affect the macroeconomy and monetary policy?

7.4 Functionality and provision of CBDC

In the platform model of CBDC, presented in Chapter 4, the Bank would build a fast, highly secure, and resilient technology platform — the 'core ledger' — which would provide the minimum necessary functionality for CBDC payments. This would serve as the platform to which private sector flrms, called Payment Interface Providers, could connect in order to provide customer-facing CBDC payment services.

19 What are the advantages and disadvantages of this public-private payments platform approach? What alternative approaches might be considered?

20 Are there viable business models that would incentivise flrms to offer CBDC-related payment services in this approach?

21 What are the respective advantages or disadvantages of (a) the pooled accounts model described in Chapter 4.2, and (b) the alternative approach described in Box 3 in Chapter 4?

In the platform model, Payment Interface Providers would build 'overlay services' — additional functionality that is not part of the Bank's core ledger, but which could be provided as a value-added service for their users.

22 What kind of overlay services would be most useful? What functionality would a CBDC core ledger need to provide to enable these?

23 How could CBDC be designed to ensure businesses are able to easily accept CBDC payments at the point of sale?

24 What would be needed to ensure that CBDC would be inclusive and accessible by all sectors of society in the UK?

25 What is the appropriate privacy model for CBDC? Is it necessary, or feasible, to replicate any of the privacy aspects of cash?

26 Would offline payments functionality be required in CBDC?

7.5 Technology, infrastructure and further innovation

As discussed in Chapter 6, the technology used to power CBDC should be chosen on the basis of what best meets our design principles. It will therefore be necessary to understand the potential of a range of different technologies, and the trade-offs each of these presents.

27 The paper describes a core ledger, operated by the Bank, which supports a range of Payment Interface Providers through an API layer. What are the advantages and disadvantages of this architecture? What are the alternative architectures that we should consider?

28 What are the main trade-offs that arise in deciding on a technology approach? What should we be prioritising in these trade-offs?

29 The core ledger for this model of CBDC could be centralised, or operated through a consensus-driven distributed approach. Which is the optimum approach, and why?

30 What are the merits, or challenges, of either 'token-based' or 'account-based' approaches to a CBDC ledger? Are there particular use cases that are better supported by either approach? Are there alternative approaches?

31 What are the key use-cases for programmable money?

32 What architecture choices would best support programmable money functionality in a CBDC? Would it be preferable to build this functionality into the core ledger, via a separate module, or to enable the functionality to be provided by third parties? Are there alternative approaches?

33 How could CBDC support offline functionality? Are there technology solutions that can enable this without exposing any party to credit risk?

34 What dependencies would CBDC have on other innovations, such as digital identity solutions?

35 What other future technology and digital economy innovations should we be factoring into the potential design of CBDC? How might these impact the future demands placed on CBDC, and potential approaches to designing a CBDC?

Appendix: UK initiatives to improve payments

In Chapter 2 we set out a number of areas in which CBDC could potentially offer improvements to UK payments. This appendix describes some existing initiatives in the UK that will also contribute to improvements in these areas.

Joint Authorities Cash Strategy Group and the Wholesale Distribution Working Group

In the UK, the Access to Cash Review (commissioned by ATM network LINK) concluded that the UK is not yet ready to go cashless (Access to Cash Review (2018)). It set out flve recommendations, which call for: more co-ordinated regulation and oversight of the whole cash system; a new wholesale cash infrastructure; a guarantee that the public will be able to access cash services; that cash remains widely accepted; and that digital payments are an option for everyone (Access to Cash Review (2019)). The flrst two of these recommendations are directly relevant to the Bank's responsibilities on cash.

The Bank's formal responsibilities with respect to cash are: it is the sole issuer of banknotes in England and Wales; it delivers effective protection for holders of Scottish and Northern Ireland banknotes; and it oversees how banknotes are then distributed to the wholesale market (for example, entities such as banks and the Post Offlce). Therefore, in 2019 the Bank convened relevant industry stakeholders to develop a new system for wholesale cash distribution that is efflcient, resilient and sustainable, including in a world with lower cash volumes.

To ensure access to cash, the public needs to be able to withdraw and deposit cash. Given the shared responsibilities in this area, the Joint Authorities Cash Strategy Group was created. It has brought together HM Treasury (as chair), the Payments Systems Regulator, the Financial Conduct Authority and the Bank, with the objective of supporting access to cash for those who need it.

Open Banking and PSD2

Open Banking and PSD2[1] require banks and other payment service providers to share customer flnancial transactional data with authorised third parties in a standardised way (ie through APIs), with customer consent. This is designed to increase competition in the banking sector, and enable third parties to innovate and create new flnancial products. Furthermore, customers have the ability to authorise these third parties to automatically initiate payments on their behalf. Examples of innovation enabled by these directives include the emergence of flnancial aggregators (which allow customers to view their account information from different providers through a single interface, making it easier for customers to compare products from different providers), personal flnancial managers (which provide insights on customer spending and in some cases provide flnancial advice), and services to support SME flnancial management (allowing the automation of functions such as invoicing, tracking payments and managing payslips).

RTGS renewal

The Bank, as operator of the sterling Real-Time Gross Settlement (RTGS) service, is seeking to promote innovation in payments by expanding access to settlement in central bank money and through renewing RTGS. This could reduce the cost of on-boarding as a direct participant in domestic payment systems.[2] In 2017 the Bank announced that Electronic Money Issuers (EMIs) and payment institutions authorised by the FCA could start applying for RTGS settlement accounts.[3] To date, around half a dozen flrms have joined and others are in the pipeline.[4]

(1) Open Banking is a directive issued by the Competition and Markets Authority (CMA) that came into force in January 2018. PSD2 is EU's Revised Payment Services Directive.
(2) See RTGS Renewal Programme and A blueprint for a new RTGS service for the United Kingdom, Bank of England (2017).
(3) Settlement accounts allow flrms to offer settlement in central bank money directly to their clients, rather than over the books of a bank. They are intraday accounts and need to be funded at the beginning of the day and defunded at the end of the day.
(4) Access to UK payment schemes for non-bank payment service providers, Bank of England, FCA and Pay.UK (2019).

The programme to deliver a renewed RTGS aims to enhance resilience and promote innovation. The service will offer a range of new features and capabilities for payments and settlements between flnancial institutions. The vision is to develop an RTGS service which is flt for the future. This means increasing resilience and access, and offering wider interoperability, improved user functionality and strengthened end-to-end risk management of the UK's High Value Payment System. The flrst major milestone will be the move to ISO 20022 messaging in 2022, followed by the transition to a new core ledger in 2023.

Figure A.1 Our vision for the new RTGS service

By developing a RTGS service with features such as a flexible and modular architecture, near-24/7 operating capacity and an API layer to support automated data transfer, the Bank is seeking to ensure it can accommodate and facilitate the emergence of new business models in payments.(5)

There are new settlement systems emerging (such as Fnality), proposing to issue digital settlement tokens that would be fully backed by central bank money, allowing instant settlement. The Bank aims to publish proposals on how, and under what conditions, new settlement providers could open accounts at the Bank to facilitate similar innovative wholesale settlement models.

Balance Sheet Access Review

The Bank's response to the 'Future of Finance' report committed to 'consult in 2020 on the appropriate level of access to the Bank's payments infrastructure and balance sheet, including necessary safeguards'. Our focus is on whether, and how, to give non-bank payments service providers (NBPSPs) the ability to hold deposits at the Bank overnight. It is critical that access supports fully the stability and resilience of the system while also allowing innovation in payments.

Pay.UK's New Payments Architecture

In 2018 the operators of the main UK retail payment schemes — Bacs, FPS and Cheques — were consolidated into Pay.UK. Pay.UK are now developing the 'New Payments Architecture' (NPA) that will replace the existing interbank retail payment systems with an aim to develop world-leading infrastructure that supports instant settlement with a view to ending multiple-day clearing cycles (in Bacs and cheque clearing) and ensuring fast and resilient 24/7 clearing. The goal is to establish a system that is easy to access, easy to upgrade and innovate on, and able to provide new capabilities that payment service providers (including banks) can exploit for their customers' beneflt. Successful delivery of the NPA will provide a highly resilient and instant payment system for interbank payments.

(5) A new messaging standard for UK payments: ISO 20022, Bank of England (2020).

HMT Payments Review

At Mansion House the Chancellor announced a Treasury-led review of the payments landscape that brings together policymakers and regulators to ensure that regulation and infrastructure keeps pace with new payment models. The review aims to investigate what the UK needs to do to remove barriers and support a more resilient and innovative payments system with more diversity of payments methods. This includes the methods available to make payments and the services and systems that facilitate this. The objectives include action to explore if amendments are needed to 'future-proof' the regulatory approach for changes in the payments landscape.

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Central banks and the future of digital money

An overview and proposal for central bank digital currency on the Ethereum blockchain

Prepared by ConsenSys AG
January, 2020

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Foreword

Davos, 20 January, 2020

As the World Economic Forum meets in Davos for the 50th time, it does so against the backdrop of a sea change in the mechanics of money.

The rise of cryptocurrencies and blockchain technology over the last decade has brought about new possibilities in the issuance and use of money as well as exciting new forms of digital assets and markets. At the same time a rapidly evolving geopolitical, economic and social environment has created new expectations and new requirements for secure, reliable, easy-to-use, globally available digital payments and means of exchange.

Among the most significant innovations we are witnessing today are stablecoins, or privately issued cryptocurrencies pegged to a stable asset, which today have a market cap over $5B USD, as well as the parallel phenomenon of central bank-issued digital currencies, commonly referred to as CBDC, that are the subject of this paper.

According to the Bank of International Settlements, over 70% of central banks are looking at issuing a digital currency on a blockchain. We think this is a development to be applauded.

CBDCs can offer a range of advantages. They can play a central role in advancing the digital assets revolution in a regulated, lower-risk and – crucially – accessible way, helping make financial markets more efficient and available to all global citizens. CBDC can give the central banks more effective, future-oriented tools to allow them to implement monetary policy in

more direct and innovative ways and keep pace with technological change. CBDCs could also simplify and reduce the cost of cross-border remittances, while forming the basis for more efficient, more secure interbank payments networks. The list goes on.

Below we provide both an overview of CBDC and a concrete example of how a CBDC might be implemented on the Ethereum blockchain. We believe that Ethereum is the best-suited blockchain network for the kind of maximally secure, global-scale, interoperable settlement platforms that CBDCs require. But we are well aware that there are many other possibilities.

What is important is that central banks have come to realise the extent of the transformations that are already happening in digital currencies, and that they see the importance of embracing a significant role in bringing about this change. We hope this paper provides a useful and thought-provoking example of one promising approach.

Joseph Lubin, Founder and CEO of ConsenSys, Co-Founder of Ethereum

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Executive summary

Over the past year we have seen a number of groundbreaking announcements from central banks around the world exploring the issuance of central bank digital currencies (CBDC). In this paper we provide an overview of the potential and risks of CBDC, as well as an example of how a CBDC could be designed and built on the Ethereum blockchain. The intention is to give the reader not just a good background to this important topic, but also – by means of a concrete proposal – a practical look at what the implementation of a CBDC might entail.

Blockchain-based CBDC, which represents a new technology for the issuance of central bank money at the wholesale and retail level, offers a number of potential advantages for central banks. It could be a strong catalyst for financial services innovation by providing a viable, large-scale payments system for tokenised assets markets – offering a risk-free, widely accessible alternative to privately-issued stablecoins, like Facebook's Libra, which serve a similar purpose but could expose users to credit and/or liquidity risk.

Widespread use of CBDC instead of private payment tokens could also help central banks retain sovereignty over monetary policy in tokenised assets markets, an important consideration should such markets come to represent significant portions of the economy. Other benefits include potentially new regulatory monitoring and enforcement tools, cheaper cross-border remittances, improvements to the interbank payments infrastructure and innovation in retail markets. CBDC could also be a superior replacement to physical cash, helping alleviate some of the risks and costs associated with banknotes. Depending on how it is designed, a CBDC could support financial inclusion by providing wide-scale access to risk-free reserves.

There are risks as well – particularly in retail CBDC (that is, tokenised central bank money accessible to the general public). For this reason, we propose that central banks issue CBDC on a large-scale, private, permissioned, Ethereum-based network in which central-bank appointed intermediaries act as nodes and service providers. In the proposed setup, the central bank would issue the currency as well as authorise and onboard intermediaries, but only intermediaries would distribute CBDC directly to the public. Because the integrity of the system is embedded in the technology, the number and type of intermediary service providers on this platform would however be much larger and broader than is the case with the distribution of central bank money today.

Such a setup recommends itself on many grounds. As the issuer of the digital currency, central banks would have direct control of the money supply, while users of the currency would not be exposed to the risks of private currencies. It would provide the basis for a large-scale, evolving and easily adaptable infrastructure offering a continuously expanding number of shared services to various stakeholders. End users would benefit from a much more open, vibrant, competitive and above all innovative environment than today, with secure and user-friendly access to the benefits of tokenised assets markets.

For reasons we lay out in the paper, we believe that Ethereum is one of the best technologies available today to meet the technical requirements for such a CBDC. But there are other possible solutions as well. What is important is that central banks have come to realise the importance of CBDC as an innovative tool, and that they continue to learn about and experiment with it.

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1. Introduction

From China to Sweden, Singapore to South Africa, over the past year we have seen a number of groundbreaking announcements from central banks around the world exploring the issuance of central bank digital currencies (CBDC).

The idea of digital money issued directly by a central bank is not new. The 1990s and 2000s saw a period of interest as well, particularly for retail uses among the general public, though for various reasons central banks ultimately decided not to pursue the projects.

Much has changed since then, both in the global economy and in the world of technology. The main catalyst for today's renewed interest in CBDC has been the advent of blockchain technology. And while explorations to date have been more ad hoc than holistic, with proofs of concept here and there to investigate specific aspects of the problem, the trend is clear.

In this paper we provide an overview of the history and current state of CBDC as well as an example of how a CBDC could be designed and built on the Ethereum blockchain. Our intention is to give the reader an overview of the potential advantages and the challenges in a CBDC as well as, through a concrete proposal for a specific approach, to move the debate beyond the theoretical.[1]

CRYPTOCURRENCIES, STABLECOINS AND THE EVOLUTION OF DIGITAL MONEY

A blockchain-based CBDC is a type of crypto asset. To understand the resurgence of CBDC today it is necessary to take a short look at the history of crypto assets in general.

The first crypto asset was Bitcoin. A "decentralised electronic cash system," Bitcoin billed itself as a new form of money whose main characteristics were that it

1 Note: While blockchain is not necessary to issue a CBDC, it offers many advantages, and the majority of CBDC projects under contemplation today are based on blockchain. For the purposes of this paper, therefore, we will use the term CBDC to refer solely to blockchain-based CBDC.

was fully digital, lived on a blockchain, and was independent of any government or private institution. Quickly dubbed a cryptocurrency[2], it was followed by an explosion in similar blockchain-based cryptocurrencies known as altcoins. In 2014 the Ethereum blockchain launched adding new capabilities, in particular full programmability on a blockchain allowing the creation of "smart contracts." With this it became possible to represent almost any asset, not just money, on a blockchain by means of a unique digital token (hence the term "tokenisation").

What makes crypto assets interesting is not the fact that they are digital representations of assets. Most assets today already exist in digital form as entries in computer databases. Rather it is the fact that they are digital assets represented on a distributed ledger that is a) shared in a network and b) that acts as a single source of truth about the assets and their ownership independent of any organisation or third-party authority.

Such decentralised, communally maintained ledgers have a number of advantages over the centralised ledgers that are used in the financial system today. Chief among these is that asset transfers on distributed ledgers do not require reconciliation between different databases – an extremely complex and costly process. Markets based on tokenised assets have a lot of promise, including – depending on the asset and use case – faster, cheaper and more secure infrastructure than in traditional markets, higher levels of automation, lower levels of risk and lower barriers to entry.

Despite this great promise, almost all crypto asset projects to date have run into a similar problem: the ability to execute payments in the real world of fiat currencies. Originally it was thought that cryptocurrencies like bitcoin or ether would be able to provide the means of payment in crypto asset markets and act as a bridge to the fiat world. But cryptocurrencies have proven to be extremely volatile, and cryptocurrency networks slow, cumbersome and complex

2 Cryptocurrencies are a subset of crypto assets.

for users. Today they are generally considered unsuitable as a means of payment.

The initial response to this problem in the blockchain community was stablecoins – cryptocurrencies that are either pegged to fiat currencies or that maintain a stable value by some other means.[3]

The first stablecoins began appearing in 2017, with one of the most well-known early projects being Tether. These were generally focused on solving the payment problem for blockchain-based platforms specifically. As people began to understand the value of stablecoins for tokenised asset markets, we have seen a second generation of stablecoin projects by private and public entities, often as part of consortia and with the participation of technology providers. These include Facebook's Libra, Fnality (formerly USC), Binance coin, JP Morgan's JPM Coin, Terra, USD Coin, the Gemini dollar and China's DC/EP project.

Of these, perhaps the most widely publicised has been Libra, and it serves as a good example of the promise but also the issues surrounding such projects. The Libra cryptocurrency will be stabilised by a basket of currencies and other assets[4], and potentially other means. While hailed as a way to help the billions of unbanked in the world, Libra has also raised concerns among central bankers, regulators and governments about infringements on monetary policy and risks to financial stability.[5]

While we see many benefits to stablecoins issued by private companies, the discussion around Libra highlights their limits as well. By leveraging blockchain technology for CBDC, central banks may be able to address some of these issues and so help realise some of the key benefits stablecoins can offer. In the rest of this paper, we look specifically at CBDC.

INTRODUCING CENTRAL BANK DIGITAL CURRENCIES

In modern societies there are two main types of fiat money. Central bank money is legal tender created and backed by a central bank. It represents a claim against the central bank and – with the crucial exception of cash in the form of banknotes and coins – is mainly used for wholesale payments. Commercial bank money is created by commercial banks when they issue credit, either through loans or credit lines. Most of the fiat money in the world is commercial bank money, and it is widely used as a retail means of payment,(with retail here meaning paymnt between non-financial institutions, corporates or individuals).

CBDC represents a new technology and approach for the issuance of central bank money, and can be characterised by the following:

- **Digital assets.** CBDC is a digital asset, meaning that it is accounted for in a single ledger (distributed or not) that acts as the single source of truth.

3 There are many different stablecoins in circulation today, using many different methodologies. A discussion of the types of stablecoins is beyond the scope of this paper however. We direct the reader to Stablecoins: The Complete Guide.

4 Libra "will be backed by a collection of low-volatility assets, such as bank deposits and short-term government securities in currencies from stable and reputable central banks." Libra White Paper, Section 04: The Libra Currency and Reserve.

5 Libra Crypto Is 'Undoubtedly' a Wakeup Call for Central Banks, Says ECB Exec, CoinDesk, 26 September, 2019.

- **Central bank-backed.** CBDC represents a claim against the central bank, just as banknotes do.
- **Central bank controlled.** The supply of CBDC is fully controlled and determined by the central bank.

We distinguish between two types of CBDC:

- **Wholesale CBDC.** CBDC that would be used to facilitate payments between banks and other entities that have accounts at the central bank itself.
- **Retail CBDC.** CBDC used for retail payments, for example between individuals and businesses, and akin to digital bank notes.

Blockchain technology could be used to support both types of CBDC. For example, it could be used as an alternative approach to existing wholesale central bank systems, either real-time gross settlement systems such as CHAPS, Target 2, Fedwire, or deferred net settlement systems like BACS, EURO1, TIPS, ACH. It could also be used to create platforms for the distribution of retail CBDC on a broad scale, and with it true, government-backed electronic cash.

According to the BIS, today some 70% of central banks are looking at CBDC, with the majority of them considering blockchain as the underlying technology.[6] While many of these banks have expressed interest in both wholesale and retail use cases, most of the admittedly few actual experiments or pilots carried out to date have focused on wholesale. These include Project Ubin[7] by the Monetary Authority of Singapore, Project Khokha by the South African Reserve Bank[8], China's DC/EB[9], and Project Stella[10], a joint research project by the ECB and the Bank of Japan.

Despite the current focus on wholesale, many industry observers think there is high potential for both wholesale and retail CBDC, and that central banks will consider both.

6 Proceeding with caution – a survey on central bank digital currency, BIS Papers 101, January 2019.
7 Project Ubin Phase 2, Accenture, November 2017.
8 Project Khokha: Blockchain Case Study for Central Banking in South Africa, ConsenSys Case Study.
9 China's digital renminbi could increase commercial bank competition, Ledger Insights, January 2020.
10 Project Stella: the ECB and the Bank of Japan release joint report on distributed ledger technology (Phase 3), Bank of Japan, 4 June 2019.

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2. Benefits of digital currencies for central banks and the economy

While we have yet to see CBDC projects in production and so have no empirical evidence of their impact, many believe CBDC can offer a number of significant benefits for central banks and the wider financial system. These include the following.

FOSTERING THE DIGITAL ASSETS REVOLUTION

Digital assets in general are set to disrupt today's capital markets, offering among other things cheap issuance and distribution, massively increased efficiency and flexibility due to programmability, instant delivery versus payment, and automated lifecycle management.

As tokenised asset markets are created there will be a need for tokenised payments for the immediate settlement of transactions. CBDC could be the key ingredient in introducing a viable, broad-based blockchain-based payments system that could enable a large-scale, decentralised clearing house and asset register and in turn allow digital assets to reach their potential.

If central banks do not issue their own digital currency, the markets will move to private payment tokens. This would expose users to various risks. There is credit risk: if private issuers fail, holders of the currency would lose all their money. Privately issued tokens may also not be accessible to all, leading to financial exclusion. A CBDC would represent a risk-free, widely accessible alternative.

It could have other benefits too. It could help bring massive efficiencies and cost savings to the financial system. Studies have placed the cost of clearing and settling securities in G7 countries at over USD 50 billion per year, mostly due to the resources needed to transfer the assets and reconcile accounts.[1] By replacing various middlemen and providing for increased automation, a decentralised clearinghouse based on a distributed ledger could be a far cheaper and, through reduced complexity, a likely more secure system.

1 Speech by Mr Ben Broadbent, Deputy Governor for Monetary Policy of the Bank of England, at the London School of Economics, London, 2 March 2016.

An international equivalent for tokenised national currencies could also reduce risk in foreign exchange transactions by allowing for payment-versus-payment settlement approaches. That could have benefits for governments, but also for millions upon millions of businesses and individuals.

Central banks might also find CBDC to be superior to physical cash. In some countries the creation and distribution of banknotes is expensive and can be a major catalyst for unlawful activity. In many parts of the world it is also difficult for citizens to access physical cash because they live far from bank branches and ATMs. CBDC could be distributed easily on mobile phones, which would help address these problems.[2]

Retail CBDC could also be a way to offer individuals access to digital and risk-free reserves, something that is only available to major financial institutions at the moment. This could be a major advantage in the many parts of the world bank where deposits are not insured and where depositors risk losing all if a bank becomes insolvent. As this is generally not an issue with a central bank, CBDC does not carry this risk.

FUTURE-ORIENTED MONETARY POLICY AND REGULATORY TOOLS

As noted, if central banks do not issue their own digital currency, then privately issued payment tokens – which for all intents and purposes are akin to digital cash – will be the only choice for payments. In some developing countries we are already seeing a significant decrease in the use and acceptance of banknotes in favor of digital solutions. If, as many believe, such solutions become very large and broad-based, they can potentially represent significant, systemically relevant portions of the economy.

If central banks do not have their own digital currency as a basis for payments in these markets, then they risk losing some of their ability to carry out their monetary policy and

2 Projects such as mPesa have shown that the mobile phone is an excellent distribution mechanism for digital forms of money in developing countries.

regulatory mandates. CBDC would mitigate this risk by giving central banks direct influence over all or a portion of the money supply in digital markets.

CBDC could also give central banks new tools for expanding and reducing the supply of money. It could make it easier to employ innovative retail-oriented interventions, for example, direct distribution of money to individuals (as opposed to the indirect methods typically used by governments today, like tax breaks). It could help central banks fight against financial and social exclusion for individuals and enterprises that do not have access to commercial bank created money, for instance due to reasons of cost or availability. If the retail CBDC bears interest, either positive or negative, it could strengthen their ability to pass through policy interest rates to money and lending markets as well as directly to individuals. Finally, if structured in a way that allows the CBDC to be traced, it could be useful in more efficient sanctions and AML enforcement contexts.

CHEAPER CROSS-BORDER REMITTANCES

Today, cross-border payment transactions, whether for businesses or individuals, are very expensive. This is generally a function of the state of the technology when the infrastructures for cross-border payments were developed, which at the time did not allow for direct transfer without intermediaries. In the current financial system, a typical cross-border payment involves transfers through several different correspondent banks, with the attendant cost of transacting and reconciliation as well as significant wait times. For individuals – in particular migrant workers sending remittances back home, one of the largest sources of financial inflows to developing countries – there is the added cost of the dense network of physical outlets at both the sending and receiving end.

If we imagine a world where both the origin currency and the destination currency are based on CBDCs, it is quite easy to imagine money transfer systems that are almost entirely automated and use cryptographic techniques to permit interoperability between different systems and distributed ledgers. Many financial actors can then connect to these ledgers and compete to offer the best price and service to customers, driving costs down and reducing delays. With the prevalence of mobile phones among all sections of the population, including in developing countries, such a system would also obviate the need for physical distribution outlets, further driving down costs.

IMPROVING THE SETTLEMENT OF INTERBANK PAYMENTS

Today the settlement of interbank transactions using central bank money is increasingly carried out on Real-Time Gross Settlement (RTGS) systems. These have the advantage of settling payments on an individual order basis between counterparties, instead of netting payments

at the end of the day.[3] The downside to these systems is that they rely on batch processing overnight and require collateral to cover the outstanding positions. These systems therefore do not completely eliminate settlement risk. Many RTGS systems today also rely on antiquated technology, including mainframes, older programming languages like Cobol, or messaging platforms like SWIFT, and as a result, have a certain amount of operational risk.

With CBDC, interbank payments would be much more akin to the transfer of digital cash (albeit in very large amounts), and would be true real-time payments between counterparties with no settlement risk and greatly reduced operational risk. We can also expect CBDC-based systems to be more secure and performant than current approaches.

ACCELERATING INNOVATION IN RETAIL MARKETS

Even though real-time money transfers can be made quite cheaply and in quasi real-time by centralised settlement platforms like SEPA, it does not mean that all consumers and businesses have access to real-time and low cost remittances.

In fact, many financial institutions charge their customers for real-time money transfers at rates well above the cost that they incur. While some of this revenue is necessary to fund their operations, it could be considered unfair that end users are not able to take advantage of the technological improvements driven by central banks. Additionally, in some developing countries, particularly in South East Asia, the fact that intra bank payments are free and inter bank money transfers are not free or not real-time, has resulted in massive competitive advantage for the largest bank networks, which have disproportionate access to consumer deposits, which diminishes competition in the retail and SME banking sectors.

In this context, the creation of central bank-sponsored digital currency, freely and quickly transferable between users, can be a way for regulators to set new market standards, encouraging retail financial institutions to improve their value proposition to consumers and SMEs. This could include extended operating hours, potentially 24/7, richer data in payment messages and transparency on processing status, higher interoperability between platforms and further supporting the development of programmable money, one of the great promises of blockchain.

3 Real-Time Gross Settlement (RTGS), Investopedia.

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3. Requirements for successful implementation of CBDC

While there are many benefits to CBDCs, before they can be introduced many challenges will need to be tackled and risks will need to be addressed. There are also a number of key design decisions that will need to be taken, some of which will have far-reaching consequences in terms of how the CBDC is used and its potential impact. In this section we outline some of the requirements and issues that central banks will want to keep in mind.

WHAT KIND OF CBDC

First and foremost, central banks will need to make a fundamental decision about who will have access to the CBDC. The basic choice will be between a retail or wholesale CBDC, or both. The answer will depend on the central bank's goals for the CBDC. For instance, wholesale CBDC can support financial innovation and add efficiencies and lower cost to interbank payments. Retail CBDC can be a way for central banks to provide risk-free, easy to use digital cash to the general public.[1] The central bank will also want to decide to what extent it sees the CBDC as a tool for monetary policy, and in particular whether the CBDC should be interest-bearing.

DISTRIBUTION

While central banks will be the issuers of CBDCs, they will have to decide on how they will be circulated. Here there are a wide variety of choices, running from reliance on banks and select institutions to distribute CBDC, as is done today with central bank money, to using CBDC as an opportunity to increase the number of intermediaries with access to central bank money (which is what we propose below), to distributing CBDC directly to the public, something which could easily be done with a blockchain-based CBDC platform.

SOUND GOVERNANCE

Another crucial issue is governance. While decentralised systems offer many advantages, a broad-based decentralised platform with no responsible entity can be

1 For more see Central Bank Digital Currency: One, Two or None?, Christian Pfister, Banque de France Working Paper, October 2019.

problematic. Lack of structured governance could hamper decision making both on the technical and design level, making it hard for the platform to evolve. Lack of clear ownership would raise many difficult legal and regulatory questions, for example around liability if things go wrong.[2] There would therefore be a need for a controlled and regulated infrastructure with clear governance structures in terms of design, development, maintenance, funding, upgrades and the like.

PRIVACY VERSUS TRANSPARENCY

It will technically be possible to design CBDCs with various mixes of anonymity versus traceability of transactions. Central banks will have to decide on the appropriate balance between privacy and transparency. While each bank will draw its own conclusions, one promising option is to provide high privacy for small transactions by retail users, similar to cash today, while programming in high traceability for larger transactions, whether by individuals or corporations. This would allow for the implementation of KYC/AML procedures on those transactions.

TOKEN-BASED OR ACCOUNT-BASED

Another important design decision is whether the system should be token-based or account-based. In a token-based system, the CBDC is created as a token with a specific denomination. The transfer of a token from one party to another does not require reconciling two databases, but is rather the near-immediate transfer of ownership, very much like handing over banknotes from one person to another.

In an account-based system, the central bank would hold accounts for users of the CBDC, and would handle the debit and credits between users itself. Currently central banks offer accounts for financial institutions, some non-bank financial intermediaries, and in certain cases, retail customers. In this approach, central banks would have to hold accounts for all users of

2 Legal and regulatory framework of blockchains and smart contracts, EU Blockchain Observatory and Forum, September 2019.

the currency, meaning exponentially more accounts to manage.

We recommend a tokenised model on several grounds. It would for instance enable business models based on asset tokenisation, and so be the basis for significant innovation. Second, it would free the central banks from the duties of large-scale account keeping and reconciliation, as well as the attendant reputational risks should things go wrong or service quality be poor.

PERFORMANT AND OPERATIONALLY ROBUST

To achieve significant adoption, the service will need to be performant and provide a good user experience. That means it needs to be operational 24/7, be highly reliable (with no or very few failed transactions), and be fast, with near-immediate transaction speeds.

Assuming 100 million citizens carrying out one transaction per day, that implies an infrastructure with throughput rates in the thousands of transactions per second. No blockchain technology at the moment can deliver such rates at the base protocol layer, but with a mix of protocol additions as well as ongoing improvements to the base technology, we expect that this will be possible in the future. To meet user needs, the platform should also allow offline transactions.

The system should also be robust, with the capacity to continue operations even if a certain percentage of nodes are down. It should also be easy for new or disconnected nodes to come online and quickly sync with the network. It will also need a highly available and reliable backup capacity. The system will need to be safe and efficient, maintaining the integrity of its payment, clearing and settlement arrangements under all conditions, and offering both expeditious transaction finality as well as controlled reversibility of transactions when necessary.

Finally, the system will have to be well protected against cyber and other operational risks through a mix of appropriate systems, policies, procedures and controls. It should also be highly interoperable with existing and future systems, able to integrate easily into new contexts and adapt to new needs as they arise.

LEGALLY SOUND

A broad-based CBDC platform will need to be legally sound as well. That means ensuring that the CBDC enjoys protections under existing legislation including payment law, contract law, settlement finality provisions, insolvency law and conflicts of law regimes in their local jurisdictions.

As a new approach to money, CBDC may well require adjustments to regulations to take into account its new properties. There are other new legal questions as well. For example, as opposed to physical cash, it would be possible to restrict the usage of CBDC to only allow its use by citizens or residents of a certain country. Central banks, policy makers and the courts will be tasked with finding appropriate use for such capabilities and responses to such issues.

UNDERSTAND THE RISKS

While we have outlined many potential benefits of CBDC above, we are fully aware that there are risks as well. Considering the far-reaching innovation potential of CBDC, and in particular retail CBDC, before implementing them, central banks will want to conduct comprehensive analyses of their potential impact.

For example, one issue raised by retail CBDC is the potential negative impact on commercial bank deposits as people withdraw funds from commercial banks in favor of central bank money. This could weaken banks, forcing them to either increase the interest they pay on deposits to attract customers, or raise interest rates on loans to maintain adequate funding. In times of crisis, outflows could increase dramatically, leading to large-scale bank runs. This would cause the central bank balance sheet to balloon, and would oblige it to support the commercial banks, which in turn would mean expanding the balance sheet and exposing them to credit risk of the financial institutions they are supporting.

There are other risks as well, and central banks will want to understand the opportunities and risks of their approach ahead of time.[3]

3 For an overview see Central Bank Digital Currencies: 4 Questions and Answers, IMF Blog, 12 December, 2019.

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4. Proposed architecture for Ethereum-based central bank money

In this section we propose an architecture for a CBDC implementation on the Ethereum blockchain.

AN OPEN, INTEROPERABLE, PROVIDER-BASED SYSTEM

We propose that central banks issue CBDC on a large-scale, private, permissioned, Ethereum-based network in which central-bank appointed intermediaries act as nodes.

These intermediaries would work together on a single platform as providers of the currency, as well as compete to offer innovative services to citizens and businesses. The number and type of intermediary service providers would be much larger and broader than is the case with central bank money today, incorporating financial and non-financial institutions, but the system would not entail direct distribution of CBDC to the public.

Such a setup has many advantages.

First, using a permissioned blockchain, central banks would retain control over the onboarding and distribution of the CBDC to the intermediaries they choose, and would therefore maintain oversight and control, allowing them to act as wardens of the ecosystem without having to provide or manage the services themselves.

Second, since the tokenised CBDC that underlies the system is issued by the central bank and not the intermediaries, it is the CBDC and not the intermediary's balance sheet that is on the line. In the event that an intermediary goes into liquidation, it will not put the record of ownership of the digital currency at risk as the digital currency is in the e-wallet of the customer and in the blockchain ledger of the central bank.

Third, it would provide the basis for a large-scale, evolving and easily adaptable infrastructure offering a continuously expanding number of shared services to various stakeholders. Because the stability and integrity of the system is embedded in the technology, the technical and prudential requirements to be an intermediary would be much lower than those required to be a

bank or e-money provider. End users would benefit from a much more open, vibrant and competitive environment than today, while intermediaries will become more and more like utilities.

Fourth, it would allow for standardised identifiers and identity mechanisms as well as mutualised control mechanisms, for example for KYC/AML, which could simplify and reduce the cost of compliance for all stakeholders, while likely improving their effectiveness.

Fifth, the system would be easy and secure for end users, as it would allow for service providers to offer key management and custodial services, as well as compete to develop user friendly wallets and related services.

Finally, as an Ethereum-based platform, it would be easily interoperable with the public Ethereum network as well as other blockchain networks, allowing for broad, far-reaching use cases in many different contexts, including in settlement networks in other jurisdictions.

TECHNICAL REQUIREMENTS FOR OUR PROPOSED ARCHITECTURE

The system described above implies the following list of requirements:

- **Full control of the money supply by central banks.** The central bank is the only entity allowed to issue CBDC units and remove them from circulation.
- **Quasi-real-time asset transfer at negligible cost.** Transaction times should be fast, with transfers occurring at or near real-time, and at a sub-one tenth of a cent (<0.1 EUR) cost.
- **High transaction throughput.** The system should offer several thousands to several tens of thousands of transactions per second on the network.
- **Large number of network participants.** The system should support several hundred to several tens of thousands of approved intermediaries as network participants, which is the likely number

of financial and non-financial institutions and intermediaries that we can expect for a large-scale CBDC in an area like the eurozone.

- **Privacy of consumer data and transactions.** In our view, central banks should not have a comprehensive view on individual wallets and associated IDs below a certain transaction value threshold when KYC/AML requirements would kick in (see below).
- **Confidentiality of business data.** The system should also support confidentiality of critical business data of the intermediaries on the network. While the central bank would maintain a view of all large transactions, individual network participants would not be able to see the volumes or individual transactions of their competitors.
- **Compliance with KYC/AML and related regulations.** The system supports the implementation of KYC/AML and related regulations by providing traceability and monitoring capabilities to the relevant authorities. As mentioned above, we believe this should only be possible above a certain threshold.
- **Asset recovery.** The system should allow for the reversing of transactions under legally acceptable conditions, as well as the ability for end users to recover lost or misplaced funds.
- **Acceptable environmental impact.** The system should be able to run at acceptable energy usage levels so as not to have a negative environmental impact.

WHY ETHEREUM FOR CBDC

Ethereum is a decentralised, open source and distributed computing platform that was launched in 2015 as a more versatile version of the Bitcoin blockchain.

Today public Ethereum is the second-largest blockchain platform by market capitalisation, behind Bitcoin, and Ethereum has by far the largest developer community of any blockchain protocol. While public Ethereum is permissionless, meaning open to all, Ethereum has permissioned variants capable of offering enterprise grade security and performance. We believe that private, permissioned Ethereum would offer the best possible platform for the CBDC requirements specified above.

Ethereum is by nature well suited to the creation of tokens. Central banks could easily design and implement tokens that can be widely circulated yet whose issuance and destruction remain firmly under their control. As these tokens live natively on the network, they do not depend on a single issuer who establishes point-to-point private communication channels with each participant.

Ethereum offers robust permissioning capabilities that would allow central banks to easily authorise and deauthorise network participants, allowing them to maintain control over who is on the network and what activities they are authorised to carry out. Private Ethereum networks using proof-of-

authority (PoA) consensus can offer quasi-real-time asset transfers at negligible cost.

While no blockchain has the technology to support the required transaction throughput levels today, Ethereum is well placed to be able to do so in the near future. The switch to proof-of-authority at the protocol level (Level 1) and the introduction of a number of Level 2 solutions, like state channels, plus ongoing R&D efforts in the Ethereum community, will make these performance levels possible. The large number of developers on Ethereum means these R&D efforts are not only robust, but also multifaceted.

As the global user base of public Ethereum shows, the protocol is well suited for large-scale platforms. Ethereum can also easily handle the privacy and confidentiality requirements of a CBDC, through a mix of public and private smart contracts complemented by cryptographic techniques such as zero-knowledge proofs, homormorphic encryption and secure multi-party computation or newer technologies like rollups.

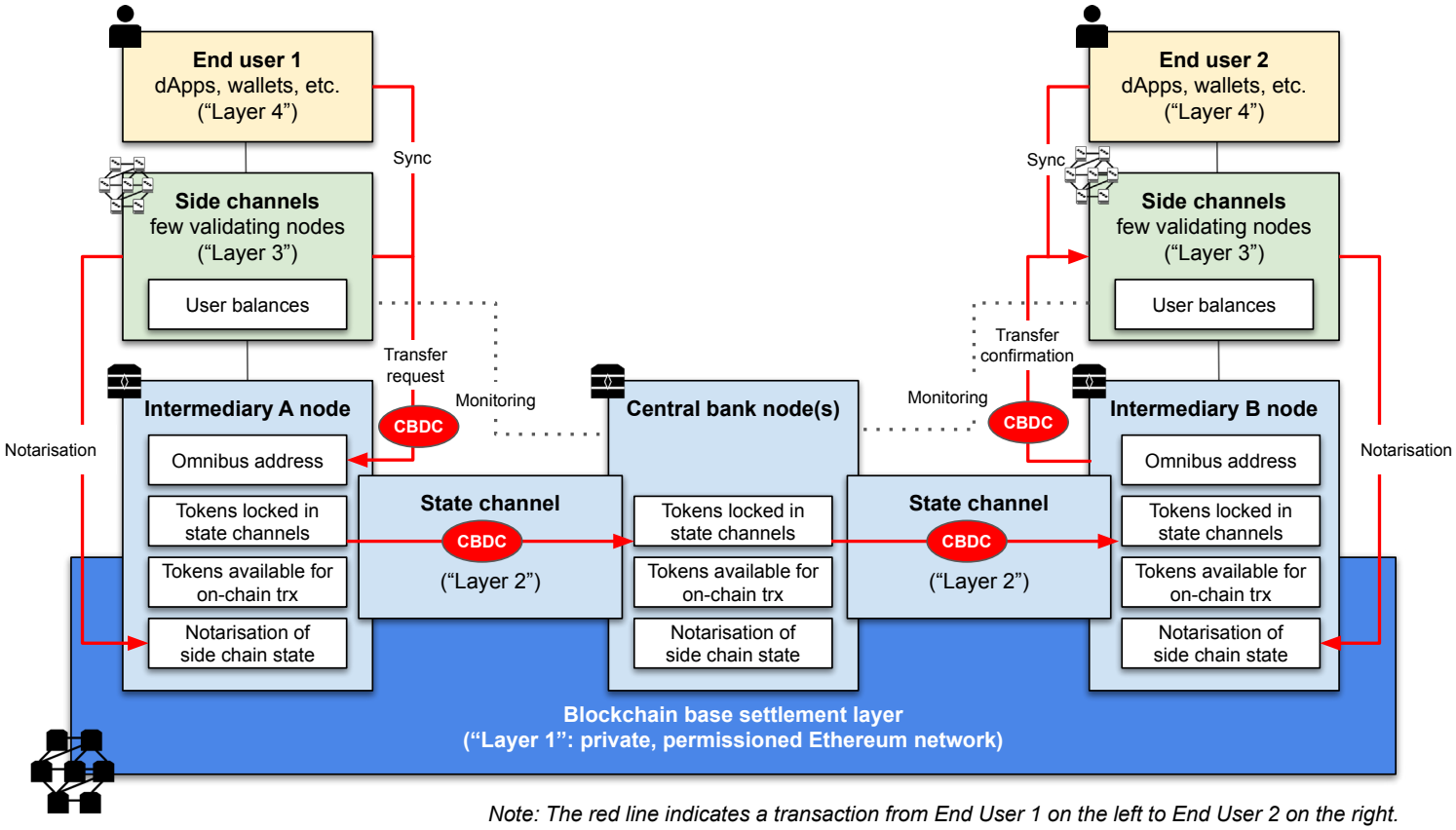
Tokens are powered by smart contracts, which are software applications that live in a distributed fashion in the network. These smart contracts can be programmed rules and business logic that are automatically enforced by the network and can restrict CBDC transfers in any way deemed suitable by the central bank and the regulator. This could make it possible to for instance "hard wire" KYC/AML procedures into the tokens themselves, greatly simplifying and improving the effectiveness of regulatory compliance mechanisms. Tokens could also be pre-programmed with rules that determine exactly under what conditions a transfer can be reversed or assets recovered.

Last but by no means least, proof-of-authority (PoA) consensus on Ethereum is not energy intensive and would support a large-scale network at low energy cost and environmental impact.

TECHNICAL SCHEMATIC

The graphic on page 25 provides a schematic overview of our proposed architecture. It is divided into the following layers:

- **Layer 1/Base settlement layer (dark blue).** There is one base settlement layer on a permissioned Ethereum blockchain.
- **Layer 2 (light blue).** The next layer is comprised of a network of state channels between intermediaries that would enable fast payments.
- **Layer 3 (green).** In this layer each intermediary operates its own side chain, where the central bank or regulator is a participant and can ensure that the supply of money remains consistent with the supply of CBDC allocated to the intermediary in the base settlement layer
- **Layer 4 (tan).** At the top we find many different end user interfaces, offered by banks, telecom operators, mobile phone manufacturers, fintechs and other providers, each in competition with each other and with their own special functionalities, in order to provide the best possible end user experience via competition between these private providers.



Note: The red line indicates a transaction from End User 1 on the left to End User 2 on the right.
Source: ConsenSys

WHITE PAPER

5. Conclusion

There is growing debate surrounding the future of cash in the digital world, and this is posing new challenges to authorities and central banks around the globe. This debate is taking place against a backdrop of doubts about financial stability that were raised by the 2008 financial crisis, of the rise of (private) cryptocurrencies, the development of new digital payment methods, and the entry of large technology companies into the payments arena.

Most countries today are analysing the potential of CBDC, seeing it as a means for governments to maintain their role as issuers and stewards of national currencies and economies. Yet the introduction of a CBDC would itself mean major changes to the existing monetary system and would raise a number of fundamental economic, monetary policy and legal questions. It is no wonder that there is heated debate on the subject in both banking and academic circles.

There are certainly risks involved in issuing a CBDC, as we have touched on above, and central banks will have to weigh these carefully. But they will need equally to evaluate the risks of not issuing CBDC, or doing so too slowly. Without a CBDC, the future of digital money would be largely if not wholly in private hands, leaving businesses and individuals exposed to the risks of private issuers or lack of access to digital tokens in certain markets.

Similarly, being an early mover in the CBDC space could bring significant benefits to a currency, while being behind the curve compared to other jurisdictions could be costly. ECB President Christine Lagarde has said as much with regards to Europe's central bank.[1] Ideally, central banks should be working together to agree on CBDC standards that would allow them to interoperate across borders.

1 ECB should be 'ahead of the curve' on digital currency: Lagarde, Reuters, 12 December, 2019.

In this paper we have tried to both provide some background to the topic and its importance, as well as a concrete proposal as to how to implement a CBDC. While the introduction of a CBDC will involve more than a narrow, technical evaluation of the efficiency of a payments system, it is sometimes by jumping in and trying it out that policy makers and central bankers can get the best sense of both the big picture and the nuts and bolts of CBDC.

At ConsenSys, we strongly believe that Ethereum is one of the only technologies available today that has the potential to answer the technical requirements for such CBDC over the short and mid term. We have also gained a great deal of experience in a short time working with central banks and others on the topic, and thinking about the related issues, both big and small. We are happy to share our experience and expertise and encourage any interested party to reach out to us.

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CONSENSYS

FSB FINANCIAL STABILITY BOARD

Addressing the regulatory, supervisory and oversight challenges raised by "global stablecoin" arrangements

Consultative document

14 April 2020

The Financial Stability Board (FSB) is established to coordinate at the international level the work of national financial authorities and international standard-setting bodies in order to develop and promote the implementation of effective regulatory, supervisory and other financial sector policies. Its mandate is set out in the FSB Charter, which governs the policymaking and related activities of the FSB. These activities, including any decisions reached in their context, shall not be binding or give rise to any legal rights or obligations under the FSB's Articles of Association.

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Addressing the regulatory, supervisory and oversight challenges raised by global stablecoin arrangements

Background

The G20 called on the FSB in June 2019 to examine regulatory issues raised by "so-called global stablecoin" (GSC) arrangements and to advise on multilateral responses as appropriate, taking into account the perspective of emerging market and developing economies (EMDEs).

This consultative document (i) describes GSCs and how they may differ from other crypto-assets and other stablecoins; (ii) analyses the potential risks raised by GSCs; (iii) considers existing regulatory, supervisory and oversight approaches to GSCs and (iv) identifies issues that regulators, supervisors and oversight authorities may need to address; (v) considers the specific challenges arising in a cross-border context, including the need for cross-border cooperation and coordination; and (vi) makes high-level recommendations for regulatory, supervisory and oversight responses, including multilateral actions.

The FSB is inviting comments on this consultative document and the questions set out below. Responses should be sent to fsb@fsb.org by 15 July 2020. Responses will be published on the FSB's website unless respondents expressly request otherwise.

1. Do you agree with the analysis of the characteristics of stablecoins that distinguish them from other crypto-assets?
2. Are there stabilisation mechanisms other than the ones described, including emerging ones, that may have implications on the analysis of risks and vulnerabilities? Please describe and provide further information about such mechanisms.
3. Does the FSB properly identify the functions and activities of a stablecoin arrangement? Does the approach taken appropriately deal with the various degrees of decentralisation of stablecoin arrangements?
4. What criteria or characteristics differentiate GSC arrangements from other stablecoin arrangements?
5. Do you agree with the analysis of potential risks to financial stability arising from GSC arrangements? What other relevant risks should regulators consider?
6. Do you agree with the analysis of the vulnerabilities arising from various stablecoin functions and activities (see Annex 2)? What, if any, amendments or alterations would you propose?
7. Do you have comments on the potential regulatory authorities and tools and international standards applicable to GSC activities presented in Annex 2?
8. Do you agree with the characterisation of cross-border issues arising from GSC arrangements?

9. Are the proposed recommendations appropriate and proportionate with the risks? Do they promote financial stability, market integrity, and consumer protection without overly constraining beneficial financial and technological innovation?

    a. Are domestic regulatory, supervisory and oversight issues appropriately identified?

    b. Are cross-border regulatory, supervisory and oversight issues appropriately identified?

    c. Do the recommendations adequately anticipate and address potential developments and future innovation in this sector?

10. Do you think that the recommendations would be appropriate for stablecoins predominately used for wholesale purposes and other types of crypto-assets?

11. Are there additional recommendations that should be included or recommendations that should be removed?

12. Are there cost-benefit considerations that can and should be addressed at this stage?

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Executive summary

So-called "stablecoins", like other crypto-assets, have the potential to enhance the efficiency of the provision of financial services, but may also generate risks to financial stability, if they are adopted at a significant scale. While such financial stability risks are currently limited by the relatively small scale of these arrangements, this could change in the future. Stablecoins are an attempt to address the high volatility of "traditional" crypto-assets by tying the stablecoin's value to one or more other assets, such as sovereign currencies. They have the potential to bring efficiencies to payments (including cross-border payments), and to promote financial inclusion. If widely adopted, however, a stablecoin could become systemically important in and across one or many jurisdictions, including as a payments infrastructure. Ensuring the appropriate regulatory approach within jurisdictions and internationally will therefore be important.

Against this background, the G20 mandated the FSB in June 2019 to examine regulatory issues raised by "global stablecoin" arrangements (GSCs) and to advise on multilateral responses as appropriate, taking into account the perspective of EMDEs. In February 2020, the G20 reiterated the importance of evaluating and appropriately addressing the risks of GSC arrangements before they commence operation and supported the FSB's efforts to develop regulatory recommendations with respect to these arrangements.

In response to these requests, this consultative document proposes 10 high-level recommendations that are addressed to authorities at jurisdictional level to advance consistent and effective regulation and supervision of GSC arrangements. This document also highlights key international financial regulatory standards from BCBS, FATF, CPMI and IOSCO that could apply to GSCs. These recommendations focus on financial regulatory and supervisory issues relating to privately-issued GSCs predominately intended for retail use. Wider issues such as monetary policy, monetary sovereignty, currency substitution, data privacy, competition, and taxation issues are beyond scope.

Through a stocktake of a broad mix of jurisdictions, the FSB finds that existing regulatory, supervisory and oversight regimes generally apply in whole or in part to stablecoin arrangements and address at least some of the risks they generate. Regulatory coverage is reported to be less comprehensive in many EMDEs.

The activities associated with GSCs and the risks they may pose can span across banking, payments, and securities/investment regulatory regimes both within jurisdictions and across borders. These potential risks may change over time, and so challenge the effectiveness of existing regulatory, supervisory and oversight approaches. GSCs also introduce specific vulnerabilities. For example, depending on the facts and circumstances, the decentralised nature of GSC arrangements could pose governance challenges; stabilisation mechanisms and redemption arrangements could pose market, liquidity, and credit risks; and, the infrastructure and technology used for recording transactions, and accessing, transferring and exchanging coins could pose operational and cyber-security risks.

Authorities expect stablecoin arrangements to adhere to all applicable regulatory standards and address risks to financial stability before commencing operation, and to construct systems and products that can adapt to new regulatory requirements as necessary. Authorities agree on the need to apply supervisory and oversight capabilities and practices under the "same business,

same risk, same rules" principle to address the emerging business models and technologies employed by a GSC and other crypto-assets. In some jurisdictions, however, the bundling of different attributes of a GSC could mean that not all of a GSC's functions fit within regulatory frameworks designed to apply by sector, such that existing approaches might need clarification, adjustment, or new regulation. In addition, a GSC could potentially substitute for domestic currencies, particularly in some EMDEs with volatile domestic currencies.

The performance of some functions of a GSC arrangement may have important impacts across borders. This requires authorities to take a holistic approach to regulation, supervision and oversight, and close international cooperation and information sharing.

Relevant authorities should, where necessary, clarify regulatory powers and address potential gaps in their domestic frameworks to adequately address risks posed by GSCs. This is critical to achieving common regulatory outcomes across jurisdictions and reducing opportunities for cross-sectoral and cross-border regulatory arbitrage, and enabling appropriate regulation and supervision of GSC arrangements as a whole.

To assist the authorities in developing a robust regulatory and supervisory response towards GSCs, this document:

(i) maps the vulnerabilities arising from various stablecoin functions and activities against the relevant regulatory authorities, tools and international standards (Annex 2);

(ii) analyses potential risks to financial stability arising from stablecoin arrangements (Section 2); and

(iii) outlines 10 high-level recommendations to advance consistent and effective regulation, supervision and oversight of GSC arrangements as well as effective cross-border cooperation and information sharing (Section 5).

These recommendations are motivated by GSCs predominantly intended for retail purposes that may pose financial stability risks, but could also apply to stablecoins or other crypto-assets that pose similar risks. The recommendations seek to address the particular governance challenges of a GSC arrangement. They call for regulation, supervision and oversight that is proportionate to the risks, and stress the need for flexible, efficient, inclusive, and multi-sectoral cross-border cooperation, coordination, and information sharing arrangements that take into account the evolution of GSC arrangements and the risks they may pose over time.

The FSB invites comments on the consultative document by 15 July 2020 and will issue a final report in October 2020.

FSB High-Level recommendations to address the regulatory, supervisory and oversight challenges raised by GSCs arrangements

1. Authorities should have and utilise the necessary powers and tools, and adequate resources, to comprehensively regulate, supervise, and oversee a GSC arrangement and its multi-functional activities, and enforce relevant laws and regulations effectively.
2. Authorities should apply regulatory requirements to GSC arrangements on a functional basis and proportionate to their risks.
3. Authorities should ensure that there is comprehensive regulation, supervision and oversight of the GSC arrangement across borders and sectors. Authorities should cooperate and coordinate with each other, both domestically and internationally, to foster efficient and effective communication and consultation in order to support each other in fulfilling their respective mandates and to facilitate comprehensive regulation, supervision, and oversight of a GSC arrangement across borders and sectors.
4. Authorities should ensure that GSC arrangements have in place a comprehensive governance framework with a clear allocation of accountability for the functions and activities within the GSC arrangement.
5. Authorities should ensure that GSC arrangements have effective risk management frameworks in place especially with regard to reserve management, operational resiliency, cyber security safeguards and AML/CFT measures, as well as 'fit and proper' requirements.
6. Authorities should ensure that GSC arrangements have in place robust systems for safeguarding, collecting, storing and managing data.
7. Authorities should ensure that GSC arrangements have appropriate recovery and resolution plans.
8. Authorities should ensure that GSC arrangements provide to users and relevant stakeholders comprehensive and transparent information necessary to understand the functioning of the GSC arrangement, including with respect to its stabilisation mechanism.
9. Authorities should ensure that GSC arrangements provide legal clarity to users on the nature and enforceability of any redemption rights and the process for redemption, where applicable.
10. Authorities should ensure that GSC arrangements meet all applicable regulatory, supervisory and oversight requirements of a particular jurisdiction before commencing any operations in that jurisdiction, and construct systems and products that can adapt to new regulatory requirements as necessary.

Glossary[1]

Algorithm-based stablecoins

A stablecoin that purports to maintain a stable value via protocols that provide for the increase or decrease of the supply of the stablecoins in response to changes in demand.

Asset-linked stablecoin

A stablecoin that purports to maintain a stable value by referencing real or financial assets or other crypto-assets.

Crypto-asset

A type of private digital asset that depends primarily on cryptography and distributed ledger or similar technology.

Digital asset

A digital representation of value which can be used for payment or investment purposes. This does not include digital representations of fiat currencies.

Global stablecoin (GSC)

A stablecoin with a potential reach and adoption across multiple jurisdictions and the potential to achieve substantial volume.

Stablecoin (or coin)

A crypto-asset that aims to maintain a stable value relative to a specified asset, or a pool or basket of assets.

Stablecoin arrangement

An arrangement that combines a range of functions (and the related specific activities) to provide an instrument that purports to be used as a means of payment and/or store of value. When discussing a stablecoin arrangement, reference is made to:

- **Activity**

  Typical activities in a stablecoin arrangement are: (i) establishing rules governing the stablecoin arrangement; (ii) issuing, creating and destroying stablecoins; (iii) managing reserve assets; (iv) providing custody/trust services for reserve assets; (v) operating the infrastructure; (vi) validating transactions; (vii) storing the private keys providing access to stablecoins (wallet); and (viii) exchanging, trading, reselling, and market making of stablecoins.

- **Function**

  Functions in a stablecoin arrangement are: (i) governing the arrangement; (ii) issuance, redemption and stabilisation of the value of coins; (iii) transfer of coins; and (iv) interaction with users for storing and exchanging coins.

[1] The glossary is for the purposes of this document and does not replace other existing taxonomies.

- **Governance body**

  A body responsible for establishing the rules governing the stablecoin arrangement which would cover, among other issues, the types of entities that could be involved in the arrangement, the protocol for validating transactions, and the manner in which the value of the stablecoin is "stabilised".

- **Provider of function/activity**

  An entity that provides a particular function or activity associated with that function in a stablecoin arrangement

- **User**

  A person or entity that uses a stablecoin as a means of payment or store of value.

- **Validator node**

  An entity on a network which validates transactions. In the context of distributed ledger technology, a node will commit transaction blocks to the ledger once they are validated.

- **Wallet**

  An application or device for storing the private keys providing access to stablecoins

Introduction

So-called "stablecoins" are a type of crypto-asset or, more broadly, digital asset.[2] Stablecoins may be used for different purposes. Some stablecoin projects have the ambition to facilitate payments, especially cross-border retail payments, which have remained relatively slow and expensive. A stablecoin, particularly if linked to a fiat currency or a basket of currencies, may become a widely used store of value. The use of stablecoins could also evolve over time, particularly so that a stablecoin initially intended to be used as means of payment could also be increasingly used as a store of value.

While the introduction of so-called GSCs has the potential to contribute to developing new global payment arrangements they could present a host of challenges to the regulatory, supervisory, oversight and enforcement authorities. This is because such instruments may have the potential to pose systemic risks to the financial system and significant risks to the real economy, including through the substitution of domestic currencies. Risks may relate to (i) challenges for financial stability; (ii) consumer and investor protection; (iii) data privacy and protection; (iv) financial integrity, including compliance with rules governing anti-money laundering and countering the financing of terrorism and proliferation (AML/CFT); (v) tax evasion; (vi) fair competition and anti-trust policy; (vii) market integrity; (viii) sound and efficient governance; (ix) cyber security and other operational risks; (x) the safety, efficiency and integrity of financial market infrastructures (FMIs) (e.g. payment systems); and (xi) resolution and recovery considerations.[3] No existing, operational stablecoins or other crypto-assets currently appear to have reached a scale that could pose financial stability risks. However, existing stablecoins or those at the development or testing stage could potentially scale quickly if such stablecoins were offered to and used by a large, existing customer base, though the factors and conditions that could drive such potential mass adoption may require further analysis.

Against this backdrop, the G20 mandated the FSB in June 2019 to examine regulatory issues raised by GSCs and to advise on multilateral responses as needed, taking into account the perspective of EMDEs. In line with the G20 mandate, this consultative document:

1. describes GSCs and how they may differ from other crypto-assets and other stablecoins (Section 1);
2. identifies the potential risks raised by GSCs (Section 2);
3. considers existing regulatory, supervisory and oversight approaches to GSCs and identifies issues that regulators, supervisors and overseers may need to address (Section 3);
4. considers the specific challenges arising in a cross-border context, including the need for cross-border cooperation and coordination (Section 4); and

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[2] This consultative document refers to stablecoins as a category of crypto-assets rather than using the broader reference to digital assets. The reference to crypto-assets was chosen for consistency with the FSB's prior publications.

[3] For a high-level overview of the risks posed by stablecoins, see the October 2019 G7 Report, "Investigating the impact of global stablecoins." https://www.bis.org/cpmi/publ/d187.pdf

5. proposes high-level recommendations for regulatory supervisory and oversight responses, including the need for multilateral actions (Section 5).

The focus of this consultative document is on financial regulatory, supervisory and oversight issues relating to privately-issued GSCs primarily used for retail purposes, as defined in Section 1 but it may also be relevant for other types of stablecoin or crypto-asset arrangements, including wholesale stablecoins. The document draws on the analysis undertaken within the FSB of potential financial stability risks and on a comprehensive survey of regulatory, supervisory and oversight approaches to stablecoins amongst FSB members and non-FSB members represented on FSB Regional Consultative Groups (RCGs).

In line with the mandate of the FSB, the document does not address the data privacy, competition, and taxation issues related to GSCs. The wider monetary policy, monetary sovereignty and currency substitution questions, the issue of public versus private provision of digital money and payment services and issues related to central bank digital currencies are also outside the scope of the analysis.

Along with the work done by the FSB, the G20 asked the IMF to consider the macroeconomic implications including monetary sovereignty issues in IMF member countries, taking into account country characteristics, and the Financial Action Task Force (FATF) to consider AML/CFT issues. This consultative document will not focus on AML/CFT considerations to avoid duplication of the work the FATF is leading. The FSB has been working closely with the IMF, the FATF as well as the other standard-setting bodies (SSBs) to ensure that the work underway is coordinated and mutually supportive. The FSB, the Committee on Payments and Market Infrastructures (CPMI), the FATF, and the International Organization of Securities Commissions (IOSCO), among others, are also monitoring market developments on an ongoing basis.

1. Characteristics of global stablecoins

The term *stablecoin* commonly refers to a crypto-asset that aims to maintain a stable value relative to a specified asset, or a pool or basket of assets. In turn, the value of these assets typically determines or affects the market value of a stablecoin. A stablecoin may also employ algorithmic or other means to stabilise or impact its market value by, for example, automatically adjusting its supply in response to changes in demand.

The term stablecoin does not necessarily denote a distinct legal or regulatory classification. Importantly, the use of the term "stablecoin" in this document is not intended to affirm or imply that its value is in practice necessarily stable.[4] Rather, the term is used here to ensure consistency, as the term stablecoin is commonly employed by market participants. Similarly, the attribute *global* refers to a stablecoin with a potential reach and adoption across multiple jurisdictions and the potential to achieve substantial volume, thus posing financial stability risks, rather than a specific legal or regulatory concept.

In the absence of a universally agreed, precise definition of stablecoin, it is important to identify the characteristics that may distinguish a GSC from other crypto-assets and other stablecoins,

[4] In fact, alternative terms such as private asset-linked tokens may characterise more accurately the technical nature of such instruments

and the materiality of such distinctions. This section highlights three such characteristics. The first two (the existence of a stabilisation mechanism and a specific combination of multiple functions and activities) distinguish stablecoins from other crypto-assets. The third, the potential reach and adoption across multiple jurisdictions, differentiates GSCs from other stablecoins.

1.1. Stabilisation mechanism

A stablecoin arrangement seeks to stabilise the value of the stablecoin through the use of a stabilisation mechanism. Stablecoin designs currently reflect two broad types of stabilisation mechanisms: asset-linked and algorithmic, with some approaches being a hybrid of the two:

- Asset-linked stablecoins purport to maintain a stable value by referencing real or financial assets or other crypto-assets. For example, many stablecoins attempt to achieve stability through a "peg" to a single fiat currency.[5] The mechanism by which the stablecoin's value is maintained in relation to the referenced asset may vary and includes the use of creation and redemption structures, arbitrage, and direct rights to receive underlying reserve assets. Depending on the structure, stablecoin holders may or may not have a redemption right against the issuer or direct claim on the reserve assets. Reserve assets may or may not be available to be used in case of a redemption request and may or may not benefit from consumer and investor protection arrangements or other guaranty schemes. Additionally, there may not be any assets in reserve if the stablecoin merely references another asset as a peg.
- Algorithm-based stablecoins attempt to maintain a stable value via protocols that provide for the increase or decrease of the supply of the stablecoins in response to changes in demand. While the amount to be increased or decreased may be based on an algorithm, the actual issuance or destruction may not be automatic.

1.2. Combination of multiple functions and activities

To be useable as a means of payment and/or store of value, a stablecoin arrangement typically provides three core functions:[6]

(i) issuance, redemption and stabilisation of the value of the coins;

(ii) transfer of coins;

(iii) interaction with coin users for storing and exchanging coins.

Considering these functions, stablecoins could share functional similarities with payment systems or financial services or products, such as deposit liabilities or securities (including collective investment schemes), and therefore be subject to the same risks. However, they may also pose new risks, depending on the design of the stablecoin arrangement.

Each of these functions involves a number of constituent activities. For instance, the issuance, redemption and stabilisation of the value of the coins typically involves creating and destroying

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[5] Other examples anchor to a mix of currencies, a combination of currencies and government bonds, and commodities, like gold.

[6] G7 (2019), https://www.bis.org/cpmi/publ/d187.pdf.

coins, as well as managing the corresponding reserve assets and providing custody/trust services for those assets. The transfer of coins typically entails the operation of a suitable infrastructure and a mechanism for validating transactions. The interaction with users typically occurs through devices or applications that operate as "wallets", which store the private keys providing access to stablecoins, as well as applications that enable the exchange of coins against fiat currencies or other crypto-assets. Considering this range of activities performed, a *stablecoin arrangement* is generally understood as an arrangement comprised of different, interrelated functions and activities that can be provided by one or several entities.

The operating model employed may differ considerably across stablecoin arrangements (see Annex 1 for examples). The core system is typically a book of records that registers ownership of coins and changes therein. This is typically a shared ledger, which operates in a decentralised way, for example by using distributed ledger technology (DLT). Based on the design, transactions can be processed without the need for a trusted third party. Depending on the operating model, one or more entities may perform the activities, or design protocols or codes to perform them. Moreover, other variants and ways to perform the activities are emerging. In particular, technological innovation, such as developments in DLT, may enable the increased use of decentralised processes. Table 1 summarises, in a stylised manner, how the core functions of a stablecoin arrangement relate to activities and operational design elements.

Table 1: Functions and activities in a stablecoin arrangement		
Functions	**Activities**	**Operational design elements**
Governance of the arrangement	Establishing rules governing the stablecoin arrangement	The rules covering, among other issues, the types of entities that could be involved in the arrangement, the protocol for validating transactions, the mechanism for stabilising the value of the stablecoin, and the arrangements for the management and ownership of the reserve assets. Generally, a governance body is essential to a stablecoin arrangement and also may have a role in promoting adherence to common rules across the stablecoin arrangement.
Issuance, redemption and stabilisation of value of coins	Issuing, creating and destroying stablecoins	The mechanism through which stablecoins may be issued or created, and subsequently destroyed by one or more entities or software protocols designed by these entities.
	Managing reserve assets	The activity of managing the assets that are "backing" the value of a stablecoin, where a stablecoin fully or partially maintains its value or confidence in its value based on real or financial assets or other crypto-assets. This may involve buying and selling assets based on an investment policy. The activity may also be undertaken by using software protocols that adjust the composition of the reserve through smart contracts and algorithmic decision-making.
	Providing custody/trust services for reserve assets	The activity of holding the assets that are "backing" the value of a stablecoin. The entity or entities issuing the stablecoin or other entities may hold the reserve assets.
Transfer of coins	Operating the infrastructure	A DLT protocol determining roles in and access to the system. Access may be permissioned (access, including the ability to hold and transfer stablecoins, is controlled with defined access conditions) or permissionless (anyone can access and transfer the stablecoins peer-to-peer, directly to other wallets).
	Validating transactions	Mechanism by which a transaction is authorised and validated by validator nodes.
Interaction with users	Storing the private keys providing access to stablecoins (wallet)	Cryptographic wallets storing private and public keys which are used to digitally sign transaction instructions performed by the stablecoin arrangement. Wallets can be custodial, where a third party operates the wallet and holds the private keys on behalf of the users, or non-custodial, where the users hold the private keys directly. Multiple different parties can develop wallets, based on a set of specifications provided by the stablecoin arrangement.
	Exchanging, trading, reselling, and market making of stablecoins	The activity of purchasing/exchanging a stablecoin with fiat currencies, or a stablecoin with other stablecoins or crypto-assets.

1.3. Potential reach and adoption across multiple jurisdictions

As with many financial services that utilise the internet, the technological infrastructure underlying stablecoin arrangements is not limited in its geographic scope. If a stablecoin arrangement combines such infrastructure with features that may be attractive to a broad range of users across multiple jurisdictions, its user base may rapidly grow, i.e. it may become a GSC.

A potential reach and adoption across multiple jurisdictions and the potential to achieve substantial volume would differentiate a GSC from other stablecoins. A framework to identify a GSC arrangement could seek to measure the global systemic importance that the arrangement could pose (Annex 5 presents potential elements that could be used to determine whether a stablecoin qualifies as a GSC). The criteria to be considered in determining a GSC should take into account the potential extent of the stablecoin's use as a means of payment or store of value in multiple jurisdictions.

Individual jurisdictions on their own may not be able to adequately monitor stablecoin adoption and materiality of risks. For example, a stablecoin that may not pose systemic risk in any one jurisdiction may nonetheless pose such risk globally if it has a presence across many jurisdictions and therefore has a high linkage to the global financial system. This may create a case for monitoring of stablecoin use at the global level.

2. Risks and vulnerabilities raised by global stablecoins

Financial stability risks from the current use of stablecoins are currently contained. This is largely due to the relatively small scale of these arrangements. However, the use of stablecoins as a means of payment or a store of value might significantly increase in the future, possibly across multiple jurisdictions. In addition, the different activities within a stablecoin arrangement, in particular those related to managing the reserve assets, may considerably increase linkages to the existing financial system. Such developments could change the current assessment.

Understanding how stablecoins, particularly GSCs, may create risks to financial stability is necessary to support effective regulation, supervision and oversight. To this end, this section first sets out the channels through which the use of GSCs may adversely affect financial stability. The second part of the section discusses how the specific activities performed by a GSC arrangement, and their interaction, may affect these channels. Linking these activity-specific risks to the financial stability outcomes provides the basis for considering which functions and activities of a GSC arrangement may warrant particular attention by regulators, supervisors and oversight authorities.

2.1. Potential risks to financial stability from a GSC

GSCs could pose financial stability risks through some key channels:

First, if a GSC were used as a common store of value, even a moderate variation in its value might cause significant fluctuations in users' wealth. Such wealth effects may be sizeable enough to affect spending decisions and economic activity. Wealth effects may be particularly pronounced in EMDEs where the likelihood of GSCs becoming a mainstream store of value may be higher than in advanced economies (AE).

Second, if widely used for payments, any operational disruption in the GSC arrangement might have significant impacts on economic activity and financial system functioning. If users relied upon a stablecoin to make regular payments, significant operational disruptions could quickly affect real economic activity, e.g. by blocking remittances and other payments. Large-scale flows of funds into or out of the GSC could test the ability of the supporting infrastructure to handle high transaction volumes and the financing conditions of the wider financial system.

Third, exposures of financial institutions might increase in scale and change in nature – particularly if financial institutions played multiple roles within a GSC arrangement (for example as resellers, wallet providers, managers or custodians/trustees of reserve assets). This may be a source of market, credit and operational risks to those institutions.

In addition, the large-scale use of GSCs might magnify confidence effects. A greater sensitivity to confidence effects could also reflect the extent of the use of a GSC as a store of value and/or means of payment. Moreover, closer linkages to financial institutions might also expose a GSC to adverse confidence effects, such as when a financial institution that acts as reseller/market maker of the GSC arrangement comes under financial distress. The reverse may also be true - the potential failure of a GSC might expose the financial institutions involved in the GSC arrangement to adverse confidence effects.

These channels may also interact. For example, disruption to payments may cause further decline in confidence, which in turn could prompt further redemptions and decline in the GSC's value, compounding wealth effects.

Macrofinancial risks may arise particularly if, over time, households and businesses in some economies (e.g. EMDEs) come to hold substantial portions of their wealth in GSCs, rather than in local currencies. During periods of stress, households in some countries might come to regard GSCs as a safe store of value over existing fiat currencies and exacerbate destabilising capital flows. Volatile capital flows can have a destabilising effect on exchange rates and on domestic bank funding and intermediation.

The significance of these channels and their impact on financial stability depend on how widely and for what purpose a GSC is used, and whether linkages to the financial system increase. For example, if a GSC were adopted as a widespread means of payment, but not as a store of value, its potential implications for financial stability may be narrower. If, however, a GSC also became adopted as a significant store of value by some of its users, other channels – including those pertaining to confidence effects, interlinkages to financial institutions and macroeconomic stability – may become more prominent.

2.2. Vulnerabilities arising from the functions and activities of a GSC arrangement

While the significance of the individual channels discussed above depends on what a GSC is used for and how widely it is used, the vulnerability of the GSC itself to shocks depends on how the functions and activities of the GSC arrangement are designed and performed. A scenario analysis conducted by the FSB identifies three main types of vulnerabilities. This scenario analysis focuses on asset-linked GSCs that have reserve assets and where the user has the ability to redeem the GSCs.

The first type of vulnerability relates to traditional financial risks – market, liquidity and credit risk – in a GSC arrangement. Of key importance in this regard is the choice and management of the GSC reserve assets, particularly the degree to which they could be liquidated at or close to prevailing market prices. Otherwise, large-scale GSC redemptions might result in "fire sales" of reserve assets that could reduce the "stable" value of the GSC relative to the reserve assets absent secondary guarantees. Such loss of value could impair user confidence in the resilience of the GSC arrangement as a payment mechanism, the financial institutions and the markets in which such assets were invested. Large-scale redemptions of GSCs might lead to large-scale sales of other assets and stress transmitted to wider financial markets. Also, significant changes

in the composition of the reserve assets, in the absence of large-scale redemption of GSCs, might trigger spillover effects to the wider financial system.

The ability of GSC arrangements to sell reserve assets in large volume at (or close to) prevailing market prices would depend on the duration, quality, liquidity and concentration of the GSC's reserve assets. The degree of transparency as to the nature, sufficiency and liquidity of these reserve assets might also affect confidence in the GSC.

Other design features of a GSC arrangement may add to financial stability risks. For instance, the withdrawal of liquidity provision by resellers/market makers might cause a sharp reduction in the liquidity of the GSC and dislocation in its price, which might in turn undermine user confidence and prompt further redemption. Moreover, users' loss of confidence could be more pronounced for GSCs which are not fully backed by reserve assets.

A second type of vulnerability concerns potential fragilities in the governance, operation and design of the GSC arrangement's infrastructure, including its ledger and the manner of validating users' ownership and transfer of coins. This vulnerability could crystallise for example due to an operational incident at a custodian or a compromised ledger resulting from a design defect, a cyber incident, or a failure of validator nodes. A lack of network capacity to validate – and subsequent delays in processing – large volumes of transactions might amplify users' loss of confidence, and trigger further redemption requests.

In the event of a disruption in the GSC arrangement, ambiguity about rights and protection afforded to users could amplify confidence effects. In particular, if users do not have redemption rights or a direct claim on the underlying assets, confidence could be undermined.

The degree of vulnerability would be impacted by the effectiveness of the GSC arrangement's governance and controls. The clarity of the roles and responsibilities of the GSC arrangement's governance body – including in respect of setting and enforcing the rules on establishing the GSC's value and on the functioning of the infrastructure – could affect users' confidence.

The third vulnerability relates to the applications and components on which users rely to store private keys and exchange coins. Such vulnerabilities could crystallise due to an operational incident at a wallet or exchange, for example. The scope of affected users might depend on the market share of the associated provider, and the degree to which it, for example, serves users in different jurisdictions.

The degree of vulnerability would depend on the operational resilience arrangements for wallets and exchanges, including stand in and fall-back arrangements that ensure continuity of service to users, and of the continued liquidity of the secondary market for coins.

Table 2 summarises, in a stylised way, the above types of vulnerabilities, their main determinants, and the functions and activities of a GSC arrangement that are particularly relevant in this regard.

Table 2: Examples of vulnerabilities and related functions and activities in a GSC arrangement (stylised presentation)		
Type of vulnerability	**Main determinants**	**Functions and activities primarily concerned**
Financial exposures in the GSC arrangement, giving rise to market, liquidity and credit risks.	• Choice, composition and management of the GSC reserve assets • Robustness of liquidity provision by GSC resellers/market makers • Ability of actors in the GSC arrangement to employ leverage	• Governing the GSC arrangement • Issuing, creating and destroying GSCs • Managing reserve assets • Exchanging, trading, reselling and market making of stablecoins
Weaknesses in the GSC infrastructure, giving rise to operational risk (including cyber risks) and risk of loss of data.	• Reliability and resilience of the GSC's ledger and validation mechanism, including validator nodes • Capacity of network to validate and process large volumes of transactions • Reliability of custodians/trustees	• Governing the GSC arrangement • Operating the infrastructure • Validating transactions • Providing custody/trust services for reserve assets
Vulnerabilities in those parts of the GSC arrangement on which users rely to store, exchange and trade GSCs, including operational or fraud risk	• Effectiveness of governance in preventing fraud • Operational resilience • Clarity about the nature of claims that users have • Robustness of liquidity provision by GSC resellers/market makers	• Governing the GSC arrangement • Storing of private keys providing access to GSCs • Exchanging, trading, reselling, and market making of GSCs

The interlinkages that exist between the various functions and activities in a GSC arrangement may add to vulnerabilities. For instance, a design failure in the validation process used for coin transfers could undermine confidence in the payment mechanism, but also in the performance of GSCs as a store of value and eventually of the GSC arrangement as a whole. As a consequence, the resilience of the arrangement may depend on the proper functioning of a range of different activities and processes.

3. Existing regulatory, supervisory and oversight approaches and challenges

3.1. Findings from the FSB Stocktake

To take stock of existing regulatory, supervisory, and oversight approaches, the FSB surveyed FSB and RCG members. The survey included questions on current approaches with respect to the regulatory classification of stablecoins and stablecoin arrangements and activities, as well as potential regulatory gaps (see Annex 3 for more details). A total of 51 jurisdictions completed the survey, including 25 FSB and 26 RCG jurisdictions.

The survey findings highlight that most jurisdictions do not currently have regulatory regimes specific to crypto-assets in general or stablecoins in particular. However, in most jurisdictions, existing regulatory, supervisory and oversight approaches, while not specific to crypto-assets or stablecoins, would apply in whole or part and would address some of the risks associated with stablecoins or with entities that are part of the stablecoin arrangement. The most common approach is to identify the activity performed by a stablecoin arrangement and the participants involved, and apply the relevant existing regulation for that activity or entity according to the "*same business, same risks, same rules*" principle.

Most respondents note that stablecoins could be classified under more than one regulatory category, and that the classification could change as the nature and use of a stablecoin evolves. Which existing regulatory regime applies typically depends on the specific design features and characteristics of a stablecoin or of the entities that are part of the stablecoin arrangement. The application of existing regulatory regimes is therefore subject to a case-by-case assessment. For instance, whether a "stablecoin" qualifies as e-money may depend on the nature of the claim of a stablecoin holder against the stablecoin issuer or its assets. Stablecoins that do provide a claim may also fall under the definition of a collective investment scheme or deposit. A change in the features of the stablecoin or the activities of the stablecoin arrangement over time may lead to a change in the applicable regulatory and supervisory regime.

The extent to which existing regulations may be applied to the activities of GSC arrangements differ by jurisdiction. Some survey responses indicate that some jurisdictions may require clarifications or new regulatory authorities to fully capture GSC activities. Activities are often, at least partly, covered by multiple relevant regulations in AEs, while some of the activities are not covered by any regulations in EMDEs. In general, the functions and activities that are most frequently covered include the issuance and redemption of stablecoins; managing reserve assets; providing custody/trust services for stablecoin reserve assets; exchanging and trading stablecoins (including reselling to retail users) and storing the private keys providing access to stablecoins (wallets). The survey indicates that jurisdictions were less likely to regulate the governance over the whole stablecoin arrangement, the operation of the infrastructure of a stablecoin arrangement and the validation of transactions.

The type of regulatory coverage of stablecoin activities varies. Survey results indicate that many jurisdictions have AML/CFT regulations that seem to apply more generally to stablecoin activities. The results also indicate that fewer jurisdictions have other types of financial regulation, such as market integrity, investor and consumer protection regulations, that may apply to stablecoin activities like issuance, exchanging and trading of stablecoins. See also the table in Annex 2 on potential vulnerabilities arising from stablecoin activities and the regulatory authorities and potential tools to address such vulnerabilities.

3.2. International standards that could apply to GSC arrangements

Several international financial standards could potentially be applicable to the activities of a stablecoin arrangement, including standards for prudential regulation as well as AML/CFT regulation depending on the specific design of the stablecoin arrangement and regulatory regime of each jurisdiction. Standard-setting bodies – BCBS, FATF, CPMI, and IOSCO – are undertaking work to review whether and how existing international standards can apply to stablecoin arrangements.

Basel Committee on Banking Supervision (BCBS)

Banks could be subject to a range of direct and indirect exposure channels in a GSC arrangement, including as an issuer, investor, lender, custodian / wallet provider and market maker of stablecoins. Such exposures would in principle be subject to prudential capital and liquidity requirements.

However, the current Basel framework does not specify the prudential treatment for banks' exposures to crypto-assets at large or crypto-assets that make use of stabilisation tools. The BCBS is considering the appropriateness of a global prudential standard and other approaches. The BCBS issued a discussion paper that outlines a set of general principles and considerations to guide the design of a prudential treatment of banks' exposures to crypto-assets, including an illustrative example of potential capital and liquidity requirements for exposures to high-risk crypto-assets. The BCBS is continuing to assess the appropriate prudential treatment for such types of crypto-assets, and will consult on any specific measures.[7]

Banks having a role in a GSC arrangement could be subject to cyber, fraud, and other operational risks as well as legal, third-party and implementation risks. The BCBS Principles for the Sound Management of Operational Risk should help address those risks by calling a strong control environment, appropriate internal controls and business resilience and continuity plans.[8]

Moreover, as noted in the March 2019 BCBS statement on crypto-assets, one of the first steps in analysing the impact of crypto-assets on banking institutions is to assess the permissibility of a banking institution to engage in such activity.[9]

Financial Action Task Force (FATF)

The FATF, as the global standard setter for AML/CFT, set out in June 2019 how the FATF standards should apply to virtual asset activities and Virtual Asset Service Providers (VASPs).[10,11] It set out recommendations that require countries to assess and mitigate the money

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7 See www.bis.org/bcbs/publ/d490.pdf.

8 See www.bis.org/publ/bcbs195.pdf.

9 See www.bis.org/publ/bcbs_nl21.htm.

10 On 21 June 2019, the FATF issued an Interpretive Note to Recommendation 15 on New Technologies (INR. 15) that clarifies the FATF's previous amendments to the international Standards relating to virtual assets and describes how countries and obliged entities must comply with the relevant FATF Recommendations to prevent the misuse of virtual assets for money laundering and terrorist financing and the financing of proliferation.

11 The terms "virtual asset" and "virtual asset service provider" are used by FATF according to the definitions available at http://www.fatf-gafi.org/glossary/u-z/.

laundering and terrorist financing risks associated with virtual asset activities and VASPs; license or register such providers; subject them to supervision or monitoring; and require that they implement all of the AML/CFT preventive measures under the FATF recommendations just like other financial institutions, including customer due diligence, record-keeping, suspicious transaction reporting, and screening all transactions for compliance with sanctions.

In October 2019, the FATF clarified that both global "stablecoins" and their service providers would be subject to the FATF standards either as virtual assets and VASPs or as traditional financial assets and their service providers, and that stablecoins should "never be outside of the scope of anti-money laundering controls."[12] Accordingly, the FATF has made clear that countries should effectively implement the FATF standards as part of their domestic regulatory and supervisory regimes for virtual assets, including stablecoins and VASPs.

The FATF is currently reviewing the money laundering (ML) and terrorism financing (TF) risks associated with stablecoins and other virtual assets and whether these are adequately mitigated. The particular ML/TF risk associated with stablecoins would be amplified by any potential for mass adoption, but a large part of these risks could be mitigated when the stablecoins are intermediated by either financial institutions or VASPs that are effectively regulated and supervised in a manner consistent with the FATF standards. There may be material residual risks if the stablecoin enables large-scale anonymous peer-to-peer transactions without an intermediary, where additional clarifications may be needed. The FATF will undertake further work to review the business models of stablecoins to identify any gaps and significant residual risks, to consider further clarifications on how the FATF standards apply to global "stablecoins" and their service providers, as well as whether further updates are necessary, and report on this to the G20 in July 2020.

Committee on Payments and Market Infrastructures (CPMI) and International Organization of Securities Commissions (IOSCO)

The CPMI and IOSCO have carried out a preliminary analysis on the application of the Principles for Financial Market Infrastructures (PFMI) stablecoin arrangements and their activities. The PFMI include 24 high-level principles applicable to systemically important FMIs. Principles include the existence of a well-founded legal basis, clear governance promoting safe and efficiency and supporting stability of the broader financial system, risks management, and operational resilience. Responsibility E of the PFMI provides the framework for cooperation among central banks, market regulators, and other authorities for promoting the safety and efficiency of systemically important FMIs.

In this preliminary analysis, the CPMI-IOSCO established that the PFMI apply to systemically important stablecoin arrangements that perform systemically important payment system functions[13] or other financial market infrastructure (FMI) functions that are systemically important. To the extent that systemically important stablecoin arrangements perform

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[12] FATF, October 2019, https://www.fatf-gafi.org/publications/fatfgeneral/documents/statement-virtual-assets-global-stablecoins.html.

[13] The PFMI note that a payment system is "…a set of instruments, procedures, and rules for the transfer of funds between or among participants; the system includes the participants and the entity operating the arrangement." The instruments could potentially be the tokens issued by a stablecoin issuer, the procedures could be the payments made between token holders (or to participating retailers), and the rules would likely be set out by the stablecoin issuer (and codified on the blockchain).

additional functions not covered by the PFMI, they will be subject to relevant standards for those functions in addition to the PFMI.

The CPMI-IOSCO considered that, while it may be challenging for systemically important stablecoin arrangements, in particular for those that are partly or highly decentralised, to comply with the standards of the PFMI, systemically important stablecoin arrangements need to adapt to comply with them. In this regard, CPMI-IOSCO is considering the need for some clarification or interpretation to help explain how systemically important stablecoin arrangements may comply with the PFMI, but such clarification or interpretation would not change the underlying principles that apply to systemically important stablecoin arrangements. Further work will now be required by CPMI-IOSCO to supplement this preliminary analysis before a definitive statement on applicability of each of the individual PFMI principles to stablecoin arrangements can be made.

International Organization of Securities Commissions (IOSCO)

IOSCO is reviewing the applicability of IOSCO standards and principles to GSC initiatives and published a report on 23 March 2020.[14] The report assesses the implications that global stablecoin proposals could have for securities market regulators. It concludes that GSCs may, depending on their structure, present features that are typical of regulated securities or other regulated financial instruments or services. It then engages in a lifecycle analysis of a hypothetical stablecoin used for domestic and cross-border payments. The hypothetical stablecoin uses a reserve fund and intermediaries to try to achieve a stable price vis-a-vis a basket of low volatility currencies.

The report concludes that several principles and standards could apply to the hypothetical stablecoin offering. These include (i) IOSCO's 2012 Recommendations on Money Market Funds; (ii) Issues, Risks and Regulatory Considerations for Crypto-asset Trading Platforms (2020); (iii) the 2013 Principles for the Regulation of ETFs; and (iv) the IOSCO work on Market-Fragmentation including the 2015 Cross Border Regulation Task Force Report and the work of the Follow-Up Group to address potential regulatory arbitrage as well as IOSCO work on Cyber Resilience and Client Assets. These findings may equally apply to stablecoin arrangements other than the hypothetical stablecoin offering, subject to a facts and circumstances assessment of the individual proposal at hand. The report also sets out considerations of broader issues of relevance to securities market regulators and contains the CPMI-IOSCO's preliminary analysis of the applicability of the PFMI to GSCs. A more detailed summary of the report's findings along with the CPMI-IOSCO analysis are both set out in Annex 4.

Future IOSCO work will expand the functional analysis in the published report to look at other structures of GSCs offerings and how they might interact with the perimeter of securities markets regulation, as well as supplementing the analysis with any relevant additional information, if and when GSC proposals come to market.

[14] See https://www.iosco.org/library/pubdocs/pdf/IOSCOPD650.pdf.

3.3. Potential issues to consider

The analysis of jurisdictions' existing regulatory, supervisory and oversight approaches and of the applicability of existing international standards raises some issues that national authorities should consider

Clarity about the applicability of existing regulatory regimes and powers

There is a broad consensus among survey respondents that existing regulatory authority over the activities and risks of stablecoins needs to be clarified. Most authorities reported that they planned to clarify how existing regimes apply to stablecoins and their providers, and that some adaptation of their regulation may be necessary. Some jurisdictions have already provided guidance on how to apply existing regulation to crypto-assets and/or stablecoins. This guidance has typically sought to help firms understand which regulatory requirements apply and how to ensure compliance. Others are currently developing new legislation or regulation to address the risks posed by crypto-assets, including stablecoins. Some jurisdictions have chosen to issue warnings to the public, highlighting the risks of these investments and/or that some of these activities are not licensed or regulated. In a few cases, jurisdictions have chosen to prohibit crypto-assets.

Potential gaps in existing regulatory frameworks

Some authorities identified potential gaps in existing regimes that need to be addressed. One source of gaps may be an unanticipated *bundling* of attributes that conventional regulations, in particular those designed to be applied by sector, may not fully capture. For instance, legal frameworks in some jurisdictions may not allow stablecoins to fall under multiple regulatory classifications, so certain activities may not be captured at present (a simple example being that if a GSC falls exclusively under securities regulation in such jurisdiction, activities related to the transfer of coins may not be covered). Another source of gaps may be the *unbundling* of activities in a stablecoin arrangement. As a consequence, some of the activities in a GSC arrangement may fall outside of traditional regulatory boundaries. Survey responses suggest that potential gaps in existing frameworks at domestic level may include:

(i) potentially incomplete implementation and coverage of FATF standards for all activities of a GSC arrangement; (e.g. peer-to-peer transfers of stablecoins may not be addressed);

(ii) inability to effectively supervise and oversee a GSC arrangement if the legal classification of a stablecoin falls outside an existing regulation framework (e.g. e-money or a security);

(iii) partial regulatory coverage of the functions and activities under a GSC arrangement that are economically similar to those that would fall under the remit of existing regulation, but as a result of their particular design, do not engage the perimeter of existing regulation (e.g. exchange and trading, wallet services used for storing keys) with a range of risks not or not fully addressed (e.g. market integrity, consumer protection);

(iv) insufficient risk mitigation tools within a regulatory framework applicable to a given activity (e.g. no specific capital or liquidity requirements for issuing stablecoins or managing the reserve assets, incomplete measures addressing cyber security and

operational risks of the underlying technology used for operating the infrastructure, validating transactions or storing keys in wallets).

Considerations on classifications for individual jurisdictions

As with many other financial instruments, there is currently no common and consistent regulatory classification of the nature, functionality, structure and rights associated with stablecoins across jurisdictions. In different jurisdictions, a stablecoin could fall within one or multiple regulatory classifications, depending on the design of the stablecoin and how it is offered and sold. In AE jurisdictions, stablecoins were most frequently classified as e-money and a collective investment scheme (CIS), followed by deposits, a security other than CIS and derivatives. For EMDEs, the most common classifications were e-money and payment instrument.

Individual jurisdictions may assess the effectiveness of their current regulatory, supervisory and oversight approaches by referring to Annex 2 in conjunction with Section 5. The table in Annex 2 maps the activities in a stablecoin arrangement to the associated vulnerabilities and highlights appropriate regulatory, supervisory and oversight tools as well as international standards that could be relevant.

While different classifications (and regulatory approaches) may be taken in individual jurisdictions, these different approaches should adequately address the risks posed by GSC activities, and gaps, if any, should be closed. Functions and activities of a GSC arrangement are typically distributed over multiple jurisdictions (discussed further in Section 4 below). Differentiated regulatory, supervisory and oversight arrangements across jurisdictions, if they do not work broadly towards the same outcomes, could therefore result in less comprehensive regulatory coverage or give rise to regulatory arbitrage.

4. Cross-border regulation, supervision and oversight

4.1. Cross-border challenges

Cross-border challenges are inherent to GSC arrangements. The ease with which stablecoin arrangements and entities providing various functions and activities within the arrangements can operate across borders and reorganise or relocate their activities challenges the effectiveness of regulation, supervision, oversight and enforcement at jurisdictional levels. A stablecoin issued in one jurisdiction may be easily accessible online to users in another jurisdiction. Operational and cyber security risks related to the technology and infrastructure used in a stablecoin arrangement may affect multiple jurisdictions. The governance arrangements over operations and infrastructure should therefore be of interest to regulators across the jurisdictions where the stablecoin arrangement has activities in.

Differentiated jurisdictional approaches could give rise to regulatory arbitrage and fragmentation without close coordination and a common set of standards. Jurisdictions generally seek to apply their rules and regulations to activities taking place in their jurisdiction, including in situations where stablecoins are offered to local users from abroad. However, the effective application and enforcement of a jurisdiction's rules may be difficult as users access services on the Internet and authorities cannot easily locate the provider of the services. It may be further complicated by the fact that different regulatory classifications of stablecoins and

hence different regulatory, supervisory and oversight approaches are adopted across jurisdictions.

These cross-border challenges may be particularly significant for EMDEs. The use of stablecoins as a means of payment and/or store of value may be more widespread in EMDEs, for example due to the substitution of local currency, than in AEs with developed financial systems. At the same time, the activities of a stablecoin arrangement may typically be performed by entities that are located outside EMDE jurisdictions. Taken together, EMDEs may face a combination of relatively high systemic relevance of a stablecoin and constraints in regulating and supervising the arrangement.

4.2. Issues for cross-border cooperation and coordination

Addressing the cross-border challenges requires effective cross-border cooperation, coordination and information sharing amongst the relevant authorities to ensure sufficient cross-border supervision and oversight of the stablecoin arrangement.

Existing cooperation mechanisms between sectoral authorities would help support cooperation and coordination, possibly with some adaptations (e.g. through Memorandums of Understanding (MoU)). However, challenges could arise around the ability to supervise and oversee a stablecoin arrangement holistically, rather than in a piecemeal framework based on individual functions and activities.

Implementing effective cooperation requires an understanding of how a specific stablecoin arrangement is organised and operates and how the individual activities are connected and generate contagion channels. Based on this understanding, authorities need to determine the scope of application of their respective regulatory frameworks and how the regulations of multiple jurisdictions may interact so as to avoid any regulatory underlap or gap and ensure an effective holistic oversight.

The level and nature of cross-border cooperation needed may depend on:

- *Use and systemic importance* - what the GSC is used for and where users are located;
- *Governance* - where the decisions across the GSC arrangement are made and policies set and enforced;
- *Issuance and redemption of coins, reserve management* - where the issuance and redemption of coins and the management of reserve assets occurs; the jurisdiction whose currency or assets (e.g. government bonds) are included in reserve assets;
- *Transfer mechanisms* - how transfer mechanisms are operated and how stablecoins are exchanged, traded and resold, for example, whether or not these are centralised processes operated by a designated entity or decentralised processes operated by multiple entities; where data and records are located (whether transaction records and other data are centralised or decentralised);
- *User-facing elements* - where wallet and platform providers are located, whether they operate cross-border, and whether there is vertical integration between operators of the functions and activities of the GSC arrangement.

There are different approaches for cross-border supervision and oversight. For prudentially regulated financial institutions, cross-border cooperation builds on principles for

comprehensive consolidated supervision.[15] The "home supervisor', that is the supervisor in the jurisdiction where the head office or parent entity of a financial institution is headquartered, is responsible for the supervision of the group of related institutions on a consolidated basis. In this case, effective consolidated supervision requires the home supervisor to cooperate with supervisors in jurisdictions where subsidiaries or branches are located ("host supervisors").

In the case of FMIs, a FMI's competent authority ("lead overseer" which could be compared to the "home supervisor") is designated as the coordinator of the cooperation arrangement. A wide set of relevant authorities is identified and engaged in the cooperation, taking into account the features and the services that the FMI provides on a cross-border basis.

In both cases, the objective of the "home supervisor" and of the "lead overseer" is to gain sufficient knowledge of the operations of the financial group or FMI, both domestic and foreign, as a whole so as to monitor and assess risks and vulnerabilities faced by the group or FMI. Host supervisors may have different interests in relation to the supervision of the group or FMI as a whole, depending on whether the group or FMI has material risk exposures in the host jurisdiction and whether it poses a systemic risk to the host jurisdiction.

A stablecoin arrangement could be different from a financial group or FMI. Unlike a financial group, a stablecoin arrangement may be a network of unrelated entities conducting different functions and activities usually from various jurisdictions that may only be held together by common policies, standards and agreements about their respective roles. At the same time, a stablecoin arrangement may involve functions that extend beyond those of a traditional financial group or FMI. Each part, whether entity, policy, process, or technology, of a stablecoin arrangement can affect the other parts. Depending on the specific features of the stablecoin arrangement, there is a risk that a stablecoin arrangement is not subject to sufficiently robust governance and controls that are enforced through policies, standards, and contractual obligations over its entire network of functions, activities and participants.

Whereas the objectives of comprehensive consolidated supervision are relevant in the context of a GSC arrangement, the concepts of "home" and "host" cannot in certain cases be easily transposed to GSC arrangements that are operated through a loose network of entities and dispersed ownership and control structures. This is the case in particular if there is no entity responsible for the governance of the GSC arrangement or if the back-end core functions (governance, issuance of coins, stabilisation mechanism, or transfer mechanism) of the GSC arrangement are performed by different entities in different jurisdictions. There may also be different options for determining a "home jurisdiction".[16] Given these inherent limitations to the "home-host" concept, certain cross-border supervisory and oversight models existing outside the consolidated supervision context may be more relevant, as discussed further below.

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[15] See for example Basel Committee, Minimum standards for the supervision of international banking groups and their cross-border establishments, 28 July 1992.

[16] For example, the FATF standards require licensing or registration of virtual asset service providers where they are incorporated and leave individual jurisdictions to decide whether it should also be required where the service provider has management, back office presence, or a substantial customer base

4.3. Role of existing standards on cooperation, coordination and information sharing

Despite the particularities of GSC arrangements, existing international standards and principles governing cooperation, coordination and information sharing amongst authorities should help inform cross-border cooperation for GSC arrangements. Given the multi-functional and multi-jurisdictional nature and "loose network structure" of GSC arrangements, new forms of cooperation may need to be established or adapted from existing approaches.

In addition to the overarching international standards referred to in Section 3.2 that could apply to GSC arrangements, existing international standards and principles that focus on cross-border cooperation, coordination and information sharing may also be adapted to apply to GSC arrangements. These include principles related to cooperation, which underscore the importance of collaboration and information-sharing, such as:

- *Responsibility E of the PFMI* which provides that "central banks, market regulators, and other relevant authorities should cooperate with each other, both domestically and internationally, as appropriate, in promoting the safety and efficiency of FMIs." Responsibility E, together with its Key Considerations, provides a strong basis for cooperation among authorities responsible for oversight at cross-border level. Where a stablecoin arrangement may have other features and provide services in addition to those of an FMI, Responsibility E also foresees that overseers identify and engage with potentially broader set of authorities. CPMI-IOSCO is currently considering whether additional considerations would be helpful to achieve appropriate cooperation among relevant authorities.
- *BCBS standards relating to cross-border supervisory cooperation*: Supervisors overseeing international banking groups involved in GSC arrangements would build on the Committee's principles related to supervisory cooperation, which underscore the importance of collaboration and information-sharing.[17] These include the Basel Concordat[18], the Core Principles for effective banking supervision, home-host information sharing arrangements, and the Principles for effective supervisory colleges.
- *FATF standards*: The FATF standards on AML/CFT apply whether GSCs are classified as virtual assets or as other traditional assets. The FATF standards on virtual assets finalized in June 2019 require licensing or registration of virtual asset service providers in at least the jurisdiction where they are created if a legal person or where they are located, if a natural person. The standards also include optional further licensing and registration in jurisdictions where service providers operate. The FATF standards further require various forms of cross-border cooperation among authorities, include mutual legal assistance and information sharing.

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[17] See respectively, https://www.bis.org/publ/bcbsc312.pdf, https://www.bis.org/publ/bcbs230.pdf, https://www.bis.org/publ/bcbs125.pdf, and www.bis.org/publ/bcbs287.pdf".

[18] See https://www.bis.org/publ/bcbsc312.pdf.

- *The IOSCO Principles*[19] *covering Cooperation in regulation* (Principles 13 to 15)*, IOSCO's Multilateral MoU Concerning Consultation and Cooperation and the Exchange of Information*[20]*, the Enhanced Multilateral MoU Concerning Consultation and Cooperation and the Exchange of Information*[21]*, the IOSCO Principles regarding Cross-Border Supervisory Cooperation of May 2010* and the cross-border regulatory and supervisory cooperation aspects of the IOSCO 2015 Cross-Border Regulation Task Force Report as well as of the work of the Follow-Up Group to address potential regulatory arbitrage; and
- The cross-border regulatory and supervisory cooperation aspects of the *Joint Forum Principles for the Supervision of Financial Conglomerates* (2012).

In addition, bespoke oversight arrangements, such as the arrangement governing the international cooperative oversight of SWIFT[22] or of CLS[23], may provide a reference point for establishing cooperative arrangements that can help ensure comprehensive oversight and supervision of a GSC arrangement operating across sectors and borders.

5. High-Level Recommendations for effective regulatory, supervisory, and oversight approaches to GSCs

This section sets out 10 high-level recommendations that seek to promote consistent and effective regulation, supervision, and oversight of GSCs. The recommendations aim to mitigate the potential risks with the use of GSCs as means of payment and/or store of value, both at the domestic and international level, while supporting responsible innovation and providing sufficient flexibility for jurisdictions to implement domestic approaches.

Objectives and scope

The objective of the recommendations is to help authorities to determine their regulatory, supervisory and oversight approaches to mitigate potential risks to financial stability and market integrity, and risks for users (consumers) that GSCs may pose, while also being supportive of responsible financial innovation. In order to appropriately mitigate financial stability risks that may arise, the recommendations focus on reinforcing and underscoring existing standards and regulations; identifying and addressing potential regulatory gaps; and mitigating potential regulatory arbitrage. The recommendations are intended to be high-level and flexible so that

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19 See https://www.iosco.org/library/pubdocs/pdf/IOSCOPD561.pdf.

20 See https://www.iosco.org/about/?subsection=mmou.

21 See https://www.iosco.org/about/?subsection=emmou.

22 The National Bank of Belgium, as the lead overseer, conduct the oversight of SWIFT in cooperation with the other G10 central banks, i.e. Bank of Canada, Deutsche Bundesbank, European Central Bank, Banque de France, Banca d'Italia, Bank of Japan, De Nederlandsche Bank, Sveriges Riksbank, Swiss National Bank, Bank of England and the Federal Reserve System (USA), represented by the Federal Reserve Bank of New York and the Board of Governors of the Federal Reserve System. The relationship between the NBB and those other cooperating central banks has been laid downs in bilateral MoUs.

23 Similarly, a cooperative oversight arrangement is established for the oversight of CLS, which is conducted by the Federal Reserve System, which includes both the Board of Governors of the Federal Reserve System and the Federal Reserve Bank of New York, in cooperation with the G-10 and other central banks of issue of CLS-settled currencies. A protocol for cooperation has been established (see https://www.federalreserve.gov/paymentsystems/cls_protocol.htm).

they can be incorporated into the wide variety of regulatory frameworks potentially applicable to GSCs around the world.

The recommendations do not represent a complete framework that addresses all the risks and responsibilities of GSC arrangements. They do not address certain important issues such as data privacy, competition policy, taxation, monetary policy, monetary sovereignty, currency substitution, and other macroeconomic concerns. They also do not comprehensively cover AML/CFT requirements, which should be covered by the FATF standards, although the recommendations contain no contradictions with regard to the FATF's work in this area; they also do not address risks that financial institutions may face in relation to GSC arrangements.

In general, public policy goals are meant to be technology neutral. The recommendations therefore aim to promote a regulatory, supervisory and oversight framework that is technology neutral and focuses on underlying activities and risks, thereby accommodating innovation in the provision of financial services as technology changes.

The recommendations apply to any GSC in any jurisdiction and help authorities to address activities and services within GSC arrangements that may fall outside the traditional regulatory perimeter. Consistent application of these recommendations by all relevant authorities in jurisdictions in which GSC arrangements are active may help to ensure comprehensive regulatory coverage and reduce the scope for regulatory arbitrage. How these recommendations apply to the activities of specific GSC arrangements could vary depending on how the transfer mechanism is operated, how stablecoins are structured, exchanged, traded and resold, and whether or not these are centralised processes operated by a designated entity or decentralised processes.

While focusing on GSCs that may be widely used as a means of payment and/or store of value for consumers and businesses, the recommendations could also be relevant for:

- stablecoin arrangements that may pose risks to financial stability only in some countries or regions;
- stablecoin arrangements used only for wholesale transactions among financial institutions;
- stablecoin arrangements that are anticipated to become GSC arrangements; and
- other crypto assets that could pose risks similar to some of those posed by GSCs because of comparable international reach, scale and use.

The recommendations are addressed to financial regulatory, supervisory and oversight authorities. They should be read to apply at the jurisdictional level and therefore are only applicable to a particular authority to the extent that the recommendations fall within an authority's remit.

Grounded in an assessment of a GSC arrangement's economic function and the principle of "same business, same risk, same rules", and focused on regulatory objectives and outcomes, authorities should apply and, if necessary, develop effective regulatory, supervisory and oversight approaches and cross-border cooperation mechanisms within their respective mandate and legal frameworks.

At the same time, the recommendations set out expectations for providers of services and activities within the GSC arrangements and can serve as a basis for authorities' active engagement with stakeholders on GSC-related risks and how these are addressed.

The recommendations complement international sectoral standards. Authorities should rely on sectoral standards and principles for cross-border cooperation relevant to the supervision and oversight of GSC arrangements, where they perform the same economic function as existing regulated activities covered by these standards. These include, for example, the IOSCO Principles regarding Cross-Border Supervisory Cooperation, the CPMI-IOSCO Principles for Financial Market Infrastructures, including the Responsibilities of Authorities and particularly Responsibility E, the FATF standards, in particular Recommendation 15, and the relevant principles applicable to cross-border banking supervision and crisis management of the BCBS and the FSB. Efforts by the standard setting bodies to review, and where appropriate adjust their standards to take into account the novel features of stablecoins can further promote international consistency and reduce the risk of arbitrage or regulatory underlaps. See Annex 2 for examples of vulnerabilities and regulatory tools, and international standards by activity of a GSC arrangement to address these vulnerabilities.

1. **Authorities should have and utilise the necessary powers and tools, and adequate resources, to comprehensively regulate, supervise, and oversee a GSC arrangement and its multi-functional activities, and enforce relevant laws and regulations effectively.**

   Authorities within a jurisdiction, either independently or collectively, should have and utilise the appropriate powers and capabilities to regulate, supervise, oversee and if necessary prohibit effectively the activities being conducted and services being offered to users in or from their jurisdiction and the attendant risks that these services and activities may pose.

   This may include, for example, services and activities related to the governance/control of the stablecoin arrangement, operating the infrastructure of the stablecoin arrangement, issuing/redeeming stablecoins, managing stablecoin reserve assets, providing custody/trust for stablecoin reserve assets, trading/exchanging stablecoins, or storing the keys providing access to stablecoins.

   Authorities' powers should extend to entities that are engaged in GSC activities in their jurisdictions and within the scope of their authority and relevant to their mandate.

   Authorities should evaluate, identify and clarify which authorities have responsibility for each activity of a GSC arrangement, as appropriate.

   Authorities should identify and address gaps through changes in regulations, or policy, as applicable. In some jurisdictions, legislative changes may be necessary to address those gaps.

   Authorities should ensure the appropriate monitoring of GSC activities (and any significant change to the way those activities are performed) and the financial system and ensure timely access to relevant information sufficient to conduct effective regulation, supervision and oversight.

Authorities should have the powers and capabilities to enforce applicable regulatory, supervisory and oversight requirements, including the ability to undertake inspections or examinations, and, when necessary, require corrective actions and take enforcement measures. To do so, authorities should be provided with or obtain sufficient information regarding the technology and legal obligations underpinning the GSC arrangements.

Authorities should be able to identify the legal entities responsible for the relevant activities and to assess the ability of the GSC arrangement to implement corrective actions.

Authorities should have the ability to mitigate risks associated with or prohibit the use of certain or specific stablecoins in their jurisdictions where these do not meet the applicable regulatory, supervisory, and oversight requirements.

2. **Authorities should apply regulatory requirements to GSC arrangements on a functional basis and proportionate to their risks.**

   To promote a technology neutral approach that enables comprehensive oversight of GSC's multi-functional activities and mitigates regulatory arbitrage, authorities should focus on the functions performed by the GSC arrangement and risks posed and apply the appropriate regulatory framework in the same manner as they would apply it to entities performing the same functions or activities, and posing the same risks ("same business, same risk, same rules"). Authorities should apply rules and policies, including applicable international standards, as appropriate and to the extent that the GSC arrangement provides the same functions and poses the same risks as other financial service providers. This includes the relevant regulation, standards and rules for e-money issuers, remittance companies, payments and financial market infrastructures, collective investment schemes, and deposit-taking and securities trading activities. This also includes market integrity, consumer and investor protection arrangements, appropriate safeguards, such as pre- and post-trade transparency obligations, rules on conflicts of interest, disclosure requirements, robust systems and controls for platforms where the GSC is traded, and rules that allocate responsibility in the event of unauthorised transactions and fraud, and rules governing the irrevocability of a transfer orders ("settlement finality").

   Authorities should consider the extent to which existing financial regulation captures the risks of GSC functions and activities, and the potential effects of financial regulation not applying to aspects of a GSC arrangement.

   Authorities should be prepared to clarify or supplement financial regulations that do not adequately capture the risks of GSC functions and activities and to develop and implement regulations to address uncaptured risks as needed.

   Where regulations of more than one jurisdiction may apply, there should be cooperation and coordination regarding how jurisdictions' rules apply to the different aspects of the GSC arrangement's functions and activities operating across borders, as with other types of financial arrangements.

3. **Authorities should ensure that there is comprehensive regulation, supervision and oversight of the GSC arrangement across borders and sectors. Authorities should**

cooperate and coordinate with each other, both domestically and internationally, to foster efficient and effective communication and consultation in order to support each other in fulfilling their respective mandates and to facilitate comprehensive regulation, supervision, and oversight of a GSC arrangement across borders and sectors.

Cooperation arrangements should be flexible, efficient, inclusive, and multi-sectoral, and take into account the complexity and the potential evolution of the GSC arrangement and the risks it poses over time. They may take different forms (e.g. supervisory colleges, fora or networks). They should also consider the distinctive nature of GSC arrangements as usually consisting of multiple and oftentimes unrelated entities that interact and have varying roles and responsibilities.

Cooperation arrangements may be underpinned by bilateral and/or multilateral memoranda of understanding for cooperation and information sharing, and for crisis management and resolution, and complemented with mechanisms with a single focus, e.g. regarding AML/CFT or cyber security. These arrangements should also consider the potential need to seek cooperation from authorities in other jurisdictions to achieve regulatory objectives, e.g. in implementing recovery and resolution plans, or halting activities based in one jurisdiction having an adverse impact in another.

In establishing a cooperation arrangement, authorities should consider how to ensure that the arrangement takes into account the interests of each of the jurisdictions and sectors in which GSC arrangements may be operating or seeking to operate, jurisdictions where the governance body, the providers of GSC functions and activities and the GSC arrangement's users are located, where (spillover) risks reside, and the potentially differing impacts of GSC arrangements across jurisdictions and between AEs and EMDEs.

4. **Authorities should ensure that GSC arrangements have in place a comprehensive governance framework with a clear allocation of accountability for the functions and activities within the GSC arrangement.**

Authorities should ensure adequate governance frameworks over the entire network of GSC activities, functions and participants, given each part of the network can affect the other parts. The governance structures and accountabilities should have a sound legal basis and be clear, transparent, and disclosed to users and other stakeholders. Such disclosures should include how governance and accountability is allocated among different entities in different jurisdictions, as well as clarify the limits of accountability and legal liability in any one jurisdiction. This should be the case for all functions and activities of the GSC arrangement, including but not limited to, setting rules and standards for participants of the GSC arrangement, operating the stabilisation mechanism in particular the investing of the reserve assets as appropriate, providing the custody/trust services for reserve assets, and providing user-facing services such as exchanges and wallets.

GSC arrangements may vary in the degree of decentralisation of their governance design. This notwithstanding, authorities should ensure that there are one or more governance bodies or an equivalent mechanism and that the functions and activities of

the GSC arrangement are subject to appropriate oversight, governance and safeguards. Fully permissionless ledgers or similar mechanisms could pose particular challenges to accountability and governance and may not be suitable if regulators cannot be assured that appropriate regulatory, supervisory, and oversight requirements are satisfied.

Where a GSC arrangement relies on a third-party, the GSC governance body should provide a comprehensive assessment of how its reliance on the third-party does not impede its ability to meet regulatory requirements and expectations for performance, resilience, security, development and maintenance, and regulatory compliance.

5. Authorities should ensure that GSC arrangements have effective risk management frameworks in place especially with regard to reserve management, operational resiliency, cyber security safeguards and AML/CFT measures, as well as "fit and proper" requirements

Authorities should ensure that GSC arrangements have in place policies that set out how all functions and activities within the GSC arrangement are subject to risk management measures that are appropriate to and commensurate with the specific risks that GSC arrangements pose. If the risk from the fluctuation in the value of the underlying assets is borne, partially or totally by the GSC operator, the relevant prudential framework (e.g. market risk framework) should be applied to the GSC operator.

Authorities should ensure that GSC arrangements conduct due diligence (for example, by way of 'fit and proper' standards) into individuals involved in the management and control of the GSC arrangement, as well as those who exercise significant power or discharge significant responsibilities in relation to GSC activities.

Authorities should ensure that GSC arrangements have in place policies that address heightened risks for GSC arrangements, such as operational risks, AML/CFT risks, and cyber risks. Risk management measures and technical standards should cover relevant activities performed by providers of activities in the GSC arrangements, paying particular attention to compliance by permissionless or anonymous networks

Authorities should ensure that GSC arrangements conduct continuous risk assessments, contingency preparedness, and continuity planning. Authorities should ensure that GSC arrangements have a robust assessment of how its technology model and the rules for transferring coins provide assurance of settlement finality.

In addition to consumer protection considerations, authorities should address potential financial stability concerns and limit spillover effects to the wider financial system, and consider requiring GSC arrangements to adopt strict rules on reserve assets management and have adequate capital and liquidity buffers to absorb credit, liquidity and market risks, as well as risks related to legal, operational and cyber risks relevant to the stabilisation mechanism.

There should be particular attention to the degree of risk-taking in terms of duration, credit quality, liquidity and concentration of a GSC's reserve assets. In addition, asset-linked stabilisation mechanisms should have sufficient controls to ensure that GSC issuance and destruction are sufficiently matched by a corresponding increase or decrease in reserve assets and that such increases or decreases are managed to avoid adverse impacts on the broader market.

6. **Authorities should ensure that GSC arrangements have in place robust systems for safeguarding, collecting, storing and managing data.**

   GSC arrangements should implement and operate data management systems that record and safeguard in a discoverable format relevant data and information collected and produced in the course of their operations, while conforming to all applicable data privacy requirements. Adequate controls should be in place to safeguard the integrity and security of both on-chain and off-chain data and conform to applicable data protection regulation.

   Authorities should be able to obtain timely and complete access to relevant data and information to enable them to implement adequate regulatory, supervisory, and oversight approaches that capture the functions and activities of the GSC arrangement, in accordance with the level and nature of the risks posed..

7. **Authorities should ensure that GSC arrangements have appropriate recovery and resolution plans.**

   Authorities should ensure that GSC arrangements have in place appropriate planning to support an orderly wind-down or resolution under the applicable legal (or insolvency) frameworks, including continuity or recovery of any critical functions and activities within the GSC arrangement.

   Authorities should consider how such plans are implemented through effective contractual obligations among the entities in the GSC network, and address the potential involvement of authorities in all of the jurisdictions that the entities operate in.

8. **Authorities should ensure that GSC arrangements provide to users and relevant stakeholders comprehensive and transparent information necessary to understand the functioning of the GSC arrangement, including with respect to its stabilisation mechanism.**

   Information about the governance structure of the GSC arrangement, the allocation of roles and responsibilities assigned to operators or service providers within the GSC arrangement, the operation of the stabilisation mechanism, the investment mandate for the reserve assets, the custody arrangement and applicable segregation of reserve assets, and available dispute resolution mechanisms or procedures for seeking redress or lodging complaints are features of GSC arrangements that should be transparent.

   Authorities should ensure that the GSC arrangements makes appropriate disclosures to users and the market regarding the design of the stabilisation mechanism (e.g. asset-linked or algorithm-based), and the mechanism by which the stablecoin's value is maintained.

   Information to be disclosed to users and counterparties should also periodically cover the amount of GSC in circulation and the value and the composition of the assets in the reserve backing the GSC. Information pertaining to the amount of GSC in circulation and the value and the composition of the assets in the reserve backing the GSC should be subject to independent audit, and disclosed on a regular basis in a comprehensive and transparent manner.

GSC arrangements should put in place mechanisms to ensure the protection of users and counterparties, when a potential modification of the arrangement could have a material effect on the value, stability, or risk of the GSC.

9. **Authorities should ensure that GSC arrangements provide legal clarity to users on the nature and enforceability of any redemption rights and the process for redemption, where applicable.**

   Authorities should require GSC arrangements to provide appropriate information to users on the nature and enforceability of redemption rights, where available, and of any claims that users and intermediaries may or may not have on the underlying reserve assets or against the issuer or guarantors, including how claims may be treated in insolvency or resolution. The GSC arrangement should also provide adequate information on the process for redemption and the enforcement of any claims, where applicable, and how the GSC arrangement ensures smooth execution of such processes, including under stressed circumstances.

   Authorities should consider implications of GSC arrangements' decisions to grant users and/or intermediaries a direct legal claim against the GSC issuer or its reserve portfolio, including for "run" risks.

   Adequate disclosure should be made of the recovery avenues, available to a user that loses access to his/her wallet and private key because of a cyber-attack or other operational incident.

   Where a stablecoin is used widely for payment purposes, authorities should assess whether safeguards or protections consistent with similar instruments are appropriate. Where a GSC arrangement for such a stablecoin offers rights to redemption, such redemption should be at predictable and transparent rates of exchange, including, where authorities consider it appropriate, at par into fiat money consistent with similar instruments used widely for payment purposes. Authorities should ensure that such GSC arrangements follow prudential standards comparable to those required for financial institutions performing the same economic functions and posing similar risks.

10. **Authorities should ensure that GSC arrangements meet all applicable regulatory, supervisory and oversight requirements of a particular jurisdiction before commencing any operations in that jurisdiction, and construct systems and products that can adapt to new regulatory requirements as necessary.**

    Authorities should not permit the operation of a GSC arrangement in their jurisdiction unless the GSC arrangement meets all of their jurisdiction's regulatory, supervisory, and oversight requirements, including affirmative approval (e.g. licenses or registrations) where such a mechanism is in place.

    GSC arrangements should have the ability to adjust their operational features, processes and mechanisms as necessary to maintain compliance with regulatory requirements and international standards if these evolve.

    Before launching the arrangement and the provision of services to users in a particular jurisdiction, entities intending to engage in GSC functions and activities should ensure that they have a clear understanding of the regulatory requirements that apply and,

where regulations of more than one jurisdiction may apply, which jurisdictions' rules are applicable to different aspects of the functions and activities of the entities performing them and should engage proactively with authorities.

Annex 1: Different operating models for stablecoin arrangements

Stablecoin arrangements could take on a variety of structures and operating models, including from a technical perspective. The following four hypothetical examples can be used to illustrate the diversity in current and proposed stablecoin arrangements.

	Stablecoin A	**Stablecoin B**	**Stablecoin C**	**Stablecoin D**
Issuer	Single issuer	Multiple issuers	Single issuer	Smart Contracts
Liability - Who or what is the claim on, and are there conditions?	Claim on issuer	Claim on issuer, subject to holder meeting compliance requirements	Claim on approved intermediary; users have no rights or claims on underlying reserve assets	Interest in an equivalent amount held in the reserve assets
- Is it directly redeemable by the user, and if not, by whom?	Directly redeemable	Directly redeemable	Not directly redeemable; only approved participants can redeem coins with issuer	Directly redeemable
-What is it redeemed for, and are there conditions?	Redeemable for USD only at high ticket size, > $100K	Redeemable for USD (> $100)	Redeemable for local fiat currency	Redeemable for another crypto-asset
Stabilisation mechanism	Fiat currency – backed	Fiat currency – backed	Fiat currency – backed	Crypto-asset backed
Reserve assets	USD bank deposits	USD bank deposits	Bank deposits and short-term government securities in the referenced currencies	Another crypto-asset
Transaction permission	Permissionless	Permissionless	Permissionless below threshold	Permissionless
Medium of record	Multiple public blockchains	Single public blockchain	Single private blockchain	Single public blockchain
Ledger model	UTXO[24] or account depending on the blockchain	Account	Account	Account
Network permissions	Permissionless	Permissionless	Permissioned; validator nodes operated by approved parties	Permissionless

[24] The Unspent Transaction Output (UTXO)-based model records the ownership of the coins, and transfers occur through updating the ownership records of coins. The account-based model records the amount of coins associated with each account, and transfers occur through adjusting the amount of coins in accounts.

Annex 2: Examples of vulnerabilities, regulatory tools, and international standards by activity of a GSC arrangement

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
Establishing rules governing the stablecoin arrangement	Fraud or conflict of interest of those governing the GSC arrangement Lack of contractual arrangements among the entities of the GSC arrangement Difficulties to tackle the uncertainty for users due to an unclear definition of roles and responsibilities within the GSC arrangement. Inadequate governance framework	Ability to regulate and supervise the GSC arrangement in a holistic manner, e.g. through cooperation among authorities (akin to comprehensive consolidated supervision) Ability to require a GSC arrangement to be governed in a manner that facilitates effective regulation and supervision, including by prohibiting fully decentralised systems Governance, internal control and risk management requirements applicable at the level of the entire GSC arrangement Power to wind down or resolve a GSC arrangement Governance requirements requiring a solid legal basis Cybersecurity and other operational resiliency safeguards AML/CFT and sanctions controls	FATF Standards apply, while further updates and clarification may be necessary, especially regarding peer-to-peer transactions. For GSC arrangements set up entirely by banks, the Basel Framework and associated principles for supervision and colleges would provide a basis for overseeing the setup. For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the basis of a preliminary analysis, some of the most relevant principles regarding these vulnerabilities would be those on legal basis, governance and comprehensive management of risks. Responsibility E would provide a strong basis for cooperation among relevant authorities. See Annex 4 on CPMI-IOSCO preliminary analysis. For GSC arrangements where the token or the reserve qualifies as a security, IOSCO cooperation agreements are relevant (IOSCO Principles[25] covering Cooperation in regulation (Principles 13 to 15), IOSCO's Multilateral

[25] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD561.pdf

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
			MoU Concerning Consultation and Cooperation and the Exchange of Information,[26] the Enhanced Multilateral MoU Concerning Consultation and Cooperation and the Exchange of Information,[27] IOSCO's Principles on Cross-Border Supervisory Cooperation[28] of May 2010, the cross-border regulatory cooperation aspect of the IOSCO 2015 Cross-Border Regulation Task Force Report[29] and the work of the Follow-Up Group to address potential regulatory arbitrage).
Issuing, creating and destroying stablecoins	Inability to meet redemptions in stressed conditions For algorithmic arrangements, errors in the issuance or redemption algorithm that impact value	Adequate liquidity (risk) management Liquidity risk management tools (e.g. redemption gates) Certain own funds/liquidity requirements Cybersecurity and other operational resiliency safeguards AML/CFT and sanctions controls	FATF standards apply to firms "issuing and managing means of payment" or to those who provide "participation in and provision of financial services related to an issuer's offer and/or sale of a virtual asset". For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the

[26] https://www.iosco.org/about/?subsection=mmou

[27] https://www.iosco.org/about/?subsection=emmou

[28] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD322.pdf

[29] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD507.pdf

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
			basis of a preliminary analysis, some of the most relevant principles regarding these vulnerabilities would be those related to frameworks for comprehensive risk management and settlement. See Annex 4 on CPMI-IOSCO preliminary analysis. Depending on the creation/redemption processes, the IOSCO Principles for the Regulation of Exchange Traded Funds (2013)[30] could be relevant.
Managing reserve assets	A sharp fall in price and/or liquidity of reserve asset(s) Change in reserve allocation across reserve assets Lack of transparency in the composition of reserve Fraud or mismanagement of the reserve Investment in illiquid assets Significant increase in the price volatility of the reserve assets that cannot be or is not readily managed	Portfolio diversification rules and issuer limits rules Liquidity and other financial risk safeguards Liquidity risk management tools (e.g. redemption gates) Requirements on disclosure of the composition of the assets Disclosure of investment policies Cybersecurity and other operational resiliency safeguards AML/CFT and sanctions controls	FATF standards apply to those who provide "safekeeping and administration of cash and liquid securities on behalf of other persons", or "safekeeping and/or administration of virtual assets or instruments enabling control over virtual assets". For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. Depending on its structure, the reserve may engage IOSCO Liquidity Risk Management (2018)[31] or IOSCO Policy Recommendations for MMFs (2012).[32]

30 https://www.iosco.org/library/pubdocs/pdf/IOSCOPD414.pdf.

31 https://www.iosco.org/news/pdf/IOSCONEWS486.pdf.

32 http://www.iosco.org/library/pubdocs/pdf/IOSCOPD392.pdf.

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
			For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the basis of a preliminary analysis, some of the most relevant principles regarding these vulnerabilities would be those on custody and investment risks and transparency. See Annex 4 on CPMI-IOSCO preliminary analysis.
Providing custody/trust for reserve assets	Custodian failure, cross-border resolution, fraud Liquidity Lack of legal clarity regarding rights to reserve assets, particularly where legal regimes of different jurisdictions are implicated	Segregation requirements/rights for reserve assets Liquidity and other financial risk safeguards Cyber security and other operational resiliency safeguards AML/CFT and sanctions controls	FATF standards apply to those who provide "safekeeping and administration of cash and liquid securities on behalf of other persons" or "safekeeping and/or administration of virtual assets or instruments enabling control over virtual assets". For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. IOSCO Recommendations Regarding the Protection of Client Assets (2013).[33] For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the basis of a preliminary analysis, some of the most

[33] Recommendations Regarding the Protection of Client Assets Consultation Report https://www.iosco.org/library/pubdocs/pdf/IOSCOPD401.pdf; Final Report http://www.iosco.org/library/pubdocs/pdf/IOSCOPD436.pdf.

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
			relevant principles regarding these vulnerabilities would be those on custody and investment risks and transparency. See Annex 4 on CPMI-IOSCO preliminary analysis.
Operating the infrastructure	Disruption to the mechanism that links the value of the stablecoin and the value of its reserves, for example a cyber incident. Uncertainty on the revocability of the payments. GSC ledger compromised due to design flaw, operational (e.g. cyber) incident.	Liquidity and other financial risk safeguards Requirements on payments finality Cyber security and other operational resiliency safeguards AML/CFT and sanctions controls	FATF Standards apply to GSC infrastructure if it satisfies the definition of a financial institution or a virtual asset service provider provided in the FATF glossary. For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the basis of a preliminary analysis, some of the most relevant principles regarding these vulnerabilities would be those on framework for the comprehensive management of risks and settlement. See Annex 4 on CPMI-IOSCO preliminary analysis.
Validating transactions	GSC ledger compromised due to failure of multiple validator nodes	Cyber security and other operational resiliency safeguards AML/CFT and sanctions controls	For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
			systemically important, the PFMI apply. On the basis of a preliminary analysis, some of the most relevant principles regarding this vulnerability would be that on operational risk and settlement. See Annex 4 on CPMI-IOSCO preliminary analysis.
Storing the private keys providing access to stablecoins (wallets)	Disruption of a wallet, for example theft of coins from digital wallet or operational (e.g. cyber) incident. Direct loss, including by consumers	Liquidity and other financial risk safeguards Cyber security and other operational resiliency safeguards AML/CFT and sanctions controls	FATF Standards apply to all entities providing wallet services with the exception of un-hosted wallet For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk. For GSC arrangements deemed to be perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. On the basis of a preliminary analysis, a relevant principle regarding these vulnerabilities would be that on operational risk. See Annex 4 on CPMI-IOSCO preliminary analysis.
Exchanging, trading, reselling and market making of stablecoins	Withdrawal of liquidity provision by authorised resellers/market makers Disruption of a trading platform. Fraud, market manipulation, unauthorised transactions	Liquidity and other financial risk safeguards Settlement finality requirements Allocation of legal responsibility for unauthorised transactions Cybersecurity and other operational resiliency safeguards AML/CFT and sanctions controls	FATF Standards apply to all entities carrying out trading / exchanging activity with the exception of peer-to-peer transactions For GSC arrangements involving banks, the prudential risks and operational resilience vulnerabilities would be subject to the Basel Framework and Principles for the sound management of operational risk.

Activities	Vulnerabilities	Regulatory authorities and potential tools to address the vulnerabilities	
		Authority/tool	**Relevant international standard**
	Cyber incident		For GSC arrangements deemed to perform systemically important payment system functions or other FMI functions that are systemically important, the PFMI apply. See Annex 4 on CPMI-IOSCO preliminary analysis. Issues Risks and Regulatory Considerations Relating to Crypto-Asset Trading Platforms (2020)[34], discussing IOSCO Principles[35] 13, 14, 15, 33, 34, 35, 36, 37, 29, 30, 31, 32, 38 and associated IOSCO reports.

[34] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD649.pdf.

[35] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD561.pdf.

Annex 3: Summary of stocktake responses

This annex presents findings from the FSB survey on regulatory and supervisory approaches to so-called "stablecoins" (hereinafter "SCs"). All FSB members as well as the members of its Regional Consultative Groups (RCGs) were invited to participate in the survey.

A total of 51 jurisdictions completed the survey, including 25 FSB jurisdictions and 26 RCG jurisdictions. All questions have not necessarily been answered by jurisdictions, i.e. the sum of responses in tables and graphs may be fluctuant and less than the total number of responses received.

Current regulatory approaches

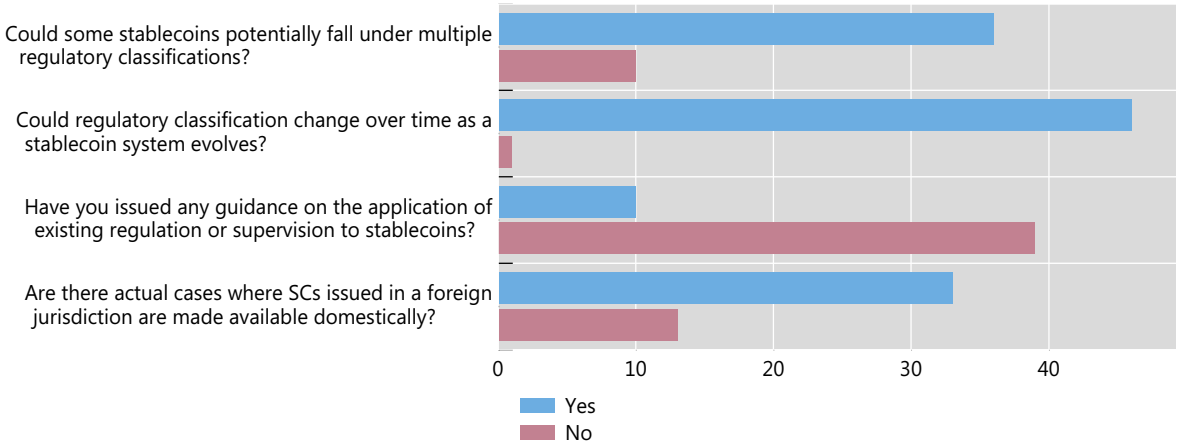
The majority of jurisdictions do not currently have SCs issued domestically. SCs are available in 31 jurisdictions, mostly cross-border. The majority of those jurisdictions, including several AE, do not currently have regulatory or supervisory regimes that are specific to SCs per se. However, regulatory and supervisory approaches in many of those jurisdictions do apply in whole or part to SCs.

Graph 1 summarises responses concerning the current regulation of SCs. Most respondents note that SCs could be classified under more than one regulatory category, and that the classification could change as the nature and use of the SC evolves. Many respondents are of the view that the existing regulatory and supervisory framework may not be adequate to address the risks emanating from SCs, and that there may be a need to adjust existing regulatory frameworks.

Regarding cross-sectoral issues, most jurisdictions are of the view that existing cooperation mechanisms between sectoral authorities enable them to address the need for cooperation and coordination, possibly with some adaptations (e.g. through Memorandums of Understanding (MoU)).

Stablecoins-Aspects of current regulation

Graph 1



Source: FSB

Regulatory classifications

Thirty-seven jurisdictions provided some information about how they *might* classify SCs. Jurisdictions in AEs were more likely to have a classification scheme in place.

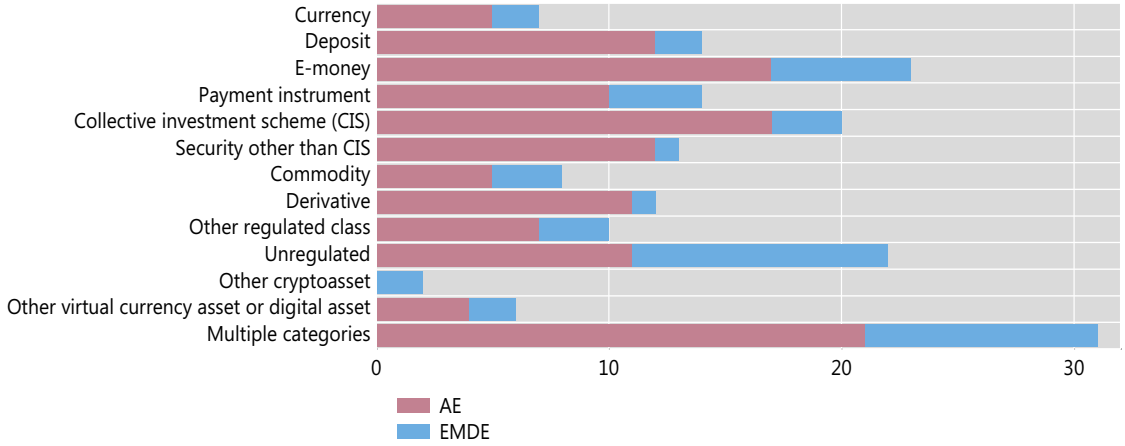
Graph 2 shows current and prospective classifications. SCs are most frequently classified as e-money, a collective investment scheme (CIS) in the AEs, followed by deposits, security other than CIS and as derivative. For EMDEs, the most common classifications used were e-money and payment instrument.

Thirty one jurisdictions indicated that SCs could fall under multiple classifications. Jurisdictions that classified SCs as e-money were likely to also classify them as either deposit or as a payment system. Four out of five jurisdictions that classified a SC as a CIS (16 out of 20) also classified it as another security, including security other than CIS, derivative, or commodity. One jurisdiction mentioned that depending on the details, a SC could exhibit bond-like features.

A few respondents indicated that under their current legal framework, it is not possible to classify SC as falling under multiple regulatory classifications. As such, certain activities may not be regulated/captured depending on which regulatory classification the SC ecosystem would fall under. Table 1 also shows that the most prominent regulation types considered by respondents are AML/CFT, cyber/technology risk, safety/soundness, and data privacy.

Current and prospective classification of SCs

Graph 2



Total number of responses: 40 including 22 from advanced economies (AEs), and 18 from emerging market and developing economies (EMDEs)

Source: FSB

Regulation by activity

Table 1 shows applicable regulation by activity within a SC ecosystem. Issuing/redeeming SCs; managing SC reserve assets; providing custody for SC reference assets; trading/exchanging SCs (including reselling to retail users) and storing SCs (wallets) are the functions that are most frequently covered by regulation, in particular provisions with respect to AML/CFT. Regulatory coverage is lowest with respect to governance and the operation of infrastructure arrangements for SCs.

One respondent noted that certain activities could be easily operated remotely and shift location quickly (e.g. mastermind, issuance of SC, reserve management) and thus would be more likely to be prone to regulatory arbitrage than those activities that tend to have domestically-focused functions (e.g. trading, storing, custody of SCs).

Table 1: Classification of SCs into activities and applicable regulations[36]

	AML/CFT	FMI/payments	Competition	Investor protection	Consumer protection	Market conduct /integrity	Cyber /technology risk regulation	Safety and soundness	Data privacy	Other
Governing/controlling the SC arrangement ("mastermind")	17	16	17	11	11	11	15	18	19	5
Operating the infrastructure of the SC arrangement (e.g. payment or settlement system)	18	20	16	7	11	11	17	20	21	3
Issuing/redeeming SCs	33	16	16	12	17	12	18	18	21	3
Managing SC reserve assets	23	9	15	15	12	10	18	22	17	3
Providing custody for SC reference assets	21	11	13	17	13	10	21	21	17	6
Trading/exchanging SCs (including reselling to retail users)	35	8	13	19	16	20	25	22	21	6
Storing keys to access SCs (wallets)	32	12	12	14	16	9	22	17	20	5
Undertaking other type of activity (please specify)	4	2	2	1	3	2	4	2	4	1

[36] Number in each cell indicate the number of responses received for a given activity and regulation type, e.g. 33 jurisdictions indicated that AML-CFT regulations exist and would apply to issuing/redeeming of stablecoins.

Cross-border regulation and supervision of SCs

Most jurisdictions have some power with respect to SCs arrangements operating in a cross-border context,[37] whether it be SC activities provided out of a foreign jurisdiction available to a jurisdiction's domestic customers (**Graph 3**), or a SC arrangements operating domestically offering services cross-border outside of the country (**Graph 4**).

An authority's regulatory/supervisory reach also depends on whether the SC could be classified under an existing regulatory framework. Most jurisdictions' authorities would have the same power with respect to SCs issued overseas but being available to users domestically, so long as the SC can be classified under the domestic regulatory framework. Jurisdictions in AE generally indicate having more powers both domestically and abroad.

A majority of respondents feel that international cooperation would be very or somewhat important in regulating and supervising SC activity (**Graph 5**), supporting cooperative oversight and cross-border information sharing (e.g. through the application of international standards such as the PFMI[38], existing regulatory regimes in geographies[39] or cooperation mechanisms between authorities[40]), or even considering the establishment of a cross-border coordination mechanism or cooperation network.[41] Considerations concerning cross-border cooperation seem to be at an earlier stage in EMDEs.

With regards to data on SCs that authorities are able to collect and exchange, including across borders, this would highly depend on the actual classification and regulation of the SC or SC arrangement. If a given entity performing an activity of a SC arrangement is regulated, generally broad powers are available to authorities to collect data, e.g. on payment transactions, exposures of financial institutions to SCs, investor and trading data (depending on the licensing regime considered). In those cases, data sharing is generally covered by existing cooperation mechanisms in place with foreign authorities. Challenges arise where entities fall outside of the regulatory perimeter.

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[37] Several so-called "stablecoins" have been mentioned as being available cross-border, with Tether being the leading one. A non-exhaustive list also includes DAO, DAI, TrueUSD, USDPax, PAXGold, Everex, SGDR, 1SG, SDS, USDC, USDS, EURX, JPYX, GBPX, AUDX, NZDX, CNYX, RUBX, CHFX, CADX, GLDX, SLVX.

[38] More precisely, Responsibility E.

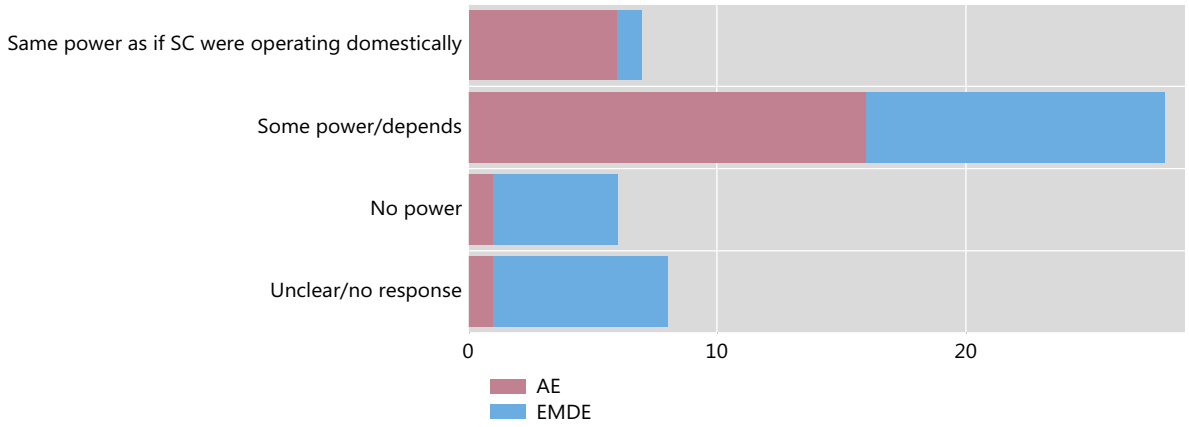
[39] E.g. in Europe, under the passporting rules for licensed entities, and through the supervisory and regulatory cooperation mechanisms in place within the European Supervisory Authorities (EBA, ESMA and EIOPA).

[40] Through existing or extended MoUs and similar bilateral/multilateral agreements between authorities (e.g. as offered by SSBs such as IOSCO).

[41] The existing arrangement for SWIFT has been mentioned.

Power that authorities have with respect to SC activities operating out of a foreign jurisdiction available domestically (incoming)

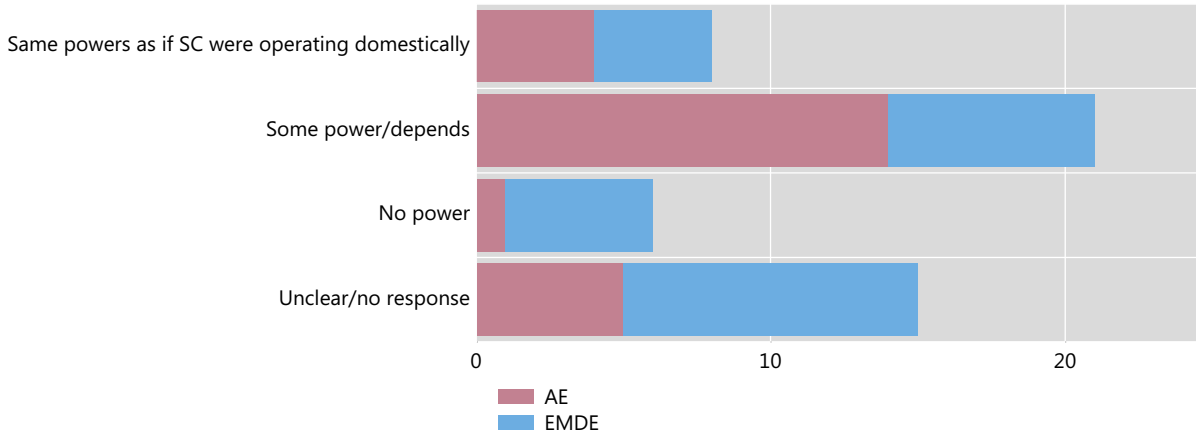
Graph 3



Source: FSB

Power that authorities have with respect to domestic SC activities operating overseas (outgoing)

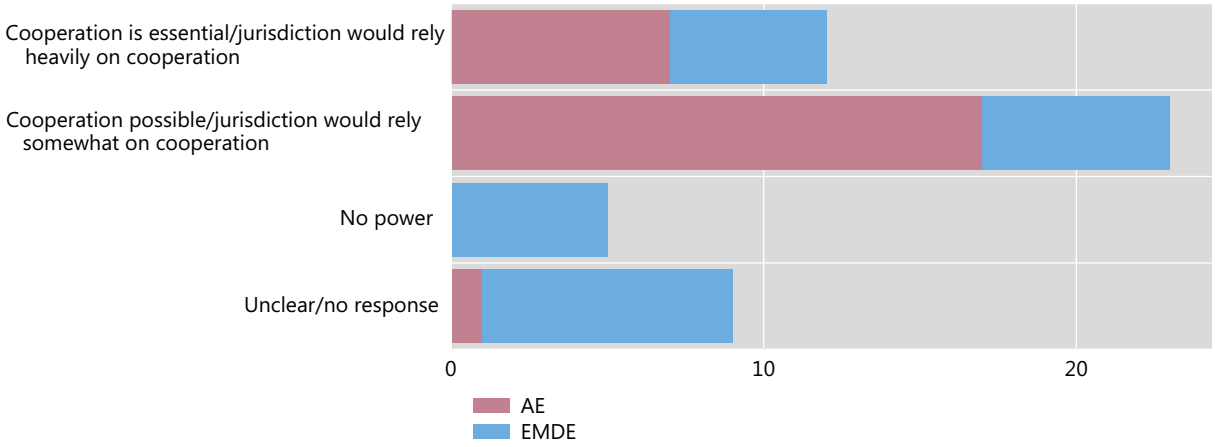
Graph 4



Source: FSB

Extent to which a jurisdiction would rely on cross-border cooperation to regulate or supervise SC activity

Graph 5



Source: FSB

Potential evolution of regulation

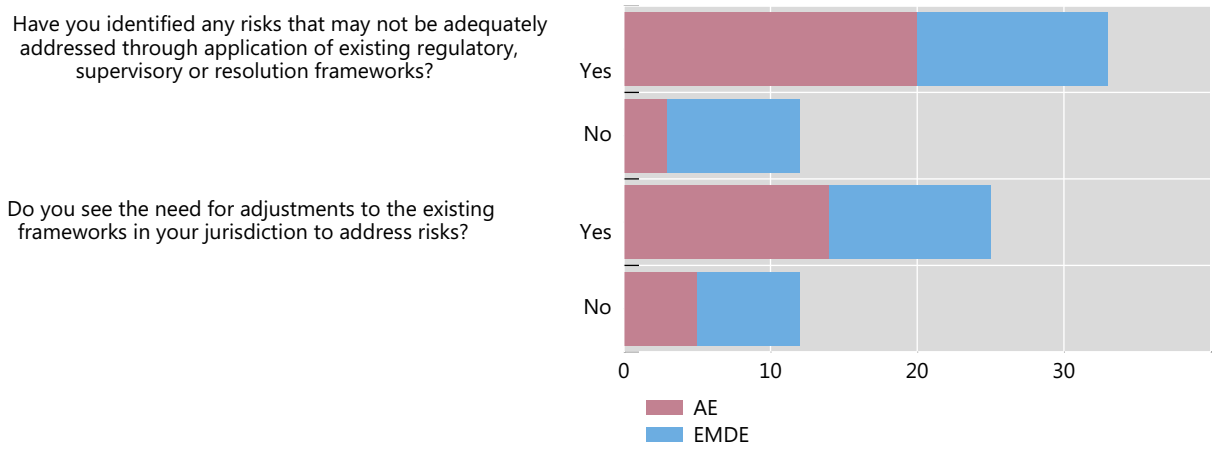
Graph 6 summarises responses concerning the potential evolution of regulation of SCs. Changes in the structure of the SC (change in the composition of the reserve, i.e. assets, stabilisation mechanism), the rights associated to it (existence of changes in the claim on the reserve assets), and the actual use of the SC (e.g. becoming a payment means, used for credit, a change in scale of the adoption) could trigger a re-evaluation of its regulatory classification. Some jurisdictions noted that a change in the regulatory environment could influence existing classifications.

Regarding risks that may not be adequately addressed, respondents noted that cross-border and cross-sectoral issues would need to be considered carefully. Most jurisdictions stressed that risks related to financial stability, monetary policy, monetary sovereignty, currency substitution, consumer and investor protection, AML/CFT, data privacy and specific operational risks linked to the underlying technology (DLT/Blockchain) used by SCs would need to be assessed further. The decentralised nature of SCs systems has been underlined by some as a complexity factor. Finally, risks of regulatory arbitrage and the risk of not capturing key activities within the regulatory ambit have also been raised. Respondents also pointed to more general risks with GSCs, which could become a substitute to currencies (especially for EMDEs, where also large and volatile capital flows could become manifest through exchange rates), retail deposits or safe assets, exacerbate bank runs, and disintermediate more traditional financial institutions. Some respondents are confident that, if a GSC system were considered a payment system, existing frameworks (e.g. PFMI) would apply and cover risks adequately.

Most respondents indicated that adjustments to existing regulatory frameworks may be needed in the future. A few respondents indicated their intention to take legislative action, either to address missing parts in their regulatory regimes (e.g. trading/exchanging, storing SCs), or to adopt a comprehensive framework (e.g. in the EU, with a potential new legislation for a common EU approach to crypto-assets, including SCs).

Stablecoins-potential evolution of regulation

Graph 6



Source: FSB

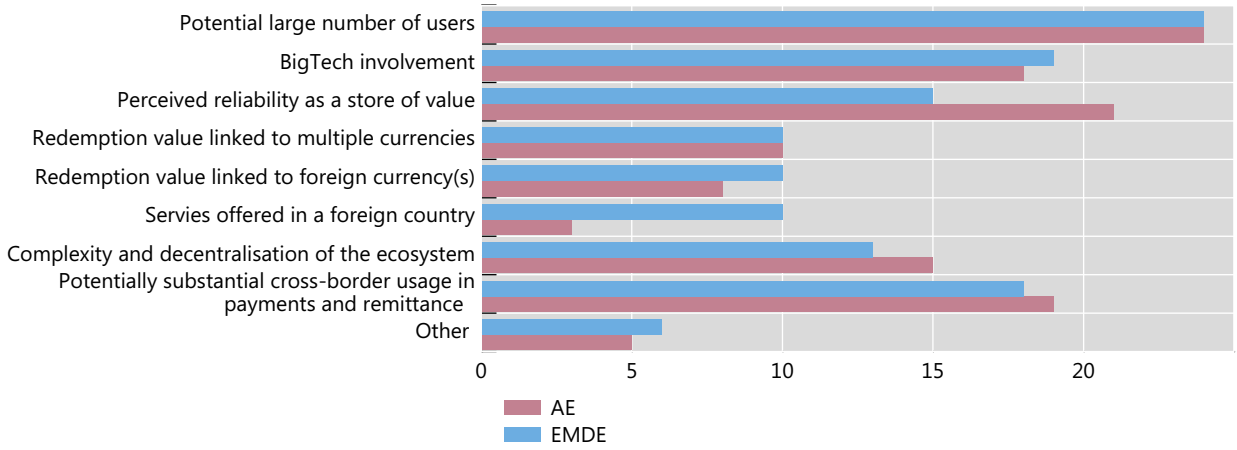
Policy development and considerations for the FSB

Graph 7 shows that jurisdictions from both AEs and EMDEs considered the potential large number of users, the involvement of BigTechs, the potential cross-border usage of a GSC for payments or remittances, and the ability for a GSC to become a store of value to be the main features of a GSC that would distinguish it from other SCs and could pose a greater risk to financial stability and regulatory objectives pursued by authorities.

Jurisdictions in the AEs tended to be more concerned by a GSC's perceived reliability as a store of value and the complex and decentralised nature of a GSC's ecosystem. On the other hand, EMDE jurisdictions expressed greater concern about a GSC being linked to foreign currency, whether it be the service provided or redemption value of a GSC being linked to foreign currency.

Features of a GSC that would distinguish it from other SCs

Graph 7



Source: FSB

Annex 4: Details from standard-setting bodies on work underway

BCBS

The Committee's work on crypto-assets comprises three broad elements:

(i) vigilant monitoring of market and regulatory developments related to crypto-assets, and an assessment of the impact of such developments on the banking system;

(ii) the quantification of banks' direct and indirect exposures to crypto-assets and related services through periodic data-collection exercises; and

(iii) an assessment of the appropriate prudential treatment for banks' crypto-asset exposures, and the extent to which this treatment should vary based on different types of crypto-assets.

In March 2019, the Committee published a newsletter on the risks associated with crypto-assets. The Committee noted that the continued growth of crypto-assets has the potential to raise financial stability concerns and increase risks faced by banks, and that many types of crypto-assets do not reliably provide the standard economic functions of money issued or backed by a government or public authority and are unsafe to rely on as a medium of exchange or store of value. The newsletter outlined a set of minimum supervisory expectations for banks that are authorised, and decide, to acquire crypto-assets and/or provide related services.

The Committee published a discussion paper in December 2019 to seek the views of stakeholders on a range of issues related to the prudential regulatory treatment of crypto-assets, including:

(i) the features and risk characteristics of crypto-assets that should inform the design of a prudential treatment for banks' crypto-asset exposures; and
(ii) general principles and considerations to guide the design of a prudential treatment of banks' exposures to crypto-assets, including an illustrative example of potential capital and liquidity requirements for exposures to high-risk crypto-assets

The Committee is also assessing the supervisory and bank implications of GSCs, including the role of banks acting as intermediaries, custodians, or providers of other services, and with respect to liquidity risk, operational risk, and AML/CFT risk.

CPMI-IOSCO Preliminary analysis of the application of the PFMI to stablecoin arrangements

Key points

- CPMI-IOSCO have undertaken a preliminary analysis of the applicability of the Principles for Financial Market Infrastructure (PFMI)[42] to stablecoin arrangements.
- The PFMI are designed to apply to all systemically important Financial Market Infrastructures (FMI). The PFMI are based on a functional approach and allow for a wide range of organisational forms, institutional designs, and arrangements.
- Stablecoin arrangements can be designed to cover a range of functions and those functions will determine the standards that will be applied. Some stablecoin arrangements will be designed to settle payments via a transfer mechanism, providing a core function that meets the definition of a payments system, as defined in Annex D of the PFMI.[43] However, other stablecoin arrangements may perform a variety of different FMI functions. Some of these arrangements may be systemically important, having the potential to trigger or transmit systemic disruption. **Where stablecoin arrangements perform systemically important payment system functions or other FMI functions that are systemically important (hereafter "systemically important stablecoin arrangements"), the PFMI apply to such arrangements.**
- **To the extent that systemically important stablecoin arrangements perform additional functions not covered by the PFMI, they will be subject to relevant standards for those functions in addition to the PFMI.** These standards may have interdependencies. For example: the PFMI (Principle 9) state that systemically important FMIs should use a settlement asset with little or no credit or liquidity risk, and where commercial bank money is used this relies on the Basel standards for commercial banks.[44] Further work may be needed to explore and lay out clearly the interdependencies of the PFMI with other international standards, including how each addresses the risks associated with a systemically important stablecoin arrangement's stabilisation activities.
- Regulatory or supervisory principles around consumer and investor protection, data privacy, Anti-money laundering (AML) and market integrity are also likely to be crucial elements of the overall regulatory framework that would apply to a systemically important stablecoin arrangement. Cross border regulatory cooperation will be important given the potential for regulatory arbitrage.

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[42] PFMI are available on the CPMI and IOSCO websites: www.bis.org/cpmi/publ/d101a.pdf and www.iosco.org/library/pubdocs/pdf/IOSCOPD377-PFMI.pdf.

[43] Annex D of the PFMI states: "*A payment system is a set of instruments, procedures, and rules for the transfer of funds between or among participants; the system includes the participants and the entity operating the arrangement*." (Paragraph 1.10 of the PFMI).

[44] Principle 9 (Money settlements) is applicable to systemically important payment systems, securities settlement systems and CCPs.

- The PFMI are technology neutral. It may be challenging for some systemically important stablecoin arrangements to comply with the high standards of the PFMI, particularly for those systemically important stablecoin arrangements that are partially or highly decentralised. **Nevertheless, systemically important stablecoin arrangements will need to adapt to meet them.**
- **Some clarification or interpretation may help explain how systemically important stablecoin arrangements may comply with the PFMI, but such clarification or interpretation would not change the underlying principles that apply to a systemically important FMI.** Such clarification or interpretation would seek to explain how the PFMI apply to organisations providing novel but systemically important FMI functions and to help such organisations understand what observing the PFMI, at minimum, will require of their design choices. **CPMI-IOSCO envisage further work to explore the need for such clarification or interpretation.**

1. Introduction

The Principles for Financial Market Infrastructures (PFMI) are designed to apply to all systemically important Financial Market Infrastructures (FMI).[45] FMIs facilitate the clearing, settlement and recording of monetary or other financial transactions, such as payment, securities, and derivatives contracts. They play an essential role in the global financial system and the broader economy. If not properly managed, FMIs can be sources of financial shocks, such as liquidity dislocations and credit losses, or a major channel through which these shocks can be transmitted across domestic and international financial markets. Responsibility E of the PFMI provides the framework for cooperation among central banks, market regulators, and other authorities for promoting the safety and efficiency of systemically important FMIs.

This note describes CPMI-IOSCO's preliminary analysis of how the PFMI[46] are relevant and applicable to systemically important stablecoin arrangements. Stablecoin arrangements can be complex, consisting of multiple entities, possibly located in several jurisdictions and possibly performing a mix of different FMI functions. Ultimately, how the PFMI are applied to a particular systemically important stablecoin arrangement would depend on the arrangement's specific design, characteristics, and features, which would have to be addressed on a case-by-case basis.

Preliminary analysis suggests that the PFMI provide relevant international standards for authorities to take into account in (1) considering regulatory approaches that may be appropriate for systemically important stablecoin arrangements, (2) promoting their safety and efficiency, and (3) cooperating in fulfilling their respective functions. While no need for an amendment of the PFMI is identified at this point in time, it is noted that proposed and prospective systemically

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[45] The PFMI define an FMI in a broad sense as a "*multilateral system among participating institutions, including the operator of the system, used for the purposes of clearing, settling or recording payments, securities, derivatives, or other financial transactions*". In particular, the PFMI apply to systemically important payment systems (SIPS), central counterparties (CCPs), central securities depositories (CSDs), securities settlement systems (SSSs), and trade repositories (TRs).

[46] The PFMI are made up of 24 principles that apply to one or more types of systemically important FMIs. Furthermore, five Responsibilities apply to authorities supervising or overseeing such FMIs. In particular Responsibility E addresses cooperation among central banks, market regulators, and other authorities. Annex F applies to critical service providers of FMIs.

important stablecoin arrangements may encounter challenges in meeting some of the relevant PFMI standards.

Certain functions of stablecoin arrangements may involve the application of other regulatory/supervisory frameworks in addition to the PFMI. Moreover, related work is already in progress in regulatory fora other than CPMI-IOSCO.[47] Thus, for systemically important stablecoin arrangements, observing the PFMI for their payment system function will be necessary, but might not be sufficient for the overall arrangement.

CPMI-IOSCO envisage conducting additional work to analyse how particular aspects of the PFMI may be applied to systemically important stablecoin arrangements. If this further analysis reveals any gaps or the need for clarifications, they would need to be addressed, but this will not amount to a derogation or disapplication of the underlying principle. CPMI-IOSCO will coordinate with other international bodies to share perspectives and avoid duplication of work.

2. Rationale for PFMI application to stablecoin arrangements

The PFMI are expected to be applied to systemically important FMIs. The PFMI are based on a functional approach[48] and allow for a wide range of organisational forms, institutional designs, and arrangements of payment processes. The key features of stablecoin arrangements may, to a large extent, be comparable to those of payment systems, as defined in Annex D of the PFMI.[49] In particular, most stablecoin arrangements appear to be inherently designed, at a minimum, to settle payments via a transfer mechanism, where "money settlement"[50] occurs, e.g. when a "token" transfer is recorded on the arrangement's "ledger".[51] In such an arrangement, the core activity of stablecoin arrangements may be a payment system function.

A stablecoin arrangement is also designed to enhance confidence in the value of the issued "tokens". Therefore, often "tokens" purportedly are "backed" by funds, such as central bank deposits, commercial bank deposits, and/or other assets such as securities.[52] This is one means by which a stablecoin arrangement may provide a stabilisation function.

Some stablecoin arrangements may also have a user interface function (interfaces may differ across stablecoin arrangements) that provides access points for users, e.g. wallets.

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47 A stablecoin arrangement, or particular parts thereof, may be classified as a different type of regulated entity (i.e. not only as a payment system) or a different type of regulated activity. Other regulatory/supervisory frameworks include IOSCO frameworks on Money Market Funds, Protection of Client Assets, and Crypto-Asset Trading Platforms, among others.

48 The PFMI emphasise the service provided, not the design choice: "*FMIs can differ significantly in organisation, function, and design. FMIs can be legally organised in a variety of forms, […] may be owned and operated by a central bank or by the private sector, […] may also operate as for-profit or not-for-profit entities, […] can be subject to different licensing and regulatory schemes within and across jurisdictions. […] There can be significant variation in design among FMIs with the same function."* Paragraph 1.9 of the PFMI.

49 "*A payment system is a set of instruments, procedures, and rules for the transfer of funds between or among participants; the system includes the participants and the entity operating the arrangement.*" Paragraph 1.10 and Annex D of the PFMI.

50 Principle 9 (Money Settlements) is directly applicable to this key function, since it covers the situation when "an FMI conducts money settlements on its own books".

51 See Graph A.1 in Annex A of the G7 Working Group on Stablecoins (October 2019), *Investigating the impact of global stablecoins* (available at https://www.bis.org/cpmi/publ/d187.pdf). Graph A.1 provides a functional view of the stablecoin ecosystem along three functions: Issues and stability mechanism, Transfer mechanism, User interface.

52 Principle 16 (Custody and investment risks) is directly applicable to this key aspect of a stablecoin arrangement, since it addresses the need for an FMI to "safeguard its own and its participants' assets" and to address the credit, market, and liquidity risks associated with the custody and investment of these assets.

More broadly, some stablecoin arrangements may also be designed to provide services ancillary to typical payment system services (e.g. some Delivery versus Payment (DVP) or CSD/SSS type services) and may thus be of a "hybrid" FMI nature.

Given that some stablecoin arrangements are designed to be used as means of payment, CPMI-IOSCO believe that, for purposes of this preliminary consideration of the application of the PFMI, the existence of functions within a stablecoin arrangement not directly linked to payments does not weigh against using payment systems as an appropriate proxy for categorising stablecoin arrangements.

For the purpose of assessing the application of the PFMI to stablecoin arrangements, three high-level forms of stablecoin arrangements have been considered. These forms attempt to capture different potential approaches to the governance of the arrangement as a whole, the design of the "ledger" itself, and the unit of account the settlement asset represents. The three forms are:

1. Centralised stablecoin arrangements that aim to fix the price of the token to a particular fiat currency, have a central governance for all functions of these arrangements, and use a private and permissioned distributed ledger.

2. Partially-distributed stablecoin arrangements that have their own unit of account, the value of which is derived from a pool or basket of assets and do not necessarily have a fixed exchange rate to a fiat currency. There is a central governance entity for the issue, stabilisation and transfer mechanism, and the arrangement is based on a private permissioned distributed ledger. However, the user interface is usually provided by independent third party entities.

3. Highly-distributed stablecoin arrangements[53] that have their own unit of account, the value of which is derived from a pool or basket of assets and does not necessarily have a fixed exchange rate to a fiat currency. A central entity may govern the issue and stabilisation mechanism. The transfer function is performed on a public un-permissioned distributed ledger meaning that no responsible entity can be identified. The user interface is provided by independent third party entities.

3. Systemic importance of stablecoin arrangements

As noted above, the PFMI are expected to be applied to systemically important FMIs, and they provide guidance for relevant authorities to assess the systemic importance of payment systems.[54] Relevant authorities have also usually developed a set of qualitative and quantitative factors to assess whether an FMI is systemically important in their own jurisdictions which could inform the assessment of the systemic importance of a stablecoin arrangement for the purpose of PFMI application. Several authorities may be relevant for the purposes of assessing the systemic importance of a stablecoin arrangement due to the number of functions a stablecoin arrangement may carry out and the number of jurisdictions in which it may operate. Additional

[53] Such arrangements seem to be theoretical at this stage.

[54] The PFMI state that "…*a payment system is systemically important if it has the potential to trigger or transmit systemic disruptions; this includes, among other things, systems that are the sole payment system in a country or the principal system in terms of the aggregate value of payments; systems that mainly handle time-critical, high-value payments; and systems that settle payments used to effect settlement in other systemically important FMIs."* Paragraph 1.20 of the PFMI.

considerations could help in capturing specificities of stablecoin arrangements including oversight implications of different levels of decentralisation.

4. Stablecoin arrangements and the application of PFMI principles

Proposed and prospective developers of stablecoin arrangements may face challenges in meeting some of the PFMI standards and may need to consider potential design changes in order to ensure that the PFMI are observed.

Based on a preliminary analysis, the most relevant principles for systemically important stablecoin arrangements would appear to be Principles 1-5, 7- 9, 11-12, 15-23, and Annex F, given that stablecoin arrangements may perform functions that cut across a variety of FMI classifications. Preliminary analysis suggests that all of these may be of general application to any systemically important stablecoin arrangement. However, there are some principles which may be more challenging for systemically important stablecoin arrangements to meet either due to the uncertainty around what PFMI observance would look like in practice for any stablecoin arrangement or because of certain design choices associated with partially and highly-distributed stablecoin arrangements. The more decentralised the arrangements are, the higher the challenges may be.

CPMI-IOSCO's preliminary analysis suggests that systemically important stablecoin arrangements would face varying degrees of difficulty in observing the principles. While this is likely to create challenges primarily for the entities themselves, it could also pose challenges for authorities when it comes to their consideration of a stablecoin arrangement's consistency with the PFMI.

As an initial matter, for most of the principles, CPMI-IOSCO preliminarily note that observance would be challenging for both partially distributed and highly distributed stablecoin arrangements. Further, CPMI-IOSCO have identified several principles that likely would be challenging to observe for all types of stablecoin arrangements. For these particular principles, the precise application or interpretation may not always be straightforward.

For example, Principle 1 states that "*an FMI should have a well-founded, clear, transparent, and enforceable legal basis for each material aspect of its activities in all relevant jurisdictions*". Because the legal qualification of stablecoins often is uncertain, stablecoin arrangements may face challenges in establishing the required (domestic and cross border) sound legal underpinnings. Moreover, protections under existing legislation, including payments law, settlement finality provisions and conflict of laws regimes in local jurisdictions, were not written with stablecoin arrangements in mind, and in some jurisdictions may not necessarily extend to such arrangements, leading to possible legal uncertainties in the absence of guidance. These challenges are expected to be even greater for partially-distributed or highly-distributed stablecoin arrangements as it may require a heterogeneous set of distributed entities (operating, for example, the transfer mechanism or parts of the user interface) potentially being located in multiple jurisdictions to function according to a common and unified set of rules consistent with Principle 1.

Further, Principle 9 states that "an FMI should conduct its money settlements in central bank money *where practical and available. If central bank money is not used, an FMI should minimise and strictly control the credit and liquidity risk arising from the use of commercial bank money.*" Stablecoin arrangements will still be expected to strictly minimise and control

the credit and liquidity risk arising from their chosen settlement asset, including when a stablecoin arrangement provides settlement on its own books. However, the characterisation of the settlement asset in stablecoin arrangements (e.g. as commercial bank money or not) may not always be straightforward. Further consideration would also be useful to clarify how the PFMI address stablecoin arrangements when a settlement asset carries risk in addition to credit and liquidity risk (i.e. market risk).

Table 1 summarises the preliminary analysis (subject to change and ongoing CPMI-IOSCO review) on the application of the most relevant principles and Annex F to three high-level cases of stablecoin arrangements.

Stablecoin arrangements and the application of the PFMI – Preliminary analysis subject to change and review

Table 1

	Centralised stablecoin arrangement	Partially distributed stablecoin arrangements	Highly distributed stablecoin arrangements
Principles			
1 Legal basis	Applicable but challenging to observe	Applicable but challenging to observe	Applicable but challenging to observe
2 Governance	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
3 Framework for comprehensive management of risks	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
4 Credit risks	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
5 Collateral	Applicable	Applicable	Applicable
7 Liquidity risks	Applicable	Applicable	Applicable but challenging to observe
8 Settlement finality	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
9 Money settlements	Applicable but challenging to observe	Applicable but challenging to observe	Applicable but challenging to observe
11 CSD	Applicable (to the extent that the arrangements are designed for asset settlements) but challenging to observe	Applicable (to the extent that the arrangements are designed for asset settlements) but challenging to observe	Applicable (to the extent that the arrangements are designed for asset settlements) but challenging to observe
12 Exchange-of-value settlement systems	Applicable (to the extent that the arrangements are designed for to Payment versus Payment (PVP) or DVP settlements) but challenging to observe	Applicable (to the extent that the arrangements are designed for to PVP or DVP settlements) but challenging to observe	Applicable (to the extent that the arrangements are designed for to PVP or DVP settlements) but challenging to observe
15 General business risk	Applicable	Applicable	Applicable
16 Custody	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
17 Operational risk	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
18 Access and participation requirements	Applicable but challenging to observe	Applicable but challenging to observe	Applicable but challenging to observe

19 Tiered participation arrangements	Applicable but challenging to observe	Applicable but challenging to observe	Applicable but challenging to observe
20 Links	Applicable but challenging to observe[55]	Applicable but challenging to observe	Applicable but challenging to observe
21 Efficiency	Applicable	Applicable	Applicable
22 Communication procedures and standards	Applicable	Applicable	Applicable but challenging to observe
23 Transparency	Applicable	Applicable but challenging to observe	Applicable but challenging to observe
Annex F	Applicable	Applicable but challenging to observe	Applicable but challenging to observe

Table 1 is intended to provide a high-level summary of the issues that CPMI-IOSCO have identified to date based on its preliminary analysis. CPMI-IOSCO do not intend for this summary table to constitute guidance or legal advice on which developers of stablecoin arrangements should rely when considering potential design choices. Going forward, CPMI-IOSCO envisage analysing further how particular systemically important stablecoin arrangements may comply with the PFMI. Some clarification or interpretation may help explain how systemically important stablecoin arrangements may comply with the PFMI, but such clarification or interpretation would not change the underlying principles that apply to a systemically important FMI. Such clarification or interpretation would seek to explain how the PFMI apply to organisations providing novel but systemically important FMI functions and to help such organisations understand what observing the PFMI, at minimum, will require of their design choices.

5. Application of Responsibility E to stablecoin arrangements

The PFMI Responsibilities are also applicable to authorities responsible for stablecoin arrangements. In particular, Responsibility E provides that "central banks, market regulators, and other relevant authorities should cooperate with each other, both domestically and internationally, as appropriate, in promoting the safety and efficiency of FMIs." Responsibility E, together with its Key Considerations, provides a strong basis for cooperation among relevant authorities for the regulation, supervision and oversight of systemically important stablecoin arrangements.

As a stablecoin arrangement may have other features and provide services in addition to those of a payment system, and the services may be provided on a cross-border basis, a wider range of authorities may have an interest or responsibility vis-a-vis the stablecoin arrangement than only payment system supervisors and oversight authorities. In addition, partially distributed or highly distributed stablecoin arrangements may pose additional challenges. Therefore, it is important to identify and engage the potentially broader set of relevant authorities. Hence the range of authorities that should cooperate could be wider. CPMI-IOSCO envisage analysing further whether additional considerations would be helpful to achieve appropriate cooperation among relevant authorities.

[55] To the extent that entities within stablecoin arrangements interact with other FMIs.

IOSCO

On 23 March 2020, IOSCO published a report on "Global Stablecoin Initiatives".[56] The report includes a discussion, at a high level, of how some of the relevant IOSCO Principles, Standards, Recommendations and Guidance (IOSCO Standards) could apply to GSC proposals. For purposes of the discussion on IOSCO Standards, the report used a hypothetical case study of a stablecoin that could act as a global currency and potential financial infrastructure used for domestic and cross-border payments, which uses a reserve fund and intermediaries to seek a stable price vis a vis a basket of low volatility currencies. The report's discussion of how this hypothetical case study could interact with the remits of securities regulators could apply to other GSC proposals, depending on their specific design and their legal and regulatory characteristics and features. The report does not provide an account of how any particular jurisdiction's domestic regulation might apply to GSC proposals.

The majority of IOSCO's report explores the potential application of IOSCO Standards to the "back-end" of a hypothetical GSC, including the management and structuring of the reserve fund; the creation and redemption of coins; coin arbitrage; and potential secondary market trading of the coin. The report also contains a preliminary analysis of the CPMI-IOSCO Principles for Financial Market Infrastructures.

Policy Recommendations for Money Market Funds (2012)[57]

Stablecoin arrangements that use a reserve fund to keep the secondary market price in line with the value of the referenced basket or assets in the reserve may have features that resemble a collective investment scheme, a securitised product, or other type of security. Certain characteristics of these reserve funds may be similar to money market funds, particularly with respect to portfolio construction, and market intermediaries may be considered to be acquiring a debt instrument. On this basis, Recommendations 1, 3, 9, 13 and 14 of the *IOSCO Policy Recommendations for MMFs (2012)* may be the most relevant.

Recommendations Regarding the Protection of Client Assets (2013)[58]

In a stablecoin arrangement, a reserve fund or the rights of the authorised participants (APs) with respect to the reserve fund, might be considered a security (e.g. an MMF, other collective investment scheme, or other security). Any third-party participants in GSC proposals involving such securities need to assess whether they are also providing regulated activities, including safeguarding activities. Intermediaries and other firms (such as investment firms, custodians, banks, payment services, e-money or trust companies) that hold or control client assets as part of their regulated business need to follow specific rules designed to protect client assets.

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56 https://www.iosco.org/library/pubdocs/pdf/IOSCOPD650.pdf

57 http://www.iosco.org/library/pubdocs/pdf/IOSCOPD392.pdf.

58 Recommendations Regarding the Protection of Client Assets Consultation Report https://www.iosco.org/library/pubdocs/pdf/IOSCOPD401.pdf; Final Report http://www.iosco.org/library/pubdocs/pdf/IOSCOPD436.pdf.

Principles for the Regulation of Exchange Traded Funds (2013)[59]

Certain features of a reserve fund may exhibit similar characteristics to exchange traded funds (ETFs) and other exchange traded products (ETPs). For example, a stablecoin arrangement may use intermediaries acting similarly to APs to effect transactions of fiat currency and the coin, facilitating redemptions and providing liquidity to coin holders. The role of the APs includes establishing the demand for a coin and distributing the coin received through third party platforms to customers. This could be akin to the role of APs that purchase and redeem ETF shares, and distribute ETF shares to the public. IOSCO's Principles for the Regulation of Exchange Traded Funds (2013) make a number of observations on the role of APs and set out nine principles that regulators could consider for ETFs.

Issues, Risks and Regulatory Considerations Relating to Crypto-Asset Trading Platforms (2020)[60]

Coin distribution could occur through APs that directly interact with the reserve fund (to mint or burn the coin) and such APs may use crypto-asset trading platforms (CTPs) to buy and sell the coin. As such, CTPs could be the main secondary market where users buy and sell coins. Where a securities regulatory authority has determined that a crypto-asset or an activity involving a crypto-asset falls within its jurisdiction, the basic principles or objectives of securities regulation should apply. The 2020 report describes some of the issues and risks associated with the trading of crypto-assets on CTPs. It describes key considerations and provides toolkits that are intended to assist regulatory authorities who may be evaluating CTPs within the context of their regulatory frameworks. CTPs may need to be regulated as trading venues and meet relevant domestic requirements and international standards.

Principles for Financial Benchmarks (2013)[61]

If any stablecoin pricing, or the value of any assets that are linked to the stablecoin, is used in the future to price or be the basis for the price of certain financial instruments, including those traded on a regulated venue (such as a fund or derivatives), there is the possibility the stablecoin or the value of the linked assets could become a benchmark. In turn, depending on the jurisdiction, the administrator of the benchmark might be carrying out regulated activity and need to be authorised. The principles outlined in this work are useful as a starting point to understand the areas of risk and key mitigants to address inherent risks in calculating and publishing prices.

Principles for the Regulation and Supervision of Commodity Derivatives Markets[62]

IOSCO's work on derivatives products may be relevant in two distinct ways. First, a coin itself could potentially be regarded as a derivative, deriving its value from an underlying basket of financial assets (*i.e.* a reserve fund). Secondly, future derivatives products could be introduced that would use the coin as the underlying asset from which they derive their value.

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[59] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD414.pdf.

[60] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD649.pdf

[61] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD415.pdf

[62] https://www.iosco.org/library/pubdocs/pdf/IOSCOPD358.pdf.

The following three IOSCO principles on commodity derivatives are potentially relevant: 1) economic utility (contracts should meet the risk management needs of potential users and promote price discovery of the underlying commodity); 2) transparency (information concerning a physical commodity derivatives contract's terms and conditions, as well as other relevant information concerning delivery and pricing, should be readily available to authorities and market participants; and 3) review of evolving practices (authorities should have, or contribute to, a process to review the perimeter of regulation to ensure that they have the power to address evolving trading practices that might result in a disorderly market).

Cooperation and information exchange

Given the cross-border nature of global stablecoins, it will be important that markets regulators and other financial supervisors cooperate amongst themselves to reduce the risk of regulatory arbitrage through fragmentation. These regulatory cooperation tools, both with other securities regulators and with banking and payments regulators, can strengthen the ability of authorities to protect their domestic investors and ensure stablecoin market transparency.

In this context, the IOSCO Principles covering Cooperation in Regulation could be important when assessing global stablecoin arrangements, by encouraging a broad range of cross-border cooperation and information sharing. The relevant principles are:

- **IOSCO Principle 13** - The Regulator should have authority to share both public and non-public information with domestic and foreign counterparts.
- **IOSCO Principle 14** - Regulators should establish information sharing mechanisms that set out when and how they will share both public and non-public information with their domestic and foreign counterparts.
- **IOSCO Principle 15** - The regulatory system should allow for assistance to be provided to foreign regulators who need to make inquiries in the discharge of their functions and exercise of their powers.

Enforcement Cooperation

IOSCO's Multilateral MoU Concerning Consultation and Cooperation and the Exchange of Information (MMoU) and the Enhanced Multilateral MoU Concerning Consultation and Cooperation and the Exchange of Information (EMMoU) will be relevant and may facilitate exchange of relevant information amongst members with respect to enforcement.

The MMoU, developed based on the Principles 13, 14 and 15 above, assists the signatories to the MMoU to exchange confidential information (including banking records, data, documents, metadata, recordings, and images, among others) to help them enforce their laws and regulations. Currently, there are 124 authorities that are signatories to the MMoU, both from developed and developing jurisdictions. IOSCO's MMoU Screening Group assesses and determines whether the prospective signatory fully complies with the standards of cooperation. Only applicants that fully comply with the standards of cooperation are admitted as signatories. IOSCO's MMoU Monitoring Group, monitors jurisdictions' adherence to the MMoU.

The IOSCO Enhanced MMoU (EMMoU) covers new areas, including subscriber records held or maintained by internet service providers, and other electronic communication providers, who are located within the jurisdiction of the requested authority, that identify subscribers (name and address), payment details, length of service, type of service utilized, network addresses, and session times/dates and durations.

Supervisory Cooperation

Due to their inherently cross-border nature, global stablecoins are also likely to create the need for cooperation in the area of supervision. Supervisory cooperation will therefore be essential to enable cooperation and coordination between regulatory authorities. In that context, IOSCO's Principles on Cross-Border Supervisory Cooperation published in 2010 can assist securities regulators in determining the form of cooperation best suited to the regulatory task at hand and by outlining the critical issues that regulators should agree upon outside of enforcement matters. These Principles remain valid in the context of stablecoins as they can assist financial regulators in identifying common concerns.

One tool – for example – that is discussed within the Report is the use of supervisory colleges. In the securities area, IOSCO published a Report on Supervisory Colleges for Credit Rating Agencies in 2013,[63] noting the challenges that the dispersion of internationally active CRAs present for domestic supervisors and promoting the use of colleges for these internationally active CRAs. Global stablecoins may similarly have global reach and raise novel risk issues; and can benefit from the supervisory cooperation applied to CRAs as indicated in IOSCO's Report.

However, to achieve effective cross-border oversight, information sharing is also an important condition of any cooperation agreement. Many jurisdictions have therefore used the sample annotated MoU developed by IOSCO in designing their bilateral supervisory arrangements. These types of agreements may also need to be explored for stablecoins as part of a wider supervisory cooperation strategy.

Deepening supervisory cooperation was identified as a key area to explore further by IOSCO and its Members in its Report on Market Fragmentation and Cross-Border Regulation.[64] IOSCO will therefore investigate ways to encourage supervisory cooperation, beginning with a review, as appropriate, of the 2010 Principles for Supervisory Cooperation and a review of the use of supervisory colleges to identify good practices in the establishment and conduct of existing and future colleges. Where appropriate, IOSCO will also identify practical issues which could be raised or usefully addressed through colleges and potential ways to increase their use. This work may provide further insights for the supervision of stablecoins.

Finally, IOSCO's 2015 Report on Cross-Border Regulation provides authorities with a toolkit of cross-border regulatory options and considerations. This toolkit has been used by authorities in other financial sectors and may assist regulators in developing, implementing and evaluating cross-border approaches with regards to stablecoins too in the future.[65]

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63 https://www.iosco.org/library/pubdocs/pdf/IOSCOPD416.pdf.

64 https://www.iosco.org/library/pubdocs/pdf/IOSCOPD629.pdf.

65 IOSCO Task Force on Cross-Border Regulation Final Report.

Annex 5: Potential elements that could be used to determine whether a stablecoin qualifies as a GSC

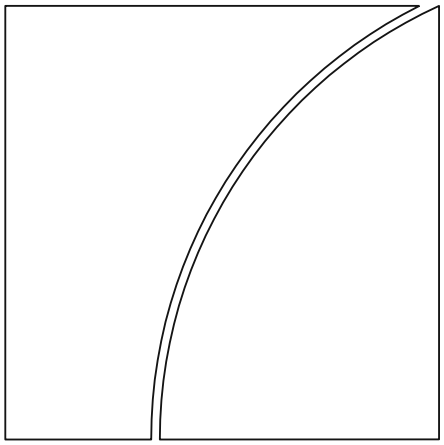
A stablecoin's global systemic importance could be measured in terms of the impact that a stablecoin arrangement's failure can have on the global financial system and wider economy.

Given that a stablecoin may be used as a means of payment or store of value, and could be used in multiple jurisdictions, the criteria to be considered in determining a GSC would need to take into account the potential uses in multiple jurisdictions. Taking reference from existing approaches such as the criteria that are often considered in determining the need for or degree of regulation, supervision, and oversight of FMIs (PFMI, 2012), and global systemically important banks (BCBS, 2013), potential elements that could be used to determine whether a stablecoin qualifies as a GSCs could include factors such as:

(i) Number and type of stablecoin users
(ii) Number and value of transactions
(iii) Size of reserve assets
(iv) Value of stablecoins in circulation
(v) Potential substantial cross-border use in payments and remittances;
(vi) Number of jurisdictions with stablecoin users
(vii) Market share in each jurisdiction
(viii) Redemption linked to a foreign currency or multiple currencies
(ix) Interconnectedness with financial institutions
(x) Available alternatives to using the GSC as a means of payment at short notice
(xi) Business, structural and operational complexity

Committee on Payments and Market Infrastructures

Markets Committee



Central bank digital currencies

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Foreword

The history of central banking began with payment services. Since then payment-related innovation has always been an integral part of central banking. Modern examples include the establishment of systems allowing for immediate interbank gross settlement and the recent increased emphasis on faster retail payment systems. Central bank digital currencies (CBDCs) represent another such potential innovation. This joint report by the Committee on Payments and Market Infrastructures and the Markets Committee provides an initial analysis of CBDCs. It offers a high-level overview of their implications for payments, monetary policy and financial stability. The analysis of the committees reflects initial thinking in this rapidly evolving area and is a starting point for further discussion and research. It also highlights that the issuance of a CBDC requires careful consideration.

The Committees thank Klaus Löber (European Central Bank) and Aerdt Houben (Netherlands Bank) and the two Committee working groups for their efforts in preparing this report.

Benoît Cœuré
Chair, Committee on Payments and Market Infrastructures

Jacqueline Loh
Chair, Markets Committee

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Executive summary

Interest in central bank digital currencies (CBDCs) has risen in recent years. The Committee on Payments and Market Infrastructures and the Markets Committee recently completed work on CBDCs, analysing their potential implications for payment systems, monetary policy implementation and transmission as well as for the structure and stability of the financial system.

Key highlights of the work are:

- CBDC is potentially a new form of digital central bank money that can be distinguished from reserves or settlement balances held by commercial banks at central banks. There are various design choices for a CBDC, including: *access* (widely vs restricted); degree of *anonymity* (ranging from complete to none); operational *availability* (ranging from current opening hours to 24 hours a day and seven days a week); and *interest bearing characteristics* (yes or no).
- Many forms of CBDC are possible, with different implications for payment systems, monetary policy transmission as well as the structure and stability of the financial system. Two main CBDC variants are analysed in this report: a wholesale and a general purpose one. The wholesale variant would limit access to a predefined group of users, while the general purpose one would be widely accessible.
- CBDC raises old questions about the role of central bank money, the scope of direct access to central bank liabilities and the structure of financial intermediation. Traditionally, central banks have, for various reasons, tended to limit access to (digital) account-based forms of central bank money to banks and, in some instances, to certain other financial or public institutions. By contrast, physical central bank money, ie cash, is widely accessible. This approach has, in general, served the public and the financial system well, setting a high bar for changing the current monetary and financial structure.
- Wholesale CBDCs, combined with the use of distributed ledger technology, may enhance settlement efficiency for transactions involving securities and derivatives. Currently proposed implementations for wholesale payments – designed to comply with existing central bank system requirements relating to capacity, efficiency and robustness – look broadly similar to, and not clearly superior to, existing infrastructures. While future proofs of concept may rely on different system designs, more experimentation and experience would be required before central banks can usefully and safely implement new technologies supporting a wholesale CBDC variant.
- In part because cash is rapidly disappearing in their jurisdiction, some central banks are analysing a CBDC that could be made widely available to the general public and serve as an alternative safe, robust and convenient payment instrument. In circumstances where the traditional approach to the provision of central bank money – in physical form to the general public and in digital form to banks – was altered by the disappearance of cash, the provision of CBDC could bring substantial benefits. However, analysing whether these goals could also be achieved by other means is advisable, as CBDCs raise important questions and challenges that would need to be addressed. Most importantly, while situations differ, the benefits of a widely accessible CBDC may be limited if fast (even instant) and efficient private retail payment products are already in place or in development.
- Although a general purpose CBDC might be an alternative to cash in some situations, a central bank introducing such a CBDC would have to ensure the fulfilment of anti-money laundering and counter terrorism financing (AML/CFT) requirements, as well as satisfy the public policy requirements of other supervisory and tax regimes. Furthermore, in some jurisdictions central banks may lack the legal authority to issue a CBDC, and ensuring the robust design and operation of such a system could prove to be challenging. An anonymous general purpose CBDC would raise further concerns and challenges. Although it is unlikely that such a CBDC would be considered, it would not necessarily be limited to retail payments and it could become widely used globally, including for illegal transactions. That said, compared with the current situation, a non-anonymous CBDC could allow for digital records and traces, which could improve the application of rules aimed at AML/CFT.

- Issuance of a CBDC would probably not alter the basic mechanics of monetary policy implementation, including central banks' use of open market operations. CBDC introduces a new type of central bank money whose demand – like cash – would need to be accommodated. CBDC would also not necessarily affect the discretion that central banks have in choosing their monetary policy implementation techniques (eg reliance on purchases of securities or credit operations with banks) as well as the maturity, liquidity and credit risk of their assets. However, if flows into CBDC were to become large and not associated with offsetting declines in physical banknotes, as could be the case in times of financial stress, challenges could arise (such as a need to broaden the assets that the central bank can hold or take on as collateral).
- CBDC could enrich the options offered by the central bank's monetary policy toolkit, eg by allowing for a strengthening of pass-through of policy rate changes to other interest rates or addressing the zero lower bound (or the even lower, effective bound) on interest rates. It is not clear, however, that the current pass-through is anything but adequate. Furthermore, other more conventional tools and policies can to some extent achieve similar outcomes without introducing new risks and challenges (such as implementing negative interest rates on public holdings of a general purpose CBDC). And some of these gains might not arise without discontinuing higher denomination banknotes, which – although helping with AML/CFT requirements – would by itself entail some costs.
- Implications are more pronounced for monetary policy transmission and financial markets, especially if a CBDC was to be designed as, or de facto became, an attractive asset. As a liquid and creditworthy asset, a wholesale variant available to institutional investors that would be akin to interest-bearing central bank reserves or reverse repo facilities, yet widely tradeable, could function as a safe asset comparable in nature to short maturity government bills. A general purpose variant could compete with guaranteed bank deposits, with implications for the pricing and composition of banks' funding.
- The introduction of a CBDC would raise fundamental issues that go far beyond payment systems and monetary policy transmission and implementation. A general purpose CBDC could give rise to higher instability of commercial bank deposit funding. Even if designed primarily with payment purposes in mind, in periods of stress a flight towards the central bank may occur on a fast and large scale, challenging commercial banks and the central bank to manage such situations. Introducing a CBDC could result in a wider presence of central banks in financial systems. This, in turn, could mean a greater role for central banks in allocating economic resources, which could entail overall economic losses should such entities be less efficient than the private sector in allocating resources. It could move central banks into uncharted territory and could also lead to greater political interference.
- For currencies that are widely used in cross-border transactions, all the considerations outlined above would apply with added force, especially during times of generalised flight to safety. The introduction of a CBDC in one jurisdiction could adversely affect others. Central banks that have introduced or are seeking to introduce a CBDC should consider cross-border issues where relevant.
- Any steps towards the possible launch of a CBDC should be subject to careful and thorough consideration. Further research on the possible effects on interest rates, the structure of intermediation, financial stability and financial supervision is warranted. The effects on movements in exchange rates and other asset prices remain largely unknown and also deserve further exploration.
- More generally, central banks and other authorities should continue their broad monitoring of digital innovations, keep reviewing how their own operations could be affected and continue to engage with each other closely. This includes monitoring the emergence of private digital tokens that are neither the liability of any individual or institution nor backed by any authority. At this time, the general judgment is that their volatile valuations, and inadequate investor and consumer protection, make them unsafe to rely on as a common means of payment, a stable store of value or a unit of account.

1. Introduction

Some central banks have started to consider whether they might, at some stage in the future, issue digital currencies of their own. While providing greater access to digital forms of central bank liabilities is not an entirely new idea (eg Tobin (1985)), the recent debate has been motivated by a number of factors. These include: (i) interest in technological innovations for the financial sector; (ii) the emergence of new entrants into payment services and intermediation; (iii) declining use of cash in a few countries; and (iv) increasing attention to so-called private digital tokens. In response to the growing interest of central banks, the private sector and the public at large, the Committee on Payments and Market Infrastructures (CPMI) and the Markets Committee (MC) conducted complementary studies on the implications of issuing a central bank digital currency (CBDC).

This consolidated report is an early contribution to this topic, providing a conceptual analysis of the potential effect of CBDC in three core central banking areas: payments, monetary policy implementation and financial stability. The committees' work in this area builds on previous work they conducted on the role of central bank money, digital currencies, fast payments, access to central bank services and monetary policy implementation.[1] It is complemented by an exploration of possible effects on the structure of the financial system and for financial stability.

CBDC raises questions about the role of central bank money, direct access to central bank liabilities and the structure of financial intermediation. Traditionally, central banks have, for various reasons, tended to limit access to (digital) account-based central bank money to banks and, in some instances, to certain other financial or public institutions.[2] By contrast, physical central bank money (ie cash) is widely accessible. In some jurisdictions, however, the use of cash is decreasing, with the possibility of its complete disappearance, implying that the public would no longer have wide access to central bank money. Since the traditional approach has, in general, served the public and the financial system well, the bar for changing the current monetary and financial structure is high.

The report is organised as follows. Section 2 introduces a taxonomy of CBDC, provides an overview of key design features and describes two variants: a wholesale and a general purpose variant. The two are used as reference cases to analyse the payment system implications in Section 3, as well as the impact on monetary policy implementation and transmission in Section 4. Section 5 discusses the broader implications for the financial system, financial stability risks and cross-border issues.

2. Taxonomy

CBDC is not a well-defined term. It is used to refer to a number of concepts. However, it is envisioned by most to be a new form of central bank money. That is, a central bank liability, denominated in an existing unit of account, which serves both as a medium of exchange and a store of value. This would be an innovation for general purpose users but not for wholesale entities. Central banks already provide digital money in the form of reserves or settlement account balances held by commercial banks and certain other financial institutions at the central bank. This mix of new and already existing forms of central bank money makes it challenging to precisely define what a CBDC is. In fact, for purposes of analysing what may change,

[1] See also CPSS (2003), CPMI (2012), CPMI (2014), CPMI (2015) and CPMI (2016a, 2016b).

[2] In the early days of central banking, it was fairly common to offer accounts not just to banks but also to non-banks (see eg Reichsbank (1926) and Bank of England (1963)). However, starting in the 20th century, central banks have tended to progressively restrict access by non-banks. In recent years, access has been granted to some critical financial market infrastructures (FMIs), such as central counterparties (CCPs), mainly for financial stability purposes. Moreover, some central banks have provided access to liquidity-absorbing instruments, such as central bank bills and reverse repos, to a broader set of counterparties than banks.

it is easier to define a CBDC by highlighting what it is not: a *CBDC is a digital form of central bank money that is different from balances in traditional reserve or settlement accounts.*[3]

2.1 The money flower

To get greater clarity, it is useful to put CBDC in the context of other types of money. Graph 1 presents a taxonomy of money in the form of a Venn-diagram referred to as the *money flower* (Bech and Garratt (2017)). The version here focuses on the combinations of four key properties: *issuer* (central bank or other); *form* (digital or physical); *accessibility* (widely or restricted); and *technology* (token- or account-based).[4] Money is typically based on one of two basic technologies: *tokens of stored value* or *accounts* (Green (2008) and Mersch (2017a)). Cash and many digital currencies are token-based, whereas balances in reserve accounts and most forms of commercial bank money are account-based.

A key distinction between token- and account-based money is the form of *verification* needed when it is exchanged (Kahn and Roberds (2009)). Token-based money (or payment systems) rely critically on the ability of the payee to verify the validity of the payment object. With cash the worry is counterfeiting, while in the digital world the worry is whether the token or "coin" is genuine or not (electronic counterfeiting) and whether it has already been spent.[5] By contrast, systems based on account money depend fundamentally on the ability to verify the identity of the account holder. A key concern is identity theft, which allows perpetrators to transfer or withdraw money from accounts without permission.[6] Identification is needed to correctly link payers and payees and to ascertain their respective account histories.

Digital central bank money is at the centre of the money flower. The taxonomy distinguishes between three forms of CBDCs (the dark grey shaded area). Two forms are token-based and the other is account-based. The two token-based versions differ first and foremost by who has access, which, in turn, depends on the potential use of the CBDC. One is a widely available payment instrument that is primarily targeted at retail transactions but also available for much broader use.[7] The other is a restricted-access digital settlement token for wholesale payment and settlement transactions. Below they are referred to as (central bank) *general purpose token* and (central bank) *wholesale token*.

The account-based version envisages the central bank providing *general purpose accounts* to all agents in the jurisdiction. While the scale would be of a different magnitude, the technology to do so is arguably currently available. The novelty would be the decision to implement such accounts.

[3] Reserves and settlement accounts are available in most jurisdictions to "monetary policy counterparties", ie financial institutions that are directly relevant for monetary policy implementation, such as deposit-taking entities, which are generally already granted access to central bank deposit and lending facilities. In some jurisdictions, account holders may comprise a broader group and include non-monetary counterparties (eg treasury, foreign central banks or certain financial markets infrastructures (FMIs)). Some central banks are considering widening access. CBDC would further expand access to digital central bank money but not to central bank lending facilities.

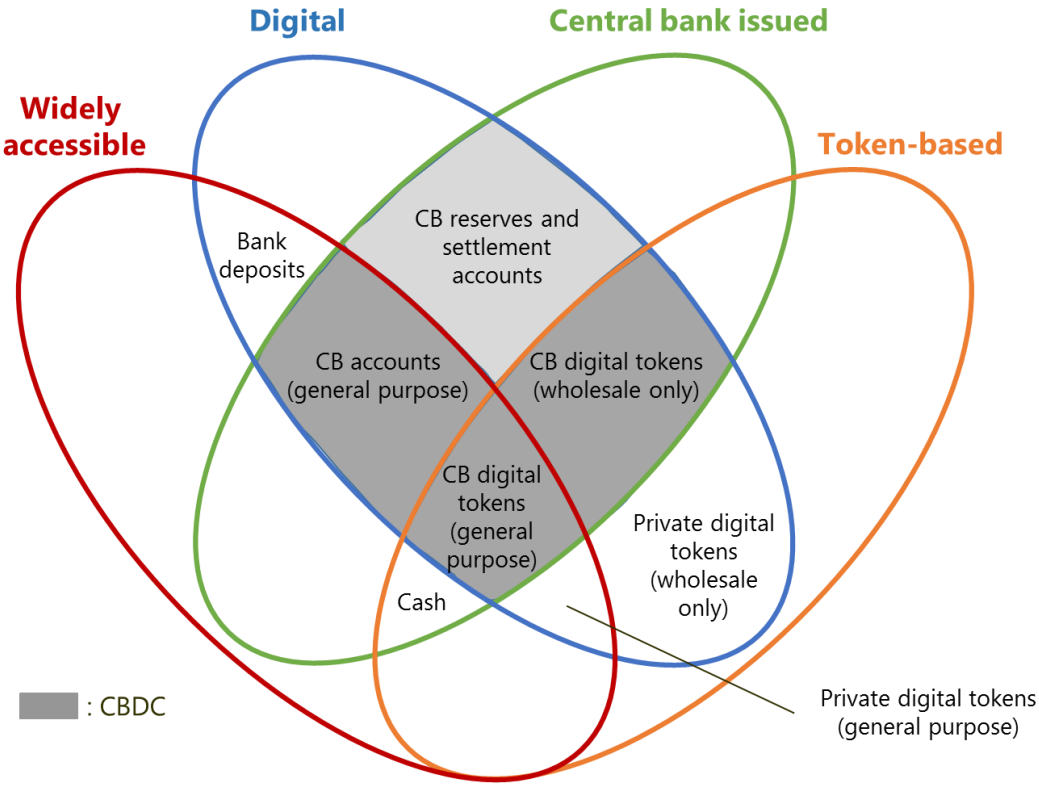
[4] Accessibility distinguishes between money that is available everywhere to everyone and money that is restricted to certain agents or jurisdictions.

[5] Double-spending is a potential problem for digital tokens. There is a risk that a payer could try to use the "same" token on two different transactions.

[6] The incident that occurred in February 2016 at the central bank of Bangladesh is an example of false verification based on compromised credentials. CPMI (2017b) presents a strategy to counter fraud in wholesale payment systems. In general, safeguarding against unauthorised access or tampering of account histories is of utmost importance. If someone maliciously breaks into the trusted intermediary hosting all the account balances, they can in principle tamper or modify any account balances at will. CPMI and IOSCO (2016) provides guidance on cyber-resilience for financial market infrastructures.

[7] It is common to divide payments into retail and wholesale segments. Retail payments are relatively low-value transactions, in the form of, for example, cheques, credit transfers, direct debits and card payments. By contrast, wholesale payments are large-value and high-priority transactions, such as interbank transfers. The distinction might become less relevant in a world with CBDCs. In fact, depending on its design, a widely available CBDC could also be used for wholesale transactions.

The money flower: a taxonomy of money Graph 1



Notes: 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, *CBDC* = central bank digital currency (excluding digital central bank money already available to monetary counterparties and some non-monetary counterparties). *Private digital tokens (general purpose)* include crypto-assets and currencies, such as bitcoin and ethereum. *Bank deposits* are not widely accessible in all jurisdictions. For examples of how other forms of money may fit in the diagram, please refer to the source.

Source: Based on Bech and Garratt (2017).

2.2 Design features

In addition to the four core properties highlighted above, there are other design features that will determine how a CBDC may serve as a means of payment and a store of value. These choices will have implications for payments, monetary policy and financial stability. The most important CBDC design options identified to date are listed below. Table 1 provides a comparison of properties across existing and potential new forms of central bank money.

Availability. Currently, access to digital central bank money is limited to central bank operating hours, traditionally less than 24 hours a day and usually five days a week.[8] CBDCs could be available 24 hours a day and seven days a week or only during certain specified times (such as the operating hours of large-value payment systems). CBDC could be available permanently or for a limited duration (eg it could be created, issued and redeemed on an intraday basis).

[8] The introduction of faster or instant payment systems in an increasing number of jurisdictions has led a number of central banks to reconsider the time during which access to digital central bank money is available, with some moving toward availability 24 hours a day seven days a week for central bank money settlement of fast retail payments (see CPMI (2016b) and Bech et al (2017)).

Key design features of central bank money — Table 1

	Existing central bank money		Central bank digital currencies		
	Cash	Reserves and settlement balances	General purpose token	accounts	Wholesale only token
24/7 availability	✓	×	✓	(✓)	(✓)
Anonymity vis-à-vis central bank	✓	×	(✓)	×	(✓)
Peer-to-peer transfer	✓	×	(✓)	×	(✓)
Interest-bearing	×	(✓)	(✓)	(✓)	(✓)
Limits or caps	×	×	(✓)	(✓)	(✓)

✓ = existing or likely feature, (✓) = possible feature, × = not typical or possible feature.

Anonymity. Token-based CBDC can, in principle, be designed to provide different degrees of anonymity in a way that is similar to private digital tokens.[9] A key decision for society is the degree of anonymity vis-à-vis the central bank, balancing, among other things, concerns relating to money laundering, financing of terrorism and privacy.

Transfer mechanism.[10] The transfer of cash is conducted on a peer-to-peer basis, while central bank deposits are transferred through the central bank, which acts as an intermediary. CBDC may be transferred either on a peer-to-peer basis or through an intermediary, which could be the central bank, a commercial bank or a third-party agent.

Interest-bearing. As with other forms of digital central bank liabilities, it is technically feasible to pay interest (positive or negative) on both token- and account-based CBDCs. The interest rate on CBDC can be set equal to an existing policy rate or be set at a different level to either encourage or discourage demand for CBDC.[11] Both non-interest bearing and interest bearing accounts could be used for retail or wholesale payment transactions. The payment of (positive) interest would likely enhance the attractiveness of an instrument that also serves as a store of value.

Limits or caps. Different forms of quantitative limits or caps on the use or holdings of CBDC are often mentioned as a way of controlling potentially undesirable implications or to steer usage in a certain direction. For example, limits or caps could make a CBDC less useful for wholesale rather than retail payments. At present, such limits or caps on holdings/use are most easily envisioned in non-anonymous account-based systems.[12]

[9] For example, bitcoin allows transactions to be (pseudo) anonymous. While all bitcoin transactions are publicly recorded using the payer's and the payee's public addresses, very much like e-mail addresses, these addresses do not necessarily reveal the true identity of users. A person sending bitcoin to a public address thus need not reveal his/her true identity to the recipient (counterparty anonymity) or to other users (one form of third-party anonymity). Recent innovations may allow even more anonymity than in the original bitcoin design.

[10] Bech and Garratt (2017) focus on the transfer mechanism (centralised or decentralised) rather than on the token- or account-based technology. Money is either exchanged in a decentralised manner known as peer-to-peer (ie transactions occur directly between the payer and the payee without the need for a central intermediary) or in a centralised manner relying on the services of one or more third parties. Tokens are often transferred peer-to-peer.

[11] Moreover, rates could be differentiated. For example, if accounts were linked to individual persons or entities, the CBDC rate could vary by counterparty, amount held in the account or some other characteristic, in a way that is similar to the current central bank practice of extensive use of differentiated interest rates on deposits held by non-monetary counterparties.

[12] The proper functioning of the payment system, however, implies one-to-one convertibility of CBDC with respect to reserves and banknotes (Fung and Halaburda (2016)). Not facilitating one-to-one convertibility would lead to an exchange rate between different types of central bank money, breaking the unity of the currency. However, some have proposed allowing this unity to break under certain circumstances. For example, Agarwal and Kimball (2015) propose abandoning one-to-one convertibility as a way of allowing a floating exchange rate between cash and commercial bank deposits and thus eliminating the effective lower bound. Abandoning convertibility between CBDC and reserves would similarly lead to a floating exchange rate between CBDC and commercial bank deposits.

The different combinations of features mean that there are many potential CBDC variants. The two variants analysed below – one with restricted access for wholesale payments and one with wide access for general purposes (either token- or account-based) – are presented for conceptual clarity purposes only; they are by no means exhaustive.

3. Payment aspects

The introduction of a *general purpose* or a *wholesale only* CBDC could bring a number of potential benefits to payment, clearing and settlement systems, but it could also pose several risks and challenges. In deciding the case for CBDCs, central banks should compare them with existing or enhanced payment, clearing and settlement solutions. And they would need to consider the impacts on other parts of their remit – most importantly monetary policy and financial stability (analysed in the next two sections).

3.1 General purpose CBDC

One rationale for introducing CBDC in a jurisdiction could be to provide a safe, central bank instrument, especially should the use of cash decline significantly. Over the past decades, technological developments have significantly improved the convenience and efficiency of digital forms of private sector payment instruments compared with central bank paper money (ie banknotes). In Sweden, these developments have led to an absolute decline in the amount of cash in circulation. The Riksbank is investigating whether an e-krona would provide the general public with continued access to central bank money and increase the resilience of the payment system (Skingsley (2016) and Sveriges Riksbank (2017)).[13]

While specifics will vary according to a country's circumstances and economic conditions, these payment-related motivations for issuing CBDC appear at this time not to be compelling for most jurisdictions. The growing use of electronic means of payment has generally not yet resulted in a substantial reduction in the demand for cash (Graph 2).[14] The rationale for considering a central bank replacement for, or supplement to, cash thus may appear less compelling (CPMI (2017a)). The efficiency gains for retail payment purposes may also be less material. In many countries, current retail payment solutions are convenient, efficient and reliable, and have earned public trust and confidence over time.

Going forward, technology will likely offer even more opportunities to enhance convenience, increase safety, lower overall costs and further improve resilience. A number of jurisdictions have already adopted or are in the process of addressing public demand for faster and more convenient approaches to payments that are also compatible with new digital and mobile technologies. Some are already providing real-time or near real-time settlement and close to 24/7 availability. One exception is perhaps cross-border retail payments, which are generally slower, less transparent and more expensive than domestic retail payments (CPMI (2018)).

Some argue that CBDC could also reinforce the resilience of a country's retail payment systems. They argue that should payments in private sector infrastructures be disrupted due, say, to technical problems or because a bank providing credit transfers was under stress, households and businesses could still make digital payments via CBDC, something especially important if cash had (largely) disappeared. On a related note, CBDC could reduce the concentration of liquidity and credit risk in payment systems (Dyson and Hodgson (2016)). However, one could, of course, also achieve operational resilience through the diversity afforded by multiple payment systems, although this could be difficult to achieve given the network effects and economies of scale present in payment systems. In addition, continued availability and use of physical currency could help ensure even greater resilience by providing an instrument that is more immune to disruptions to electric power and telecommunication networks resulting from natural or man-made

[13] Cash use has declined to the point where a growing number of merchants no longer accept cash and most bank branches have eliminated cash processing (Skingsley (2016)).

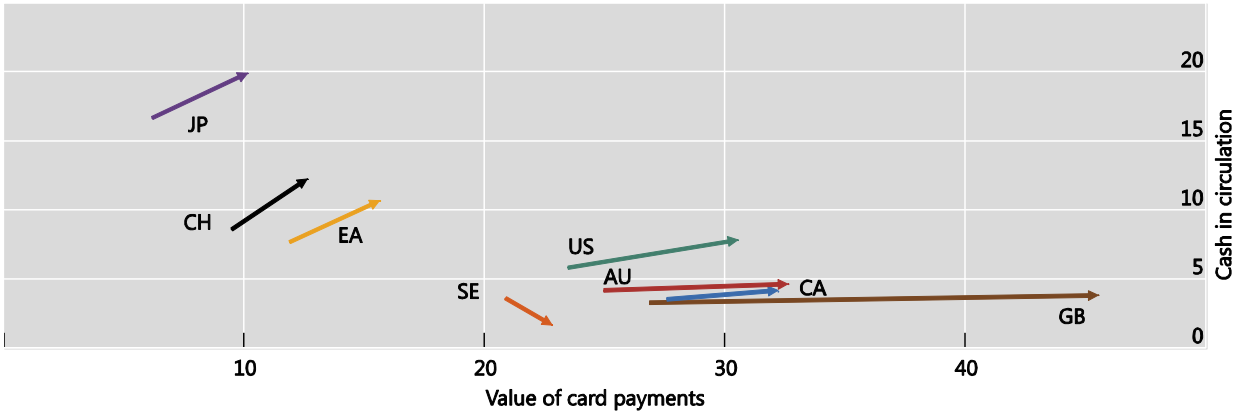
[14] Unfortunately, internationally comparable data are not available on the actual use of cash, only for cash in circulation.

disasters. Having said that, in those jurisdictions where the general public is abandoning cash, this is not an alternative.

Card payments and cash demand, change 2007–16[1]

Graph 2

As a percentage of GDP



[1] The start of an arrow represents 2007 data while the end represent 2016

Source: Bech et al (2018).

In this context, one could also consider the implications of not issuing CBDC. One is the potential for private digital tokens to more widely displace central bank money in transactions. Retail customers could face more credit and liquidity risks, relative to central bank liabilities, from exposure to either private issuers of digital tokens or from a lack of issuer. At this time, their volatile valuations and inadequate investor and consumer protection make private digital tokens unsafe to rely on as a common means of payment and a stable store of value or unit of account. Overall, while carefully monitoring the development and potential uses of new technologies, central banks are likely to continue to emphasise the need for improving the efficiency and speed of private systems.

3.2 Wholesale-only CBDC

In terms of wholesale markets, the main argument made is that settlement systems for financial transactions could be made more efficient – in terms of operational costs and use of collateral and liquidity – and more secure by using wholesale CBDC. Introducing a wholesale CBDC that is comparable to traditional central bank reserves into interbank payment systems could potentially improve efficiency and risk management in settlement (see CPMI (2017a)). If complemented by direct participation of non-banks in the settlement process, gains could further increase, including through facilitating the use of new technologies for asset transfers, authentication, record-keeping, data management and risk management. Payments and (cash legs of) securities transactions settled in CBDC, instead of through facilities hosted by commercial banks or other service providers, could help reduce counterparty credit and liquidity risks in the financial system. It could also help central banks monitor financial activity.

To meet evolving needs from financial markets and to ensure an overall stable and sound financial system, a number of central banks have been conducting experiments involving CBDC and its related underlying technology (in particular DLT). Early experimentation, however, has not shown significant benefits for wholesale payments. The design of an infrastructure using such new technology would look similar to the one currently in place in terms of legal, operational and security requirements. Doubts remain regarding the maturity of the technology and the size of efficiency gains associated with the use of DLT. Moreover, changes could imply expanded – direct or indirect – access to a central bank account with new counterparties, which could be difficult to control. That said, technologies and related possible designs are evolving quickly and central banks will need to continually assess whether introducing CBDC (potentially incrementally) in this area could be useful.

3.3 Other considerations

In addition to more efficient and safer payments and settlement systems, CBDC could come with additional benefits. Given that a CBDC can allow for digital records and traces, it could improve the application of rules aimed at anti-money laundering and countering the financing of terrorism (AML/CFT), and possibly help reduce informal economic activities. These gains may, however, be small in that the formal payment system, especially if there were to be a traceable CBDC, would not necessarily be the main conduit for illicit transactions and informal economic activities.

There are also costs. Commercial banks could lose a valuable interface with their consumers given that in some CBDC designs the "know-your-customer" function could fall to the central bank. Central banks would have to take on a much larger role in this field, with associated costs. Central banks could also be called upon to provide information to tax and other authorities (eg for judicial matters). Moreover, they would have to manage privacy and anonymity issues stemming from the insights obtained from private transactions. More generally, central banks might have to deal with many requests and customers, including some now excluded, for which they are not necessarily well equipped (although some of these challenges may be mitigated or avoided by careful design).

Another argument is that a CBDC could improve financial inclusion. In some countries, a sizable portion of the population does not participate in the formal financial system and could thus miss out on associated benefits. A CBDC, however, does not necessarily alleviate all the constraints to access; for some segments of the population, barriers to the use of any digital currency may be large, and the preference for trusted alternatives, such as cash, is strong. In addition, a CBDC may allow for better real-time data on economic activity but such gains are already largely achievable with existing payments data. A more persuasive argument is that a CBDC may help to maintain a direct link between central banks and citizens (especially where cash use is diminishing), which could help foster the public's understanding of central banks' roles and need for independence (Mersch (2017b)).

3.4 Key feasibility and operational challenges

Even if CBDCs were deemed desirable, initial exploration and experimentation have identified a number of legal, technical and operational issues that central banks and other relevant parties must consider before an instrument can be deemed suitable for wide-scale use.

In some countries, there are **legal considerations**. Not all central banks have the authority to issue digital currencies and expand account access, and issuance may require legislative changes, which might not be feasible, at least in the short term. Other questions include whether a CBDC is "legal tender" (ie a legally recognised payment instrument to fulfil financial obligations) and whether existing laws pertaining to transfers of value and finality are applicable.[15]

Central banks would also have to take account of **AML/CFT concerns and requirements** if they were to issue CBDC. Issuing a CBDC that does not adequately comply with these and other supervisory and tax regimes would not be advisable. To date, it is not clear how AML/CFT requirements can be implemented practically for anonymous forms of CBDC. Forms of CBDC that can be easily transferred across borders or used offshore are especially likely to present significant challenges in this respect. As such, the reputational risk to the central bank from a general purpose CBDC must be considered.

The use of central bank and commercial bank deposits typically provides some level of privacy (for individual banks and agents, respectively), while the use of cash provides anonymity to all users. The appropriate degree of privacy, as also judged by society, is a challenge in a digital environment. For CBDC,

[15] Existing laws are typically written broadly for direct physical transfer or for a central entity ("banks") to accept instructions and modify a ledger. In a CBDC based on DLT, multiple entities could modify a set of distributed ledgers. Other legal issues, such as the timing of the discharge of obligations and liability for errors and unauthorised payments, may also be relevant.

the appropriate degree of privacy of the currency would need to be considered carefully, which could entail difficult public policy design choices for a central bank.

Cyber-security is currently one of the most important operational challenges for central bank systems and the financial industry more generally. Cyber-threats, such as malware, and fraud are risks for nearly every payment, clearing and settlement system. They pose, however, a particular challenge for a general purpose CBDC, which is open to many participants and points of attack. Moreover, the potential effect of fraud could be more significant because of the ease with which large amounts could be transferred electronically. Robust mitigation methods of cyber-risk would therefore be a prerequisite for CBDC issuance.

More generally, the **robustness of possible new technologies** in ensuring a sound risk management framework is uncertain. Because central bank services are essential to the smooth functioning of an economy, very robust requirements for reliability, scalability, throughput and resilience are necessities. Central banks therefore typically have very rigorous operational requirements for their systems and services. Some of the proposed technologies for issuing and managing CBDC (such as DLT) are still relatively untested, and even the private sector is in the early phase of developing and applying DLT for commercial use.[16] Many questions surrounding operational risk management and governance need to be answered before deployment can be envisioned. This may especially be the case for countries at earlier stages of financial infrastructure development.

4. Monetary policy aspects

The consequences of CBDC issuance for the implementation and transmission of monetary policy are directly related to how wide access to CBDC is and whether it is attractively remunerated. Monetary policy arguments for issuing CBDC include potential strengthening of the pass-through of the policy rate to money markets and deposit rates, and helping to alleviate the zero (or effective) lower bound constraint. These arguments should be considered carefully. It is not clear that the pass-through of the policy rate needs strengthening and introducing a CBDC may also bring new risks to monetary policy. In addition, existing tools can, in many cases, achieve the same objectives. Since digital central bank money is already available to monetary counterparties and some non-monetary counterparties, as discussed in other sections, this section refers only to the monetary policy aspects introduced by wider access to CBDC.[17]

4.1 Desirability for monetary policy

Wider digital access to the central bank may strengthen the pass-through of the policy rate to money and lending markets. Monetary policy implications are likely more pronounced if CBDC emerges as an attractive asset to hold. The crucial design features that determine the extent to which CBDC may function as such include the rules regulating its access by different types of agent, its availability beyond intraday use and whether it is interest-bearing, and at what rate (Box A). Only if it combines these choices, would it be a new and liquid central bank liability likely to have an impact on the channels of transmission of policy rates to the money market and beyond.

[16] Any CBDC need not necessarily be implemented using some form of DLT; theoretically more traditional centralised technologies may suffice. The pros and cons of using DLT in general, eg as regard to scalability, confidentiality and resilience, is an area of ongoing research that is outside the scope of this report.

[17] Besides the fact that digital central bank money is already provided to monetary counterparties, and merely changing the technology behind the provision of funds is thus of limited significance, there are three reasons for this delineation. First, while central banks may need to adjust the quantity of money provided to monetary counterparties to control short-term interest rates, the demand for central bank money held by non-monetary counterparties (eg treasury, foreign central banks or certain FMIs) is more typically just accommodated. Second, there may be good reasons for central banks to provide digital central bank money on different terms (remuneration, settlement hours, individual quantitative limits and anonymity) to (various) monetary and non-monetary counterparties. Third, while monetary counterparties have some access to intraday and overnight credit (ie reserve balances may turn negative), non-monetary counterparties typically do not. Similarly, CBDC balances may not turn negative.

Box A

Features of CBDC, demand and the degree of substitution with other financial assets

The way in which access to CBDC is granted implies that substitution effects will affect different types of financial asset. CBDC accessible to individuals and designed as a non-interest bearing, retail payment instrument might primarily substitute for cash (eg token-based CBDC) and commercial bank deposits (eg account-based CBDC). CBDC that pays interest and is readily transferable would likely be attractive to professional financial market participants (eg cash pools and asset managers). It may substitute for money market instruments, such as government bills, reverse repos, central bank bills and FX swaps, and be a liquid and credit risk-free asset facilitating final settlement. CBDC accessible to non-residents may substitute for internationally-used banknotes, bank deposits and international reserve assets. Substitution may theoretically be limited by imposing individual quantitative limits in normal times, eg access could be conditional upon a commercial bank account to which payments are redirected in case this upper limit is surpassed, to try to curb demand.①

Substitution effects will be importantly influenced by whether a CBDC is non-remunerated (as is cash), whether it pays interest at an unchangeable or adjustable rate and whether that rate might possibly move with the policy rate, and, if so, at a spread that is constant or varying. Moreover, rates could be differentiated. A substantially lower interest rate on CBDC holdings exceeding, say, the amount covered by deposit insurance schemes would reduce their attractiveness in normal times.

These and other design features will influence the demand for CBDC. If designed with limited attractiveness, the substitution effects in normal times may be moderate, and so will be the effects on monetary policy transmission (as well as any structural effects on the financial system). Of course, in times of stress, central banks are unlikely to want to directly control the quantity of CBDC because they would want to maintain one-to-one convertibility with respect to reserves and banknotes.②

Even if purposefully designed to be primarily a payment vehicle, CBDC may still end up functioning like a store of value in unforeseen ways under certain circumstances. In times of financial stress, domestic (retail) investors are likely to consider CBDC attractive relative to bank deposits, with many possible side effects, including for financial stability (see section 5). And, if granted access, residents in high-inflation countries may turn to CBDC issued by a low-inflation country (as they do nowadays with cash).

① An application of overall quantitative limits to CBDC may potentially disrupt payment systems, giving rise to an exchange rate between different types of central bank money. Such issues may not occur in the case of individual quantitative limits. However, the aggregate of individual limits could in theory produce a binding overall limit in certain situations. ② The one-to-one convertibility between CBDC, banknotes and reserves means that the central bank can only control their joint quantity. While the central bank can, in principle, steer the overall quantity of central bank money outstanding through liquidity-injecting and liquidity-absorbing open market operations, the holders of central bank money jointly determine its composition, as they are free to convert one type of liability into another. Commercial banks face a similar issue in not being able to directly control the quantity of their retail deposits. This illustrates that means of payment cannot be directly quantitatively controlled but are rather indirectly influenced by their design features and adjustments in other items. Central banks already face this issue in the provision of banknotes, reserves and deposits for a relatively small number of non-monetary counterparties (see Annex A). Traditionally, central banks passively and elastically accommodate the demand for banknotes and deposits held by non-monetary counterparties to steer the quantity of reserves. This is a necessary condition for implementing monetary policy and it would apply with equal force to CBDC.

In particular, a CBDC attractively remunerated compared with other interest rates could affect holdings by institutional investors of other liquid, low-risk instruments (such as short-term government bills and repos backed by sovereign collateral).[18] If institutional investors could hold such an instrument without limits, the interest rate on it would help establish a hard floor under money market rates, which is arguably useful.[19]

An interest-bearing general purpose variant could also make pass-through more direct. If households considered a CBDC to be an alternative to commercial bank deposits, banks would have less scope for independently setting the interest rate on retail deposits. For example, banks would find it harder not to

[18] Note also that this refers to the general collateral (cash-driven) segment of repo markets, not to the "specials" (collateral-driven) segment.

[19] Duffie and Krishnamurthy (2016), who do not explicitly mention CBDC as a possible instrument, argue that the dispersion of rates that is related to imperfect pass-through signals a social cost.

increase deposit rates in tandem when the central bank was raising the CBDC rate. As such, a change in the policy rate could be more directly transmitted to bank depositors (possibly with an intermediation margin, given costs and credit risks). To the extent that an attractively remunerated CBDC reduced currency substitution, which is a possibility in some countries, pass-through more generally could be enhanced, including with respect to domestic prices.

In principle, negative rates on central bank liabilities could provide the monetary stimulus needed in extreme circumstances. Proponents have suggested that issuance of CBDC could serve to alleviate the zero lower bound if it came along with a reduced desire for cash holdings (eg Goodfriend (2016) and Dyson and Hodgson (2016)). Relatedly, some argue that having a substitute for cash in the form of (interest-bearing) CBDC makes the discontinuation of higher denomination banknotes easier to achieve (Rogoff (2016) and Bordo and Levin (2017)).[20]

There are, however, important caveats and counter-arguments. The degree to which key market rates move in conjunction with the policy rate appears satisfactory for most central banks. Whether the pass-through to money markets, for example, is impeded in material ways is not clear (Potter (2017)). Moreover, it is not clear whether one should expect bank deposit rates to respond immediately to policy rate changes. The spreads between the policy rate and retail rates represent compensations for various risks and transaction costs, including for services that are implicitly cross-subsidised (commercial banks provide a broader range of services to retail investors than any CBDC would). More generally, retail depositors tend to be less price-sensitive than wholesale investors. And, the stickiness of retail deposits allows commercial banks to perform more easily their maturity, credit risk and liquidity transformation roles in the economy.

In practice, the lack of a one-to-one response to policy rate hikes and cuts does not represent a challenge as long as central banks have appropriate control over financial conditions. Banks take into consideration a wider range of factors than simply the policy rate in the pricing of their retail deposits, including longer-term rates that encompass credit and liquidity risk premia (ie they look at the relevant investment opportunities). That said, the presence of an attractive CBDC would put pressure on commercial banks to raise their retail deposit rates to avoid losing retail funding. At the same time, some doubt that additional tools would strengthen the central bank's ability to achieve its objectives (eg Bindseil (2016)). Moreover, even if pass-through warrants strengthening, there are other conventional tools, such as central bank bills, time deposits and standing reverse repo facilities (Box B) that can accomplish the same objective.

Box B

Central bank bills, time deposits and standing repo facilities as alternatives to CBDC

Strengthening the pass-through of the policy rate to money market rates also could be achieved by the central bank supplying liquidity-absorbing instruments to non-bank money market participants. The latter includes reverse repo facilities, time deposits and central bank bills. Central banks have significant expertise and experience in the use of such tools. Considering the pros and cons of these alternatives, there are two key differences between offering liquidity-absorbing instruments and CBDC to money market participants:

- CBDC can be used as intraday liquidity by its holders, whereas liquidity-absorbing instruments cannot achieve the same, or can do so only imperfectly. At the moment, there is no other short-term money market instrument featuring the liquidity and creditworthiness of CBDC. The central bank would thus use its comparative advantage as a liquidity provider when issuing CBDC.
- Although the quantity of CBDC can be influenced by its design features, it cannot be fully controlled. By contrast, liquidity-absorbing instruments can be auctioned off in fixed quantities.

While a CBDC could carry a negative rate, this may not address effectively the zero lower bound if higher denomination banknotes were not simultaneously abolished (eg Pfister (2017)). More generally, considering political economy consequences, it is uncertain how deeply negative rates may work in

[20] Also, some have argued that CBDC could enhance the effectiveness of quantitative easing, given that monetary counterparties would no longer have to intermediate when the central bank conducted asset purchases (eg bonds would be swapped for risk-free CBDC) instead of dealing in credit-risky commercial bank deposits, possibly strengthening any portfolio rebalancing effects.

practice, (McAndrews (2017)). Finally, weaker demand for cash does not imply the need for a CBDC. In fact, monetary policy can still remain effective even without cash (Woodford (2000)). On balance, it is not clear that there is a strong basis at this time to issue a CBDC for the purpose of enhancing the efficacy of monetary policy transmission.

4.2 Implications for monetary policy implementation and interest rates

The presence of CBDC would have a limited impact on monetary policy implementation – that is, how central banks use their balance sheets to control short-term interest rates (for a review see Annex A). While a central bank would need to accommodate demand for CBDC, flows into CBDC would drain the amount of reserves in the system in exactly the same way as flows into banknotes and central bank deposits held by non-monetary counterparties (eg the treasury, foreign central banks or financial market infrastructures (FMIs)) currently do. In a corridor system, all flows in and out of CBDC need to be compensated through liquidity-injecting and liquidity-absorbing open market operations (OMOs) to keep the desired amount of reserves.[21] In a floor system, only when CBDC inflows drained reserves to the point where they became scarce would the central bank need to undertake additional liquidity-injecting OMOs.

Therefore CBDC does not alter the basic "mechanics" of monetary policy implementation (see further Annex B for a flow-of-funds representation). Demand for CBDC would just be another factor to consider for policy responses to be consistent with continued control over short-term interest rates. There are two practical implications, though. First, depending on the degree of substitution, a larger balance sheet may be needed to implement monetary policy, as agents substitute physical cash, commercial bank deposits and other safe assets for CBDC. Second, the overall volatility of autonomous factors could be affected, which, in turn, may affect their predictability.[22]

While likely requiring larger balance sheets, central banks would still have discretion in choosing the assets they hold to accommodate the demand for CBDC, just as they have for banknotes. Theoretically, assets can be made up of outright holdings of any kind or collateralised lending to monetary counterparties on any terms and conditions.[23] Subject to the overall supply of various types of asset and changes thereof, the additional duration, liquidity and credit risk stemming from accommodating the demand for CBDC is thus determined by the central bank itself, as is the case with banknotes.

Demand for CBDC may be volatile on a daily basis, as inflows and outflows result from payments between CBDC and non-CBDC holders. Whether this leads to higher overall volatility depends on the correlations with other factors.[24] If volatility proves particularly high, central banks can be forced to operate through a floor system. Whether the quality of liquidity forecasting is hampered depends on the predictability of daily flows in and out of CBDC.

The overall effects of CBDC on the (term) structure of interest rates are very hard to predict and will depend on many factors. To attract demand, short-term government paper and overnight repos with treasury collateral might have to provide some yield pickup with respect to a wholesale-oriented

[21] Under a corridor system, the (marginal) CBDC remuneration rate should not exceed the policy rate. Otherwise, monetary counterparties would have an incentive to trade their excess overnight funds with CBDC holders instead of trading them among themselves. Monetary counterparties with temporary liquidity deficits would need to bid up overnight rates, causing short-term interest rates to exceed the policy rate. Under a floor system, the marginal CBDC rate should not exceed the rate of remuneration of reserves placed at the central bank's deposit facility.

[22] CBDCs are considered an autonomous factor for monetary policy implementation for two reasons. First, from the viewpoint of the day-to-day steering of the central bank's balance sheet to control short-term interest rates, daily fluctuations in the demand for CBDC are an exogenous factor, even though CBDC would be an endogenous factor within the broader monetary policy framework. Second, even if CBDC was introduced, the amount of digital central bank money held by monetary counterparties (reserves) would still be crucial for control over short-term interest rates.

[23] As central bank credit to monetary counterparties is collateralised, a widening of collateral eligibility may be necessary to accommodate banks' increased recourse to credit facilities to compensate for the loss of funding due to CBDC inflows (Annex B).

[24] In the case of a corridor system, this may necessitate more frequent liquidity-injecting and liquidity-absorbing OMOs, higher reserve requirements with averaging provisions or wider tolerance bands around reserve targets to steer liquidity conditions.

remunerated CBDC. This means that the short end of the sovereign yield curve may end up above the CBDC rate. Contrary to the hard floor that the wholesale CBDC variant may put under money market rates, the general purpose variant is likely to put only a soft floor under retail deposit rates given the lower price sensitivity of retail depositors and switching costs.

At the same time, depending on the specific assets held to accommodate the issued CBDC, central banks would probably need to engage in various kinds of maturity, liquidity and credit risk transformation. How these two forces balance out in terms of various interest rates across assets classes and maturities is difficult to predict. More generally, the implications of a CBDC relative to other instruments are likely to depend on each jurisdiction's specific operating environment. Also, since operating environments may change in the future, monetary policy cost-benefit analyses related to CBDC may need to be revisited periodically.

5. Financial intermediation, financial stability and cross-border aspects

Whether or not to introduce a CBDC depends on an assessment of many fundamental issues that go beyond the impact on the payment system and monetary policy transmission and implementation. In this section, topics warranting further investigation are explored.

5.1 Role of the central bank

A fundamental matter raised by CBDC issuance relates to the appropriate roles – in financial intermediation and the economy at large – of private financial market participants, governments and central banks. With CBDCs, there could be a larger role for central banks in financial intermediation. As the demand for CBDC grows, and if holdings of cash do not decline in lockstep, central banks might need to acquire (or accept as collateral) additional sovereign claims and, depending on size, private assets (eg securitised mortgages, exchange-traded funds and others). If demand becomes very large, central banks may need to hold less liquid and riskier securities, thereby influencing the prices of such securities and potentially affecting market functioning. Central banks may also need to provide substantial maturity, liquidity and credit risk transformation at times to both banks and markets. Since central banks could assume more important roles, they could have a larger impact on lending and financial conditions.

Given that all this could challenge the two-tier banking system, structural implications need to be understood better before CBDC issuance can take place. A greater role for central banks in credit allocation entails overall economic losses if central banks are less efficient than the private sector at resource allocation (eg as it impedes the efficient use of decentralised knowledge in society (Hayek (1945)). It is doubtful, for example, that, from the perspective of an efficient allocation of credit, a centralised approach involving outright holdings of corporate securities would be preferred to a decentralised approach based on banks and other private actors granting loans to corporations and investing in securities. From an infrastructure perspective, central banks would have to decide on the design of the appropriate technology, create the required infrastructure and governance and manage this new form of money. This could lead to large operational demands and associated (upfront) costs, with the possible creation of new risks.

There could also be changes to market liquidity and interlinkages. If the demand for CBDC exceeded the decline in the demand for cash and/or reserves, larger outright holdings of CBDC could hamper market functioning if they reduced the free-floating share of outstanding bonds. While a CBDC would by itself be very liquid, it could result in reduced liquidity and increased "specialness" in collateral (repo) markets. The depth of repo and short-term government bill markets could decline as demand was redirected to wholesale market use of CBDC. While the central bank could step in on the demand side of these markets, it would need to broaden its holdings to match its increasing liabilities. This expanded role of central banks in wholesale markets could also reduce interbank activity and the price discovery role of these markets.

Coordination issues between the central bank and the government debt management office might occur and central banks' operations could become more challenging (Greenwood et al (2014)). By having to passively accommodate the demand for CBDC, the central bank could potentially introduce volatile demand for government debt. Related questions include which part of the public sector is best suited to issue a country's short-term public debt and determine the maturity profile of the consolidated public debt. If CBDC replaced a large portion of bank deposits, central bank demand for government securities could be large, which might then affect sovereign debt markets. More broadly, a larger balance sheet could present challenges as it reduced the role of the market in price setting. Such a reduction could lead to allocative distortions and tie up higher-quality assets. This could, in turn, adversely affect the functioning of collateral markets. All of this would have implications for financial stability.

Depending on design, central banks' seigniorage income could also be affected (see Annex C). Relatedly, if CBDC was interest bearing, the central bank would be directly exposed to stakeholders that might at times exert pressures to raise interest rates. Applying differentiated rates (eg by amount held or counterparty) could also be necessary for effective monetary policy implementation but this might prove to be technically difficult (eg on token-based CBDC). It could also lead to arbitrage as well as being controversial (eg a CBDC rate for households below the rate of remuneration on excess reserve balances).

5.2 Banks business models, financial intermediation and markets

The issuance of CBDC would have implications for the structure of payment markets. To the extent that a CBDC would further open up payments to non-banks, commercial banks would stand to see their payment-related income streams eroded by increased competition. Private sector FMIs, such as securities settlement systems and possibly central counterparties for securities trades, might be affected by the issuance of wholesale CBDC.[25] While such developments may be far off – because of the many legal, technical and market coordination challenges involved – market participants and authorities would need to be alert, as indirect or unintended consequences might occur.

A general purpose CBDC could have a large impact on financial intermediation patterns. The consequence of a larger central bank balance sheet could be a withdrawal of funding to commercial banks. For example, a flow of retail deposits into a CBDC could lead to a loss of low-cost and stable funding for banks, with the size of such a loss in normal times depending on the convenience and costs of the CBDC. Banks could try to prevent a loss of deposits by raising interest rates or seek funding to replace such outflows, eg through wholesale funds and term deposits, which would likely be more costly.[26] This could lead some banks to raise spreads and increase transaction fees in order to maintain profitability. Depending on existing market structures, including the importance of retail versus wholesale funding, banks might have to shrink their balance sheets, with possible adverse consequences.[27]

Commercial banks' business models would also have to adapt. Services that are currently cross-subsidised by deposits would need to become viable on a stand-alone basis. The contours of institutions undertaking the liquidity, credit risk and maturity transformation no longer performed by banks are not clear. If liquidity in financial markets were to decline and credit and term spreads were to rise, there could

[25] New applications of technology could allow participants to interact directly with a synchronised securities ledger to add, verify and report transactions, with activity to be accelerated, at least theoretically, to real-time settlement. In such a vision, central counterparties might no longer be necessary to guarantee trades between execution and settlement. A wholesale CBDC might be considered by some central banks to be part of their toolkit to improve settlements. Nonetheless, many legal, technical and market coordination challenges would need to be addressed first. Multilateral coordination and governance over such arrangements would also likely be necessary. And regulatory authorities would insist on prudent management.

[26] Furthermore, alternative means of funding are subject to uncertainties. First, the issuance of bonds by banks is contingent upon placement with investors, which may face some obstacles during times of market stress. Second, any increase in refinancing via the central bank is usually limited by the amount of assets that can be pledged as collateral with the central bank. Third, regulatory constraints may further limit the options available to compensate for the loss of deposits.

[27] Annex B contains a flow-of-funds analysis illustrating stylised static balance sheet adjustments of key sectors of the economy upon the introduction of an interest-bearing and widely accessible CBDC.

be adverse repercussions for the economy.[28] More generally, the implications of a shrinkage of commercial bank balance sheets and activity are very hard to assess and require further analysis.

A CBDC attracting significant demand as an asset to hold, may also change the structure and functioning of funding markets, affecting banks and corporations. Issuers of money market instruments and borrowers in repo markets would see more competition because a CBDC would substitute for such claims. Those who issue claims bought by the central bank to accommodate demand for CBDC would gain. Overall, there might also be a collateral upgrade for private balance sheets if central banks end up holding some less liquid and lower-rated assets to accommodate the issuance of CBDC.

5.3 Financial stability

Issuance of CBDC raises questions that are similar to those relating to narrow banking or full-reserve money, as analysed by several academics and critics of current monetary systems. Proponents claim that narrow banking could make the overall financial system safer because it limits the scope for commercial banks' operations. Although narrow banking raises many questions in its own right, the introduction of a CBDC does not necessarily entail the same restrictions.[29] While difficult to anticipate, the possibility that banks could try to offset the higher cost of funding by engaging in riskier forms of lending to restore profitability could create financial stability risks. While such risks would have to be compared with those associated with other (unconventional) monetary policy tools, and combined with the potential adverse economic impact of reduced lending (Stevens (2017)), there could be more, rather than less, financial stability risk.

In terms of wholesale markets, some (eg Greenwood et al (2016)) argue that the provision of a safe and ultra-liquid asset may help reduce rollover risks and excessive maturity transformation, potentially improving financial stability. However, whether a CBDC leads to these benefits relative to other tools is uncertain (Box C).

Arguably, the most significant and plausible financial stability risk of a general purpose CBDC is that it can facilitate a flight away from private financial institutions and markets towards the central bank. Faced with systemic financial stress, households and other agents in both advanced and emerging market economies tend to suddenly shift their deposits towards financial institutions perceived to be safer and/or into government securities. Of course, agents could always flee towards the central bank by holding more cash. But a CBDC could allow for "digital runs" towards the central bank with unprecedented speed and scale. Even in the presence of deposit insurance, the stability of retail funding could weaken because a risk-free CBDC provides a very safe alternative.

Depending on the context, the shift in deposits could be large in times of stress. A crucial element in such system-wide shifts is the stronger sensitivity of depositors to the actions of others. The more other depositors run from weaker banks, the greater the incentive to run oneself. If CBDC were available, the incentives to run could be sharper and more pervasive than today, as the CBDC would be the favoured destination, especially if deposits were not insured in the first place or deposit insurance was (made more) limited.[30] Whereas weaker banks could experience a run, even stronger banks could face withdrawals in the presence of CBDC.

[28] There are also questions in terms of microprudential regulation and supervision. Would, for example, regulatory requirements, such as capital and liquidity adequacy, and supervision of banks, need to be adapted?

[29] Narrow banking and CBDC differ in two ways. First, under CBDC residents hold direct claims on the central bank, whereas under narrow banking residents hold commercial bank money that is fully backed by central bank reserves or sovereign claims. Second, CBDC could coexist with commercial bank money, whereas narrow banking proposals envision no private money creation. Benes and Kumhof (2012) and Cochrane (2014), which represent examples of recent calls for narrow banking, also review historical precedents, such as the Chicago Plan of the 1930s. Bacchetta (2017) critically reviews such a proposal in the case of Switzerland.

[30] Although with a lower stock of demand deposits commercial banks might be less prone to retail runs, runs in recent times have been initiated by other (wholesale) creditors, which would become more important.

It would be difficult to stem runs under such conditions, even when providing large lender of last resort facilities. Changes in the interest rate that applies to CBDC are unlikely to succeed when agents seek safety at almost any price. Imposing quantitative limits, difficult at any time owing to various forms of evasion, could create price deviations between types of central bank money ("discounts"), negating the principle of money being exchangeable at par and hampering the conduct of monetary policy.

Box C

CBDC, rollover risk and financial stability

A secular rise of institutional cash pools① and a stronger desire among investors for secured forms of financing have increased the demand for highly liquid and safe instruments, which cannot be met by bank deposits (Pozsar (2011)). This has led to a "near-money premium" in wholesale markets, ie yields on short-term, liquid instruments that are significantly lower compared with those of slightly longer tenors or higher credit risk.② This, in turn, can incentivise agents to fund longer-term assets with short-term liabilities (eg repo or commercial paper), with associated rollover risks that could adversely affect financial stability.

Central banks may have a role in reducing these risks by providing non-banks with an attractive money-type instrument. As argued by some (eg Stein (2012)), the augmented supply of safe assets may force market participants to scale back their funding of longer-term assets with short-term wholesale borrowing. If less liquid and riskier money market instruments (eg commercial paper) lost some of their near-money premium, the incentives faced by issuers for maturity, liquidity and credit risk transformation could be weakened.③ Whether a CBDC would materially reduce rollover risks, however, is uncertain. Moreover, increased issuance of short-term debt by the government can also reduce the near-money premium, with possibly associated benefits. Moreover, central banks have other conventional tools at their disposal that could serve a similar purpose (Box B).

① The term "institutional cash pool" refers to large, centrally managed, short-term cash balances of global non-financial corporations and institutional investors, such as asset managers, securities lenders and pension funds. ② See eg Greenwood et al (2016) or Carlson et al (2016) for further analysis. Another way the near-money premium expresses itself is when short-term government bills and short-term repos with sovereign collateral trade significantly below the overnight index swap (OIS) rate and the policy rate. ③ For example, long positions in government bonds financed mostly in repo markets (leveraged fixed income strategies employed by hedge funds) could be unwound as collateral chains between institutional investors and money market funds are disintermediated (Pozsar (2011) and Singh (2016)).

5.4 Cross-border and global dimensions

For currencies widely used in cross-border transactions, many of the considerations outlined above would apply with added force. In normal times, there would be many complications should non-residents be allowed to hold and transact in CBDC. Distinctions between residents and non-residents and domestic and foreign transactions could become largely symbolic. For example, it could be more difficult to apply AML/CFT requirements because of a lack of formal powers over intermediaries involved in token-based CBDC distribution. Similarly, if foreign banks and FMIs (and even other central banks) were able to purchase, receive or otherwise hold "domestic" CBDC, legal and operational issues could arise. For example, a foreign entity could use the domestic CBDC to back or otherwise provide the functional equivalent of "offshore" accounts and payment services denominated in the domestic currency. Further, the more anonymous the instrument and the more decentralised the transfer mechanism was, the greater the opportunity for cross-border activity, arbitrage and concealed transactions would be, with related reputational risks for the central bank. A CBDC available cross-border could, in some economies, increase substitution away from the domestic currency, which could make monetary aggregates unstable and alter the choice of monetary instruments.

Even during normal times, CBDC could come with first-mover advantages and economies of scale and other externalities. In terms of market share, if CBDCs were introduced by jurisdictions with international currencies, they could reinforce existing costs and benefits, including externalities. Similarly, CBDC could change the nature of global liquidity and safe asset provision. Also, and especially if introduced in a sudden and unexpected manner, CBDC could, in some situations, lead to large capital movements and related exchange rate and other asset price effects. In addition, countries might face challenges in preparing for

what would happen if other central banks were to introduce CBDC. More generally, disturbances could easily occur.

The cross-border and global dimensions of CBDCs available to non-residents could be especially pronounced during times of generalised flight to safety. Under such conditions, exchanging a CBDC for an international currency could potentially enable faster deleveraging in capital markets. If CBDCs accelerated flights from risk, deleveraging pressures could manifest themselves in the form of tight funding conditions and sharp movements in foreign exchange markets.

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Annex A: Principles of monetary policy implementation

This Annex provides a short overview of the general principles of monetary policy implementation, namely the use of the central bank's balance sheet to achieve its operational target. This target, which can be controlled by the central bank on a day-to-day basis, is highly relevant to the fulfilment of its mandate (Bindseil (2014)).

Typically, central banks use an overnight rate as their operational target. The financial institutions that are directly relevant to this operational target and its transmission to money markets are the central bank's monetary counterparties. To achieve their operational target, central banks need to ensure that the value of attracting or trading away overnight funds from monetary counterparties equals the operational target. Two operational regimes are typically used for this purpose: a corridor and a floor system.

In a corridor system, central banks apply two interest rates to reserves: (i) up to a limited amount (depending on reserve requirements), the policy rate is applied; and beyond that (ii) a substantially lower deposit rate is paid.[31] Monetary counterparties may access an overnight lending facility at a higher rate. Central banks continuously need to ensure via open market operations (OMOs) that the overall amount of reserves equals the overall limit amount at which the policy rate applies. Central banks can increase flexibility in fulfilling this requirement by applying: (i) a band at which the policy rate applies instead of a limit; or (ii) the minimum required amount of reserves averaged over a maintenance period.

Central banks must forecast the demand for liquidity in order to be prepared to inject (or drain) the right quantity of reserves. This involves projecting day-to-day changes in autonomous factors – that is, all the balance sheet items outside of the direct control of the central bank's monetary policy implementation function that affect the amount of reserves.

The difference between the policy and the deposit rate provides an incentive for monetary counterparties to trade overnight funds among themselves, on a secured or unsecured basis. Abstracting from possible balance sheet and collateral costs, such transactions take place close to the policy rate. Thus, the policy rate becomes the marginal value of attracting or trading away overnight funds from monetary counterparties, while the overall amount of reserves can be relatively small. This enables central banks to run a relatively lean balance sheet. This means a balance sheet that is only slightly larger than banknotes outstanding, limiting the intermediary role of the central bank (Graph A1).

Under a floor system, central banks ensure that the marginal value of attracting or holding overnight funds from monetary counterparties equals the deposit rate. With substantial excess reserves, the marginal use for monetary counterparties of holding additional reserves is to earn the deposit rate (Graph A2). The deposit rate thereby becomes the de facto policy rate. To achieve this, monetary outright holdings must exceed the *original liquidity deficit*, ie the liquidity needs caused by net autonomous factors. Liquidity forecasting is less important because day-to-day fluctuations in the amount of reserves do not change the marginal value of attracting or holding overnight funds (with monetary counterparties).

In both operational regimes, flows into non-monetary deposits, that is digital central bank money held by non-monetary counterparties (eg the treasury, foreign central banks or FMIs) and banknotes result in a drain of reserves. In a corridor system, such flows need to be compensated by liquidity-injecting OMOs. In a floor system, such flows only need to be compensated if the liquidity surplus becomes insufficient and rates begin to rise above the deposit rate (monetary outright holdings threaten to fall below the original liquidity deficit). In practice, flows into banknotes are limited by the carrying cost of cash, making banknotes relatively inconvenient as a store of value. Flows into non-monetary deposits are typically limited by price

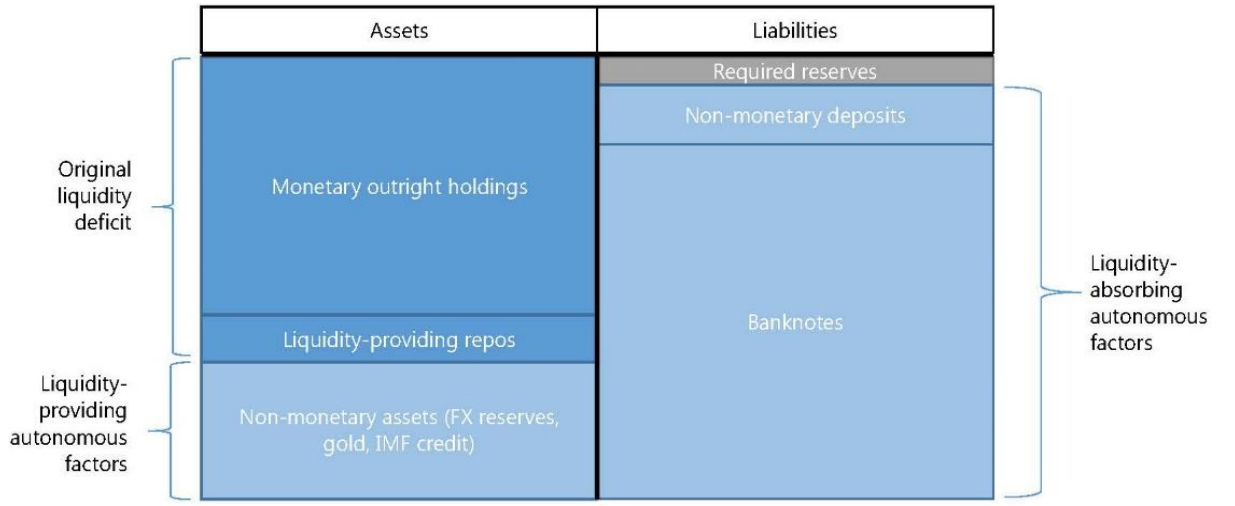
[31] Under zero reserve regimes, such as that of the Bank of Canada, the central bank charges a higher policy rate on negative balances (ie loans) and pays a lower deposit rate on positive balances. Under this system, required reserves are not necessary and the overall limit amount at which the policy rate applies can be zero.

disincentives beyond certain specified amounts, also making non-monetary deposits relatively unattractive as a store of value. Such price disincentives are often applied to limit the central bank's intermediary role. Different central banks put varying weights on this principle, however, and apply different price disincentives and access conditions to non-monetary deposits.

A stylised balance sheet of the central bank after the introduction of CBDC is depicted in Graph A3, reflecting the demand for CBDC and its increased assets holdings.

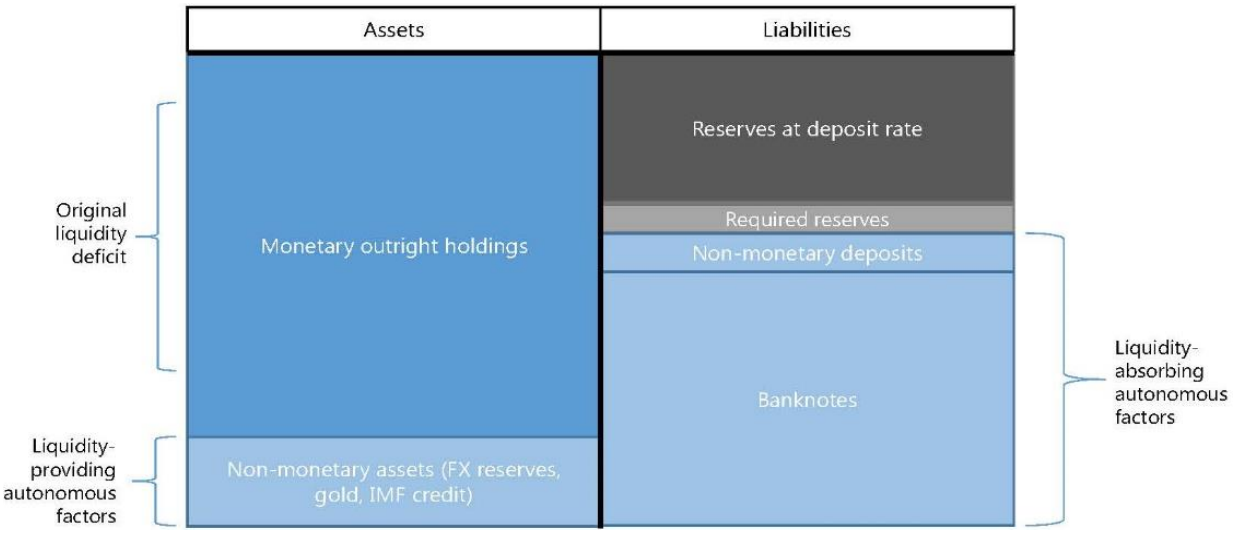
Corridor system without CBDC

Graph A1



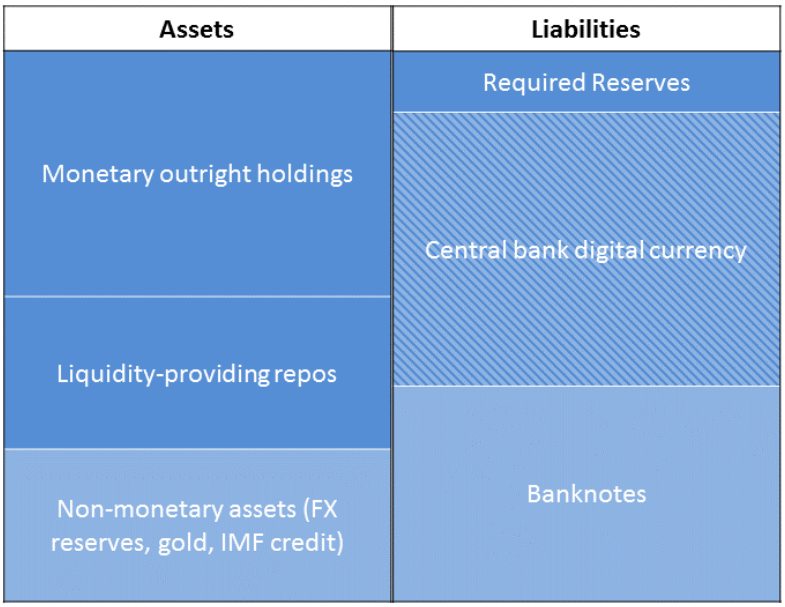
Floor system without CBDC

Graph A2



Central bank balance sheet with CBDC

Graph A3



Annex B: Flow-of-funds representation

A stylised flow-of-funds analysis illustrates qualitatively how sectoral balance sheets and the implementation and transmission of monetary policy may be affected by the introduction of a general purpose CBDC. The more CBDC is perceived by economic agents to be an attractive asset, the larger will be the substitution effects discussed below.

The balance sheets considered are those of:

i. *Households (retail)*. It is assumed that households hold real assets (RA), retail deposits at commercial banks (DEP) and banknotes (BAN). Furthermore, they invest in corporate/government and bank bonds (B + BB) and money market fund shares (FS) if their liquid funds exceed deposit guarantee schemes' coverage. They finance themselves through retail mortgage loans (RML) provided by commercial banks and their own funds or equity (E).

ii. *Corporations/government*. It is assumed that corporations and the government fund themselves via bank loans (L) and bonds (B) as well as money market instruments (MM). This sector holds real assets (eg public infrastructure, corporate facilities) and liquidity buffers in the form of cash pool participations (CPP).

iii. *Banks (monetary counterparties)*. Funding takes place by accepting retail deposits, by issuing money market instruments (eg secured funding via repos or unsecured funding via commercial paper) and bank bonds and by drawing on central bank credit facilities. These instruments fund purchases of government and corporate bonds, loans to corporates, retail mortgages to households and holdings of central bank reserves (RES).

iv. *The central bank*. The liability side of the central bank's balance sheet consists of banknotes held by households and reserve balances held by banks. On the asset side, the central bank has outright holdings of corporate, government and (covered) bank bonds and provides credit to banks, therewith implementing monetary policy.

The introduction of CBDC opens up a number of channels that affect patterns of financial intermediation in the economy (see the bold, red font balance sheet items in Table B1).[32] First, households may substitute banknotes for CBDC (**CBDCa**), which prompts a change on the central bank's liability side. Second, households may substitute retail deposits for CBDC (**CBDCb**) by making payments from retail deposits to CBDC accounts. To effect such payments, banks request the central bank to debit reserves held by them and credit the CBDC accounts. In order to ensure that reserves stay at the required level to implement monetary policy, the central bank buys bonds or provides additional credit to banks.[33]

The main question is how large these flows are likely to be and how financial market participants that attract or lose funding will adjust their behaviour. What assets will the central bank hold against the CBDC inflows? Will the financial market participants that lose funding raise funds elsewhere or will they deleverage?

Table B1 shows qualitatively one of the many possible outcomes. The central bank accommodates CBDC inflows by increasing its lending to monetary counterparties and outright holdings of bonds. The banks use the central bank's funds to compensate for the lost retail deposits (**CBDCb**). In this highly restrictive scenario, there is only a shift in intermediation and no impact on the real assets held by corporates/governments and households (ie no deleveraging and/or leveraging). Instead, the central bank intermediates between households, on the one hand, and banks and corporates/government, on the other.

[32] Further substitution effects could be induced as money market funds switch holdings of money market instruments (eg reverse, repos, commercial paper or treasury bills) for CBDC. These effects are omitted from the analysis for ease of exposition.

[33] Hence, it is assumed that the central bank either implements monetary policy through a corridor or a floor system with a minimum amount of excess liquidity, consistent with keeping short-term rates close to the deposit rate.

CBDC and the structure of the financial system: a flow-of-funds analysis[1] Table B1

Households (retail)			
Real assets	RA1	Equity	E
Retail deposits	DEP **– CBDCb**	Retail mortgage loans	RML
CBDC	**CBDCa + CBDCb**		
Banknotes	BAN **– CBDCa**		
Bonds (for investment)	B1 + BB1		
(Money market) fund shares	FS		
Corporations/government			
Real assets	RA2	Loans	L
Cash pool participation	CPP	Corporate/government bonds	B1 + B2 + B3
		MM instruments	MM1
Banks (monetary counterparties)			
Corporate/government bonds	B2	Retail deposits	DEP **– CBDCb**
Loans	L	MM instruments	MM2
Retail mortgage loans	RML	Bank bonds	BB1 + BB2
Reserves	RES	CB credit facilities	RES + BAN – B3 – BB2 **+ CBDCb**
Central bank			
CB credit facilities	RES + BAN – B3 – BB2 **+ CBDCb**	Reserves	RES
		Banknotes	BAN **– CBDCa**
Corporate/government/bank bonds	B3 + BB2	CBDC	**CBDCa + CBDCb**

[1] The analysis is performed under the assumption of a central bank operating through a corridor system.

Explanatory notes: CBDCa – amount of banknotes substituted for by households' CBDC holdings; CBDCb – amount of retail deposits at commercial banks substituted for by households' CBDC holdings; RA1 (RA2) – real assets held by households (corporates/government); MM1 (MM2) – money market instruments issued by corporates/government (banks); B1/B2/B3 – amount of bonds (either issued by corporates or government) held by households/banks/central bank; BB1 (BB2) – amount of bonds issued by banks and held by household (central bank).

In practice, however, some funding losses and gains and thereby some degree of deleveraging and/or leveraging are likely to happen as central bank credit leads to bank asset encumbrance. This, in turn, is costly to banks and may induce them to reduce their loans and bond holdings. To the extent that the shift in the structure of financial intermediation provokes higher (lower) liquidity, term and credit-risk premia on the funding for households and corporates/government, their capacity to hold real assets may decrease (increase).

Annex C: The impact of CBDC on seigniorage

Seigniorage represents income earned by a central bank from issuing (non-interest-bearing) banknotes. In a two-tier banking system, income from issuing money (banknotes and deposits at commercial banks) partly accrues to commercial banks, giving way to a broader notion of seigniorage. The design features of CBDC (described in section 2.2) determine how much of this broad seigniorage value accrues to commercial banks and to the central bank. If CBDC emerges as an attractive asset, seigniorage may move from commercial banks to the central bank, as agents substitute commercial bank deposits by CBDC.

There are two channels through which broad seigniorage value may change due to CBDC. First, CBDC affects the overall value of the money issuing function to the extent that CBDC reduces operational costs (eg costs related to printing, storage and transportation of banknotes, and settlement costs) and, especially at the outset, entails significant fixed infrastructure costs (but very low marginal costs). Second, as an additional and possibly attractive asset, CBDC may serve as a substitute for other non-deposit financial assets (eg shares in money market mutual funds). This latter effect would increase money in circulation and thereby broaden the overall seigniorage base.

Seigniorage accruing to the central bank depends on two key variables: the stock of currency in circulation and the difference in returns between central bank assets and currency liabilities. Introducing CBDC could change both factors. First, any CBDC-driven expansion of the balance sheet has a positive effect because most the funding cost equals the policy rate (ie the risk-free rate). Any asset that the central bank may buy from, lend to, or accept as collateral from its monetary counterparties should have an expected yield above the expected risk-free rate over the investment horizon. As a CBDC-driven expansion of the balance sheet entails a corresponding decline of retail deposits and money market instruments, such increased central bank seigniorage corresponds to decreased seigniorage income at banks and money market issuers. This effect may, however, be offset to some degree if CBDC were to lead to reduced demand for banknotes, which are non-interest bearing. And the impact would depend on the remuneration of CBDC: the higher the remuneration, the greater the reduction in seigniorage income from banknote circulation.

These effects would produce gains and losses for central and commercial banks, as well as for non-banks, which, in turn, could influence their financial robustness and hence have systemic financial stability consequences. For central banks, any significant reduction of seigniorage would constrain their ability to recapitalise following financial losses, in the absence of other sources of income. The persistence of low or even negative capital could put monetary policy and financial stability goals at risk.

Annex D: Members of the working groups

Committee on Payments and Market Infrastructures

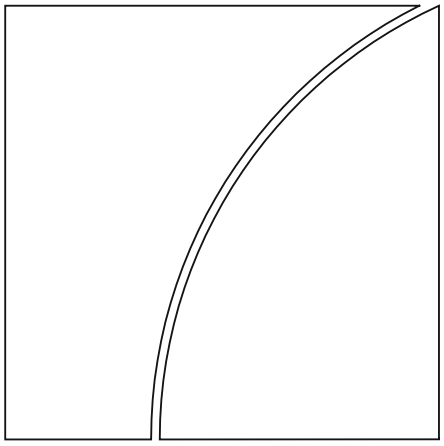
Chair	Klaus Löber (European Central Bank)
Reserve Bank of Australia	David Emery
National Bank of Belgium	Filip Caron
Central Bank of Brazil	Daniel Gersten Reiss
Bank of Canada	Ben Fung
European Central Bank	Dirk Bullmann
Bank of France	Marion Chich
Deutsche Bundesbank	Heike Winter and Marcus Härtel
Hong Kong Monetary Authority	Nelson Chow
Reserve Bank of India	Supriyo Bhattacharjee
Bank of Italy	Michela Tocci and Giuseppe Galano
Bank of Japan	Shuji Kobayakawa
Bank of Korea	Dong Sup Kim
Bank of Mexico	Ángel Salazar Sotelo
Netherlands Bank	Kirsten van Driel
Central Bank of the Russian Federation	Maxim Grigoriev
Saudi Arabian Monetary Authority	Mohsen Al Zahrani
Monetary Authority of Singapore	Tze Hon Lau
South African Reserve Bank	Arif Ismail
Sveriges Riksbank	Björn Segendorf
Swiss National Bank	Marco Cecchini and Nino Landerer
Bank of England	Simon Scorer
Board of Governors of the Federal Reserve System	David Mills and Brendan Malone
Federal Reserve Bank of New York	Vanessa Lee
Bank for International Settlements	Paul Wong (Secretary)
	Morten Bech and Stijn Claessens

Workstreams were led by Dirk Bullmann (European Central Bank), Shuji Kobayakawa (Bank of Japan), David Emery (Reserve Bank of Australia) and Brendan Malone (Board of Governors of the Federal Reserve System). Significant contributions were also made by Jiamin Lim (Reserve Bank of Australia); Hanna Halaburda (Bank of Canada); Thomas Leach (European Central Bank); Dion Reijnders (Netherlands Bank); Cordelia Kafetz (Bank of England); Jeff Marquardt and Sarah Wright (Board of Governors of the Federal Reserve System); Antoine Martin and Ray Fisher (Federal Reserve Bank of New York); and Ayse Sungur, Rebecca Chmielewski, Henry Holden, Rodney Garratt and Codruta Boar (Secretariat).

Markets Committee

Chair	Aerdt Houben (Netherlands Bank)
National Bank of Belgium	Arnoud Stevens
Bank of Canada	Parnell Chu and Scott Hendry
European Central Bank	Jens Tapking and Christoph Ohlerich
Deutsche Bundesbank	Corinna Dietzen and Dorothee Hellmuth
Hong Kong Monetary Authority	Nelson Chow
Reserve Bank of India	Senthil Kumar
Bank of Italy	Tommaso Perez
Bank of Korea	Dong Sup Kim
Netherlands Bank	Steef Akerboom and Dion Reijnders
Monetary Authority of Singapore	Jeremy Hor
Bank of Spain	Covadonga Martín Alonso
Sveriges Riksbank	Per Åsberg Sommar
Bank of England	Cordelia Kafetz, Ben Dyson and Emily Clayton
Board of Governors of the Federal Reserve System	Laura Lipscomb and Heather Wiggins
Federal Reserve Bank of New York	Elizabeth Caviness
Bank for International Settlements	Andreas Schrimpf (Secretary)
	Stijn Claessens

BANK FOR INTERNATIONAL SETTLEMENTS



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Proceeding with caution – a survey on central bank digital currency

By Christian Barontini and Henry Holden

Monetary and Economic Department

January 2019

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Contents

Proceeding with caution – a survey on central bank digital currency[1]

A survey of central banks shows that a majority are collaboratively looking at the implications of a central bank digital currency. Although many have reached the stage of considering practical issues, central banks appear to be proceeding cautiously and few report plans to issue a digital currency in the short or medium term.

Introduction

Payments are changing at an accelerating pace. Users expect faster, easier payments anywhere and at any time, mirroring the digitalisation and convenience of other aspects of life (Bech et al (2017)). And, although paper-based payments like cheques and cash still play important roles, new technologies and market entrants are challenging the traditional bank-based payment systems (Jakobsen (2018)).

In addition to changes in how payments are made, even the type of money used could be changing. Across the world, central banks are reportedly thinking about how new central bank digital currencies (CBDCs) could replace traditional money (CPMI-MC (2018)). There is significant public interest in such a fundamental potential change, and this paper takes stock of central banks' current work and thinking. It is based on a recent survey of central banks to which 63 responded[2] (representing jurisdictions covering close to 80% of the world population). The survey asked central banks about their current work on CBDCs, what motivates that work, and how likely their issuance of a CBDC is.

The survey shows that, although a majority of central banks are researching CBDCs, this work is primarily conceptual and only a few intend to issue a CBDC in the short to medium term.

Central bank digital currencies

The 2018 report by the Committee on Payments and Market Infrastructures (CPMI) and the Markets Committee (MC) defines CBDCs as new variants of central bank money different from physical cash or central bank reserve/settlement accounts. Based on four key properties, the CPMI-MC report provides a taxonomy of money ("The money flower") which delineates between two broad types of CBDC: *general purpose* and *wholesale* – with the former type coming in two varieties (Graph 1).

The four key properties of money are: *issuer* (central bank or not); *form* (digital or physical); *accessibility* (widely or restricted); and *technology*. In terms of technology,

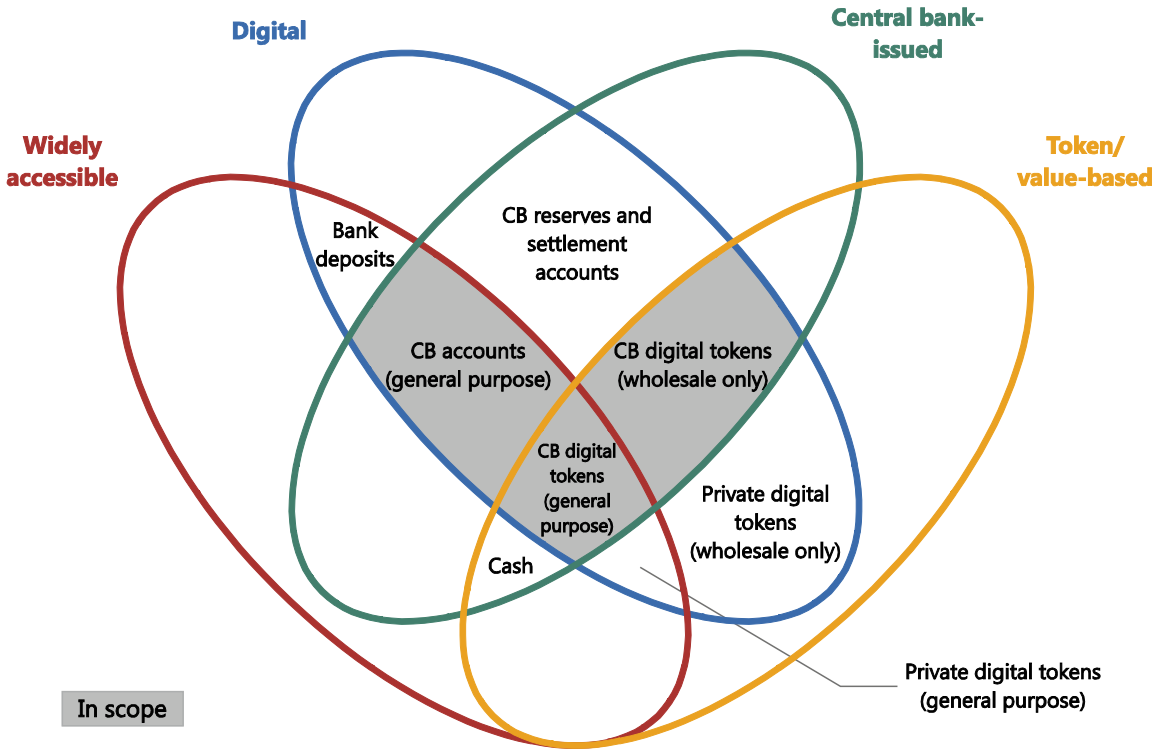
[1] We thank Morten Bech and Paul Wong for valuable comments, Codruta Boar for excellent research assistance, Harish Natarajan and World Bank colleagues for help disseminating the survey, and Klaus Löber and members of the CPMI Working Group on Digital Innovations for comments on the questions asked. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS.

[2] See complete list in Annex 1.

the report distinguishes between money that is token- or account-based. In payment economics, a key difference between tokens and accounts is in their verification: a person receiving a token will verify that the token is genuine, whereas an intermediary verifies the identity of an account holder (Green (2008) and Kahn and Roberds (2009)). However, the definition of tokens varies considerable across scientific fields, and other reports distinguish between value- or account-based forms of CBDC (eg Sveriges Riksbank (2018) and Norges Bank (2018)). This paper uses the terms value- and token-based interchangeably.

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).

In sum, this paper discusses the three variants of CBDC highlighted by the grey-shaded areas within the "money flower" above. The first is a "general purpose", "account-based" variant, ie an account at the central bank for the general public. This would be widely available and primarily targeted at retail transactions (but also available for broader use). The second form is a "general purpose", "token-based" variant, ie a type of "digital cash" issued by the central bank for the general public. This second variant would have similar availability and functions to the first, but would be distributed and transferred differently. The last form is a "wholesale", "token- or value-based" variant, ie a restricted-access digital token for wholesale settlements (eg interbank payments, or securities settlement). Two general purpose CBDC projects, the e-Peso and e-Krona, and the motivations behind them, are discussed in detail in Box A.

Box A

Motivations for general purpose CBDCs: Sweden and Uruguay

Although in many parts of the world, the amount of cash in circulation has risen over the last decade, there are some countries that buck the trend (Bech et al (2018)). In this small club of jurisdictions, a few have considered general purpose CBDCs that would be a complement to cash. Sweden and Uruguay are notable not just for the advanced stage of their work but the amount of information their central banks have made publicly available about their respective projects.

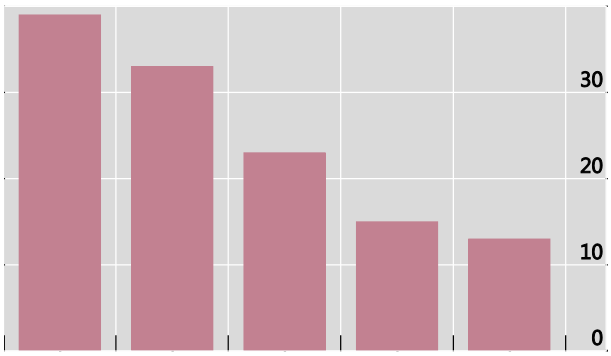
*e-Krona*①

Cash use in Sweden has declined for many years (Graph A). The country's retailers have good reason to expect that the decline will continue and the cost of accepting cash will become prohibitive, so that it will no longer be accepted in the future (Sveriges Riksbank (2018)).

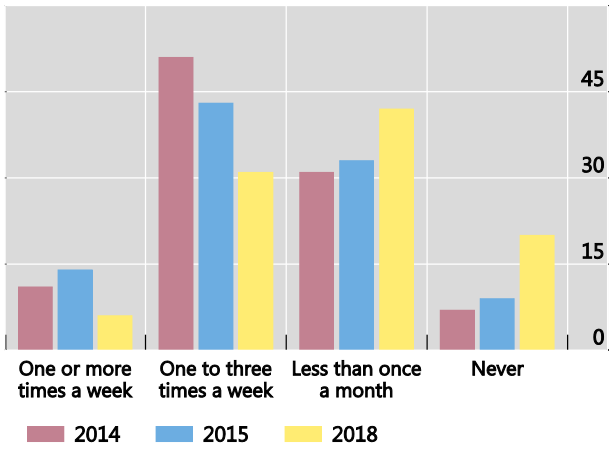
Sveriges Riksbank payment survey

As a percentage of respondents — Graph A

Who paid for their most recent purchase in cash?



How often do you withdraw cash from an ATM or cash desk at a bank?



Source: Sveriges Riksbank.

In response to this decline, the Riksbank is working on an "e-Krona" project, beginning in early 2017 and publishing its second report in October 2018. The report noted that the use of cash continues to decline and that the state needs to have a role in the payment market. A means by which to do this is to have an electronic krona. The e-krona would be a complement to cash, as well as to current electronic payments (especially in a serious crisis where other electronic payments might not be available).

Electronic payments beyond cards (specifically, a mobile payment system called "Swish") have recently seen a significant increase in Sweden, but usage is markedly lower among the elderly (Graph B). The Riksbank notes that some in society, who may have access only to cash, including the elderly and other more vulnerable groups, may need a simpler, more user-friendly offering to avoid exclusion.

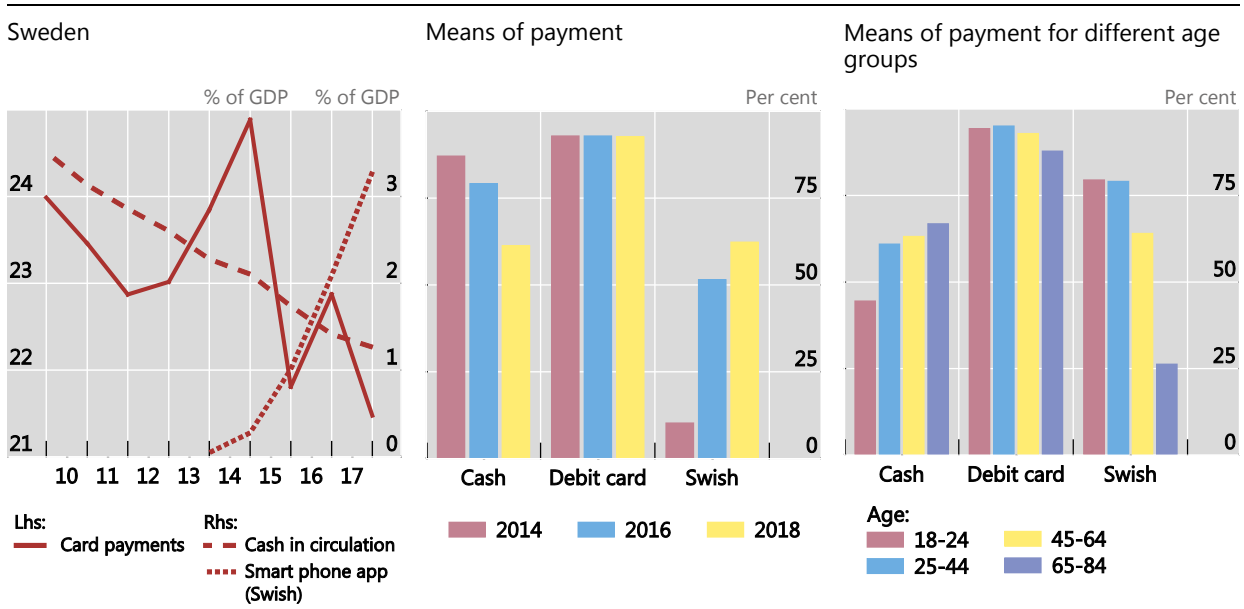
An e-krona might be "value-based" (ie not an account). However, the current versions of distributed ledger technology (DLT) are considered to be too immature, although they are not ruled out for the future. The Riksbank envisages a "platform" where payment service providers (PSPs) of the e-Krona would connect and distribute the currency. Those PSPs could, the Riksbank thinks, use DLT in providing their services.

A value-based approach would be compatible with the Riksbank's legal mandate (the Sveriges Riksbank Act), but an account-based e-Krona would require the mandate to be adapted for clarity. An account-based e-Krona is not

ruled out, but the Riksbank notes that coordination with other agencies would be necessary, and so dialogue should begin. The next stage will be a pilot programme for a prepaid value, non-interest bearing and traceable e-Krona. This will investigate a range of possible choices to better inform the decision whether to issue a full-scale e-Krona.

Rapid increase in use of new payment solution in Sweden

Graph B



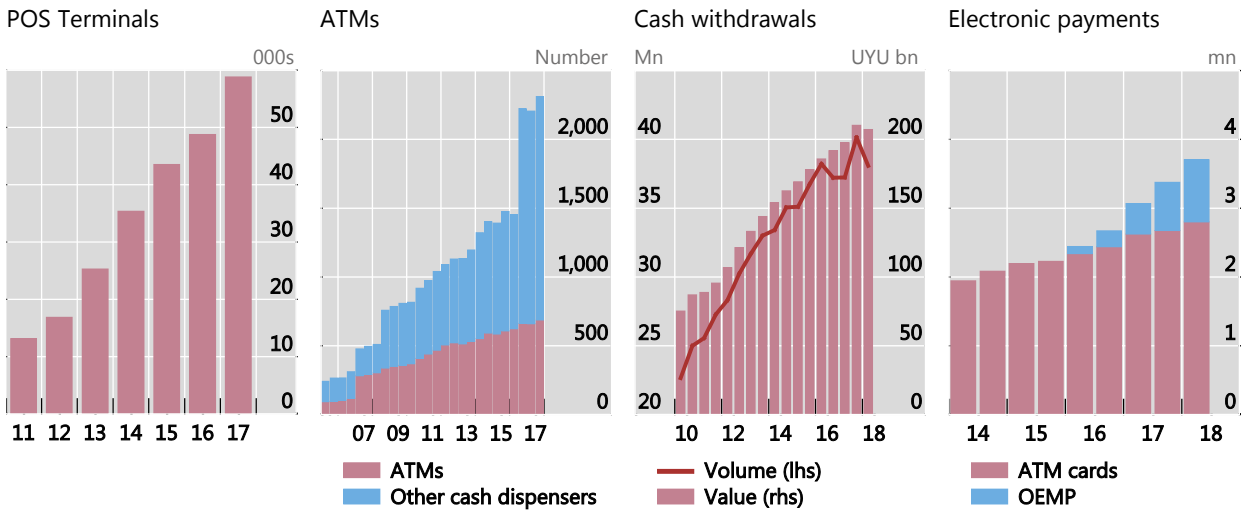
Sources: Sveriges Riksbank; CPMI Red Book statistics.

*e-Peso*②

The Central Bank of Uruguay has just completed a pilot programme on a general purpose CBDC. The pilot was part of a wider governmental financial inclusion programme, which began in 2011, aiming for greater access, labour market formalisation and payment system efficiency. Since these efforts began, the availability of ATMs and other cash dispensing mechanisms has grown enormously but cash withdrawals have plateaued (Graph C) and cash in circulation has fallen (Graph D).

Uruguay

Graph C



POS = point of sale. ATMs = automated teller machines. OEMP = other electronic means of payment.

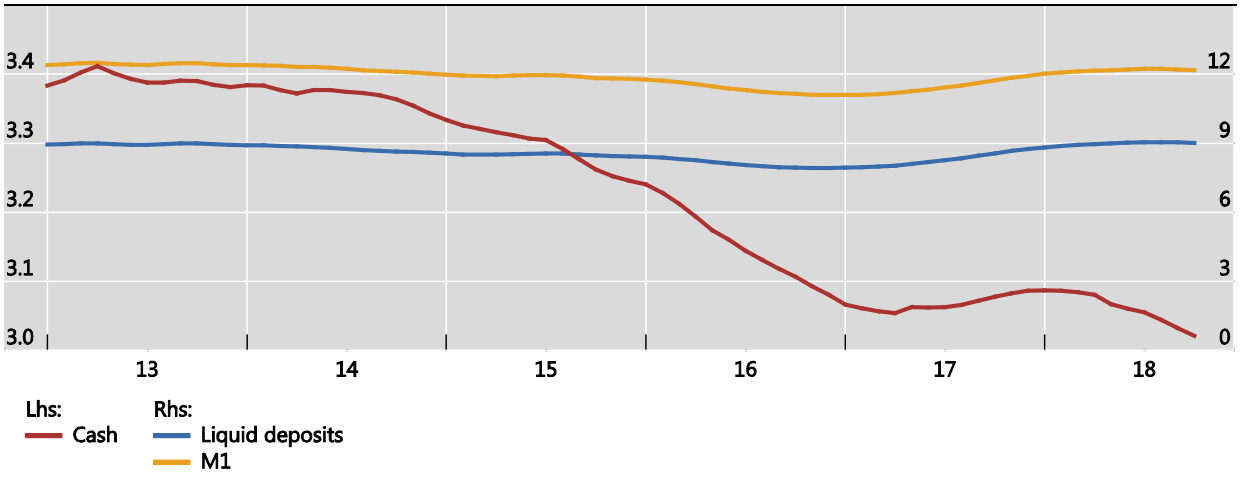
Source: Central Bank of Uruguay.

To respond to these changes and further its broader financial inclusion goals, the Central Bank of Uruguay began a pilot programme in November 2017 to issue, circulate and test an e-Peso. Unique digital banknotes in several denominations were issued for distribution to an "e-note manager platform". The platform acted as registry of the ownership of the digital banknotes. DLT was not used. In total, 20 million e-Pesos were issued, of which 7 million were distributed by a third-party PSP, which held an equivalent value of pesos in a central bank account. Individual users and businesses, in electronic wallets, could hold a maximum of 30,000 e-Pesos (roughly USD 1,000) and 200,000 e-Pesos respectively. Transfers took place instantly and peer-to-peer, via mobile phones using either text messages or the e-Peso app. The Central Bank of Uruguay's legal mandate was sufficient to issue the electronic e-Peso as a complement to physical cash.

The pilot was deemed a success and closed in April 2018, after which all e-Pesos were cancelled. The programme is now in an evaluation phase and a number of questions are being considered, before a decision on further trials and potential issuance can be made. These include design specific challenges, eg how best to manage the stock of digital banknotes in different denominations as well as wider questions eg the level of anonymity the e-Peso would have, whether it would bear interest, the final role of the central bank and what the wider impact on businesses and the economy would be.

M1 and its components in Uruguay

As a percentage of GDP — Graph D



Source: Central Bank of Uruguay.

① Sveriges Riksbank (2018).

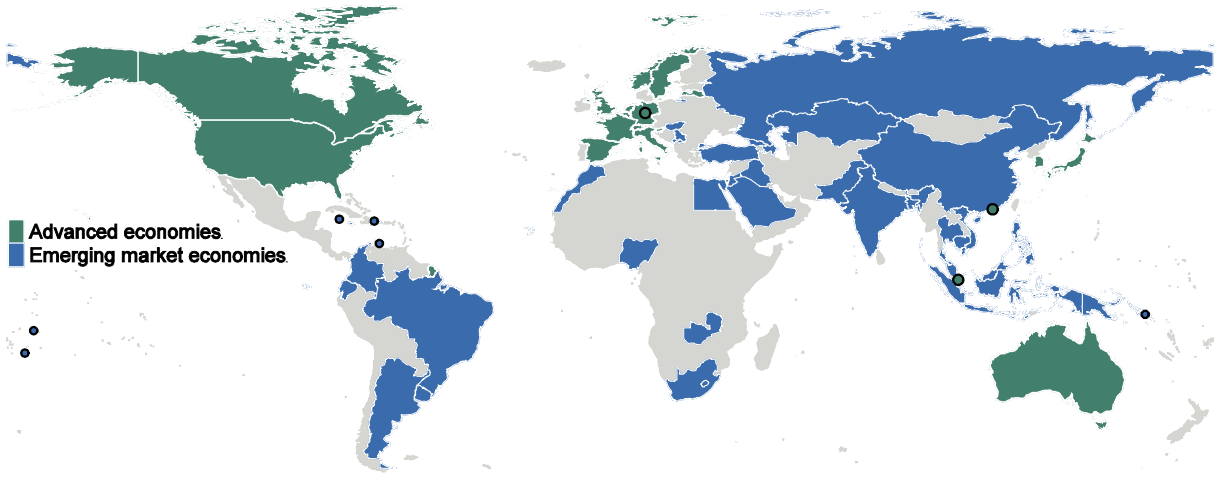
② Slides presented at the Conference on "Economics of Payments IX", hosted by the Bank for International Settlements and Committee on Payments and Market Infrastructures in Basel, Switzerland, 15–16 November 2018 (agenda).

The survey

Geographical coverage

Some 63 central banks replied to the survey, of which 41 are located in emerging market economies (EMEs) and 22 in advanced economies (Graph 2). Together, the respondents represent close to 80% of the world's population and over 90% of its economic output.

Respondents to the survey[1] Graph 2



[1] The black circles represent the Cayman Islands, the Dominican Republic, the Dutch Caribbean, the euro area, Hong Kong SAR, Samoa, Singapore, the Solomon Islands and Tonga. "Advanced economies" and "Emerging market economies" as defined by the IMF *World Economic Outlook* country classification.

The boundaries and names shown and the designations used in this map do not imply endorsement or acceptance by the BIS.

Questionnaire

The survey was conducted in latter part of 2018. It starts by asking central banks if they work on CBDCs or not and, if they do, it further inquiries about the type of CBDC and how advanced the work is. Motivations and current expectations for potentially issuing a CBDC are also queried, as well as whether central banks have legal authority to issue. The questions asked are included in Annex 2.

Given the complexities involved, central banks also provided a wealth of supplementary qualitative explanations to their answers. This survey follows a similar (but smaller-scale and unpublished) survey conducted by the CPMI in 2017. Results from the 2017 survey are included where relevant.

In addition to questions about CBDC, the survey also asked about "private digital tokens" and their use for payments. Private digital tokens encompass the wide variety of digital tokens not issued by central banks. The survey differentiated between so-called "cryptocurrencies" and other private digital tokens, with cryptocurrencies defined as decentralised tokens without an issuer or representing an underlying asset or liability. Central banks' responses are discussed in Box B.

Results

The survey finds that a wide variety of motivations is driving an increasing number of central banks to conduct conceptual research on CBDCs. However, only a few central banks have firm intentions to issue a CBDC within the next decade.

Work underway

Some 70% of respondents are currently (or will soon be) engaged in CBDC work, a slight increase compared to the 2017 survey (Graph 3, left-hand panel). Central banks currently not looking at CBDC are typically from smaller jurisdictions and/or face more pressing priorities. Some central banks indicate that they rely on research conducted by international organisations (in particular the BIS) or regional networks (eg CARICOM's fintech Advisory Work Group). Of those that *are* engaged in work, over half cover both general purpose and wholesale CBDCs (Graph 3, right-hand panel), with about a third focusing only on general purpose and an eighth only on wholesale.

Central bank CBDC work

Share of respondents — Graph 3

[1] Share of respondents conducting work on CBDCs, 2018 survey.

Source: Central bank survey on CBDCs.

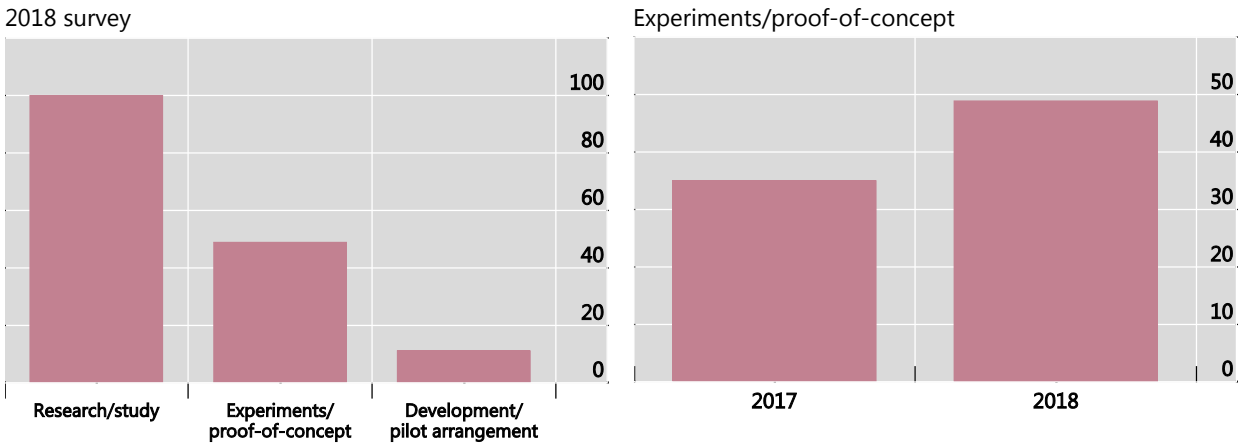
All central banks have begun their CBDC work with theoretical and conceptual research and are generally sharing their studies, with a view to developing a common understanding of this new field of study. At this point, half have moved on to experiments or more "hands-on" proof-of-concept activities to test new technologies (Graph 4, left-hand panel). This represents an increase of 15 percentage points over 2017 (Graph 4, right-hand panel).

Many central banks in both advanced economies and EMEs are attempting to replicate wholesale payment systems using distributed ledger technology (eg projects Jasper, Ubin and Khokha (Bank of Canada (2018), Monetary Authority of Singapore (2018), South African Reserve Bank (2018)).

Only five central banks have progressed to running pilot projects. The e-Peso project described in Box A is an example of a completed pilot. Importantly, despite the quantity of work underway, many of these proofs-of-concept or even pilot projects are only investigative in nature and do not imply plans to issue a CBDC.

Type of CBDC work

Share of respondents conducting work on CBDCs — Graph 4



Source: Central bank survey on CBDCs.

Central banks are also increasingly collaborating with each other to carry out proof-of-concept work on eg cross border payment and securities settlement arrangements. Collaborations include Project Stella by the ECB and the Bank of Japan (ECB-BoJ (2017)) as well as a joint project by the Bank of Canada (BoC), the Monetary Authority of Singapore (MAS) and the Bank of England (BoE) (BoC, MAS and BoE (2018)).

Motivations

The survey asked central banks about their motivations for potentially issuing a wholesale or a general purpose CBDC. Central banks chose from the same set of predefined factors for each type of CBDC, concerning payment safety and efficiency as well as other aspects of central banks' mandates. The central banks ranked their relative importance on a four-point scale ranging from "not so important = 1" to "very important = 4" and supplemented their choice with comments.

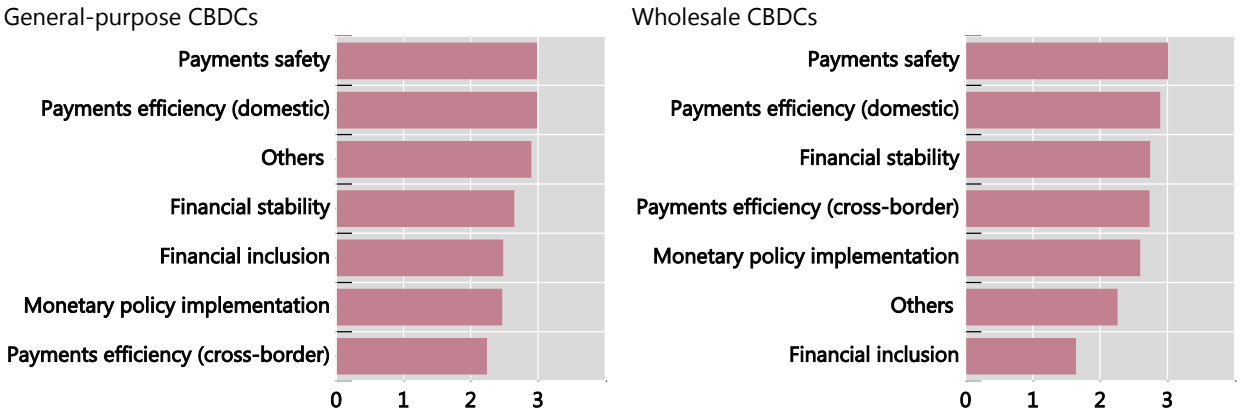
Looking across all respondents for both types of CBDC, payments safety and domestic efficiency are the most important motivating factors to central banks (Graph 5). Least important are, predictably, financial inclusion for wholesale CBDCs and, less-predictably, cross-border payments efficiency, for general purpose CBDCs. To note, however, all rankings remain in a rather narrow range which suggest at this "investigative" stage the main motivation is to learn. However, as central banks progress, more differentiation in terms of motives might emerge.

Outside the predefined choices, many central banks consider a range of other factors important as well. For general purpose CBDC, this broadly relates to issues around cash, either responding to dwindling use or discouraging it through supporting electronic innovations and payments. For wholesale CBDC, the other

factors are more diverse and overall, considered less important. They include better monitoring of transactions as well as safety and efficiency benefits for end users.

Motivations for issuing a CBDC, ranked in order of importance

Score[1] Graph 5



[1] The score is calculated as an average of the options: "Not so important" (1), "Somewhat important" (2), "Important" (3) and "Very important" (4).

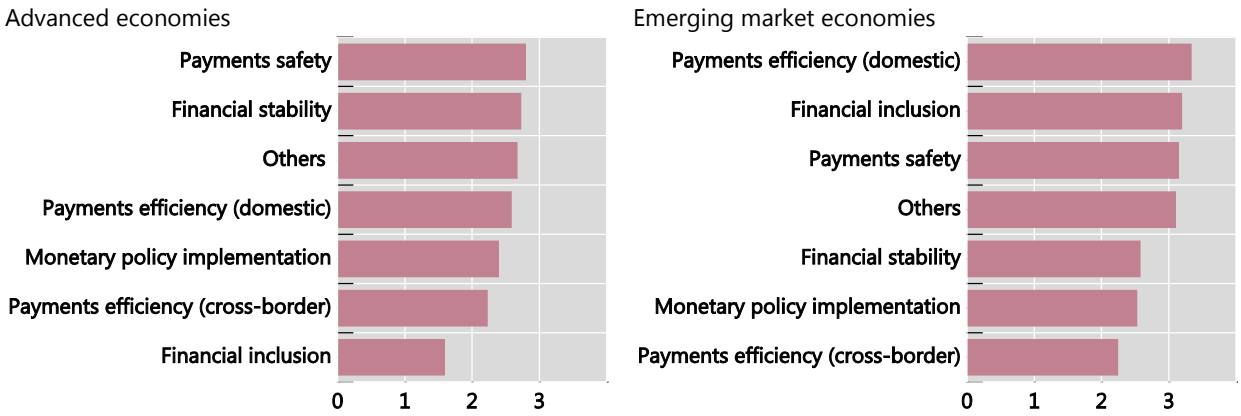
Source: Central bank survey on CBDCs.

Breaking respondents down by stage of economic development shows that, for general purpose CBDC, EMEs value domestic payments efficiency and financial inclusion most (Graph 6). On the other hand, cross-border payments efficiency is the least important. In contrast, for advanced economies, payments safety and financial stability are the primary motivators for potential issuance. Financial inclusion is clearly the least important factor.

In qualitative commentary, EME central banks also note that supporting digitalisation, incorporating the informal economy and fighting financial crime, are key motivators for potentially issuing a CBDC. Some advanced economies are motivated by the prospect of a "less-cash" or even "cash-less" society (see Box A for a discussion of the e-Krona).

Motivations for issuing general-purpose CBDCs, ranked in order of importance

Score[1] Graph 6



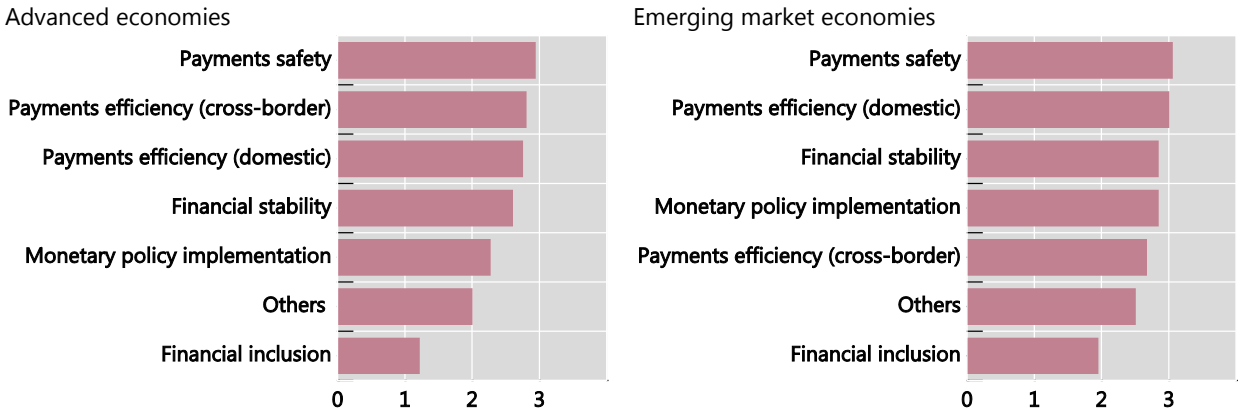
[1] The score is calculated as an average of the options: "Not so important" (1), "Somewhat important" (2), "Important" (3) and "Very important" (4).

Source: Central bank survey on CBDCs.

For wholesale CBDCs, both advanced economies and EMEs consider payments safety and efficiency the most important motivating factors (Graph 7). However, for EMEs, the cross-border dimension is somewhat less important. All central banks (including EMEs) consider financial inclusion the least important factor for wholesale CBDCs.

Motivations for issuing wholesale CBDCs, ranked in order of importance

Score[1] Graph 7



[1] The score is calculated as an average of the options: "Not so important" (1), "Somewhat important" (2), "Important" (3) and "Very important" (4).

Source: Central bank survey on CBDCs.

Outlook

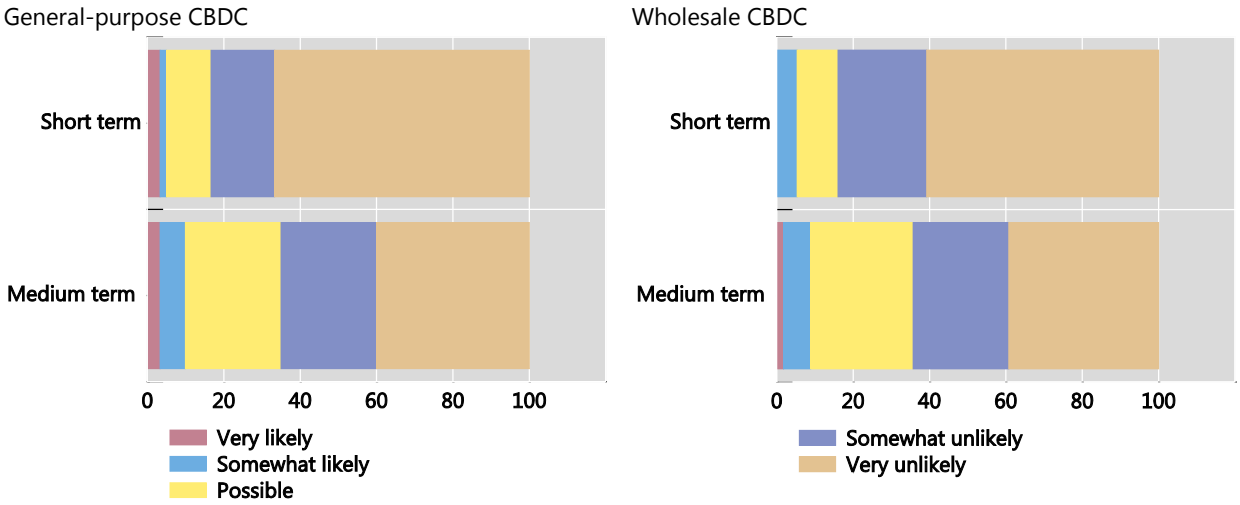
The survey asked central banks to describe the likelihood of their issuing each type of CBDC over the short (up to three years) and medium (up to six years) term. Central banks could choose from "very likely" to "very unlikely" on a five-point scale.

In the short term, over 85% of central banks see themselves as either somewhat unlikely or very unlikely to issue any type of CBDC (Graph 8). No central banks are very likely to issue a wholesale CBDC in the short term, but two EME central banks are considering issuing a general purpose CBDC over the same horizon.

Beyond the short term, an increased proportion of central banks consider the issuance of both types of CBDC to be possible. Nevertheless, a majority still consider this move at least somewhat or very unlikely. In the medium term, only one central bank reported that they see themselves as very likely to issue a wholesale CBDC. Overall, the likelihood of issuing both types of CBDC is somewhat similar, despite the perceived greater operational complexity and larger impact on the financial system of a general purpose CBDC (CPMI-MC (2018)).

Likelihood of issuing a CBDC in the short and medium term[1]

Share of respondents — Graph 8



[1] Short term: 1–3 years and medium term: 1–6 years.

Source: Central bank survey on CBDCs.

The 2017 survey also asked about the likelihood of issuing CBDC. However, the questionnaire did not differentiate between general purpose and wholesale CBDCs. Of the central banks that answered, half deemed issuance possible whereas the other half deemed it unlikely. At that time only one central bank was considering CBDC issuance to be likely but in the 2018 survey, it indicated that it is no longer pursuing any research.

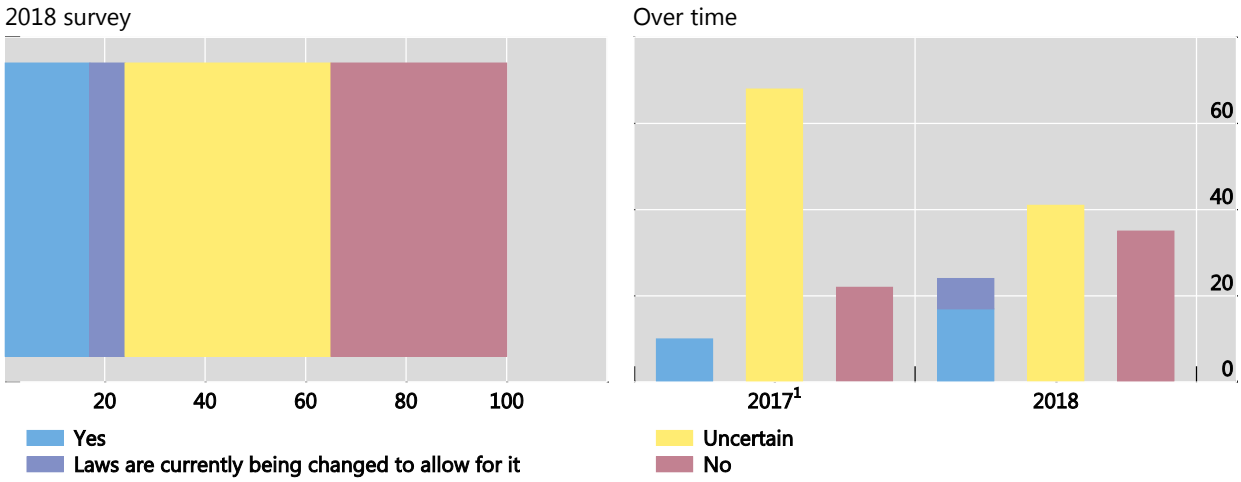
Legal authority

A prerequisite for issuing a CBDC is that the central bank has the legal authority to do so. The survey asked central banks to indicate whether they have, or are in the process of acquiring, this authority. The same question was asked in the 2017 survey.

Almost a quarter of central banks have, or will soon have, authority to issue a CBDC while a third do not, and about 40% remain unsure (Graph 9, left-hand panel). The high level of uncertainty is unsurprising, given that most central bank mandates predate not only cryptocurrencies but also many forms of electronic money. However, as central banks are studying all aspects of CBDC, the level of uncertainty has fallen compared with the 2017 survey (Graph 9, right-hand panel). The uncertainty does not differ materially by geography or a jurisdiction's economic development.

Legal authority to issue a CBDC

Share of respondents — Graph 9



[1] There was no "laws are currently being changed to allow for it" option for the survey in 2017.

Source: Central bank survey on CBDCs.

Conclusion

Most central banks are conducting research into CBDC. Many are progressing from conceptual work into experimentation and proofs-of-concept, including in cooperation with other central banks. Nonetheless, motivations for issuing a CBDC are largely idiosyncratic (eg falling availability of cash in a jurisdiction). This has meant that only a limited number of central banks are proceeding to the pilot stage with CBDCs, and even fewer see issuance of a CBDC as likely in the short or medium term.

At this stage, most central banks appear to have clarified the challenges of launching a CBDC but they are not yet convinced that the benefits will outweigh the costs. Those that do see clear benefits are predominantly from EME jurisdictions. From survey responses, this seems to be because financial inclusion projects create a clear mandate for central bank action, and a lack of current infrastructure limits the disruption a CBDC could create while simultaneously encouraging the use of new technology.

The trends identified in the survey are likely to continue. Different central banks will continue to move at different speeds. This creates a potential risk for spillover effects across borders (CPMI-MC (2018)). However, the evidence from this survey is that central banks are proceeding cautiously, and also that they are collaborating and

sharing the results of their work. Caution and collaboration will reduce the likelihood of unintended consequences.

To meet the payment needs of the future, physical cash is unlikely to be the main answer. Yet, most people will have to wait to use a CBDC. However, central banks are working hard to make sure the wait is worth it.

Box B

Cryptocurrencies and other private digital tokens

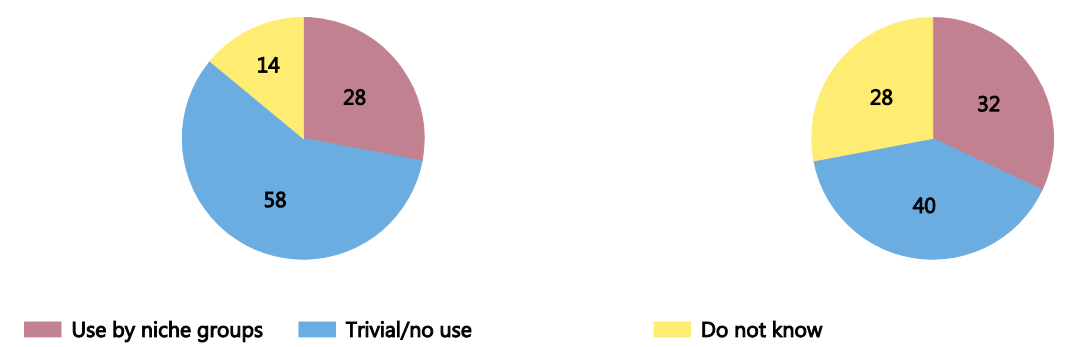
As well as questions on CBDC, the survey asked central banks about private digital tokens, encompassing the wide variety of digital tokens not issued by central banks. Decentralised digital tokens without an issuer that are not representative of any underlying asset or a liability are referred to as "cryptocurrencies". The survey included questions on the use of cryptocurrencies for domestic and cross-border payments, their judgement on whether that use would rise or fall and the state of experimentation with other digital tokens by the private sector in their jurisdictions.

Cryptocurrencies

No central banks reported any significant or wider public use of cryptocurrencies for either domestic or cross-border payments in their jurisdictions (Graph E). Usage of cryptocurrencies is assessed to be either minimal ("trivial / no use") or concentrated in niche groups for a large majority of the responding central banks. Answers were largely based on judgment, informed by industry, market and research sources although a few transaction monitoring programmes are reportedly in place. This is consistent with other research looking at payments made with cryptocurrencies (Graph G, right-hand panel), (Auer (2019)).

Current use of cryptocurrencies for payments[1]

Share of respondents — Graph E



[1] There were no responses for the options "Significant use" and "Wider public use".

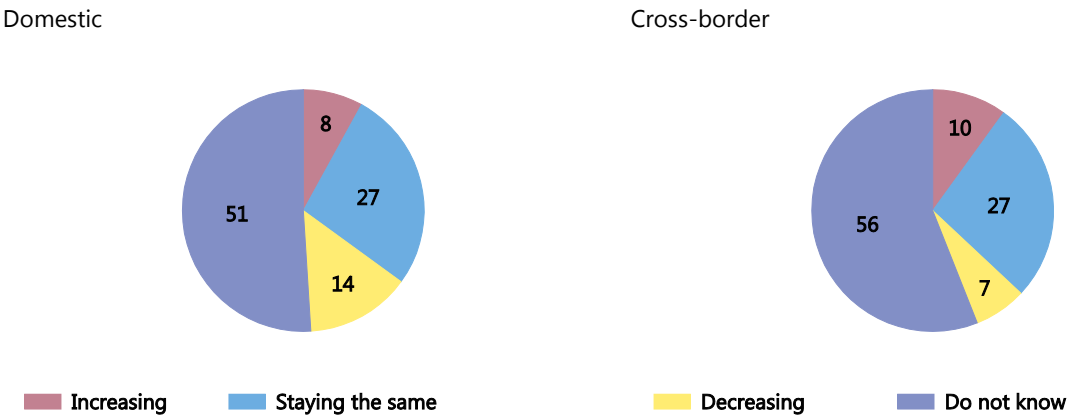
Source: Central bank survey on CBDCs.

Judgments about future usage are, unsurprisingly, difficult to make. Most central banks have not formed a firm view, especially in the case of cross-border payments (Graph F). Of those that could, the majority think use in payments will remain minor. Reasons for this judgment include low retail acceptance, compliance issues, better public understanding by the general public of the risks involved and, for some jurisdictions, outright bans. This is in line with other research that suggests the values and volumes of cryptocurrencies are influenced by regulators' actions (Auer and Claessens (2018)).

Some central banks reported that both the current and prospective use of cryptocurrencies seemed contained to such assets being used for investment purposes.

Anticipated use of cryptocurrencies for payments

Share of respondents — Graph F



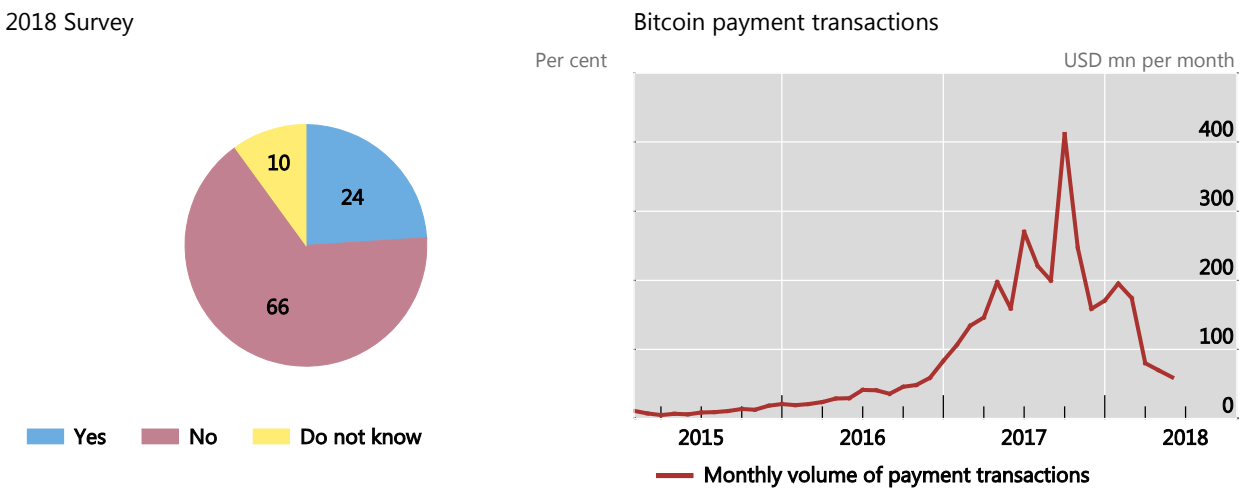
Source: Central bank survey on CBDCs.

Other private digital tokens

A great deal of attention has been paid to the distributed ledger technology (DLT) underlying cryptocurrencies, with almost a quarter of respondents reporting that banks or non-banks are experimenting with or issuing private digital tokens as part of their payment services (Graph G, left-hand panel). The reported experiments are concentrated in advanced economies and remittance-receiving EMEs in Asia and are mostly at early stages. Projects reportedly focus on cross-border payments, consistent with domestic faster payments being available in the relevant jurisdictions. Some central banks note that initiatives are often akin to more traditional arrangements (eg e-money or correspondent banking) and may blur boundaries or give rise to definitional issues

Are banks or non-banks experimenting with or issuing private digital tokens as part of their payment services?

Graph G



Sources: Auer (2019); Central bank survey on CBDCs.

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Annex 1: Central banks participating in the survey

Some 63 central banks participated in the survey from the following jurisdictions:

- Argentina
- Australia
- Azerbaijan
- Bangladesh
- Belgium
- Brazil
- Cambodia
- Canada
- Cape Verde
- Cayman Islands
- China
- Colombia
- Curaçao & Sint Maarten
- Cyprus
- Dominican Republic
- Ecuador
- Egypt
- Euro area (ECB)
- France
- Georgia
- Germany
- Hong Kong SAR
- Hungary
- India
- Indonesia
- Iraq
- Israel
- Italy
- Jamaica
- Japan
- Jordan
- Kazakhstan
- Korea
- Kosovo
- Latvia
- Malaysia
- Montenegro
- Morocco
- Netherlands
- Nigeria
- Norway
- Pakistan
- Papua New Guinea
- Philippines
- Russia
- Samoa
- Saudi Arabia
- Serbia
- Singapore
- Slovenia
- Solomon Islands
- South Africa
- Spain
- Sweden
- Switzerland
- Thailand
- Tonga
- Turkey
- United Kingdom
- United States
- Uruguay
- Vietnam
- Zambia

Annex 2: Survey questions

1. Has your central bank engaged, or will engage, in any kind of research, experiments or development work related to the development and use of CBDC? *[Yes / No]*

2. Is your work related to:

- *wholesale CBDC:*
- *general purpose CBDC*
- *both*

3. What type of work is being, or will be, conducted? Please check all that apply.

- research/ study
- experiments / proof-of-concept
- Development / pilot arrangement

4. How important are the following aspects to your motivations in issuing a:

- General purpose CBDC
- Wholesale CBDC

The following aspects were proposed:

  - financial stability
  - monetary policy implementation
  - financial inclusion
  - payments efficiency (domestic)
  - payments efficiency (cross-border)
  - payments safety / robustness
  - others (please specify below)

For each: *very important / important / somewhat important / not so important*

5. How likely is it that your central bank will issue a CBDC in the:

- General purpose CBDC
- Wholesale CBDC

For both, two time horizons were proposed:

  - short term (within the next three years)
  - medium term (four to six years)

For each: *very likely / somewhat likely / possible / somewhat unlikely / very unlikely*

6. Does your central bank have the legal authority to issue a CBDC?

- *Yes / no / uncertain / laws are currently being changed to allow for it*

7. Please provide any other details about CBDC and the thoughts and work in your jurisdiction, including your key motivations.

8. For your jurisdiction, please tick "True" or "False" for the following statements:

- Domestically:
  - There is a real-time-gross-settlement system (RTGS) available
  - The RTGS system settles more than one currency
  - There is a faster payment system used for domestic retail payments
  - There is broad participation by eligible financial institutions in the faster payments system
  - There is a legal framework for e-money

    - Non-banks are active in issuing e-money
- cross-border:
    - Payment mechanisms for cross-border e-commerce are widely available
    - There are exchange or capital controls that apply to cross-border retail payments

9. In your jurisdiction, how significant do you think consumer use of cryptocurrencies or crypto-assets for payments is?

- For domestic payments
- For cross-border payments

For each, the following options were proposed:

    - Significant use
    - Wider public use
    - Use by niche groups
    - Trivial / no use
    - Do not know

10. In your jurisdiction, do you think consumer use of cryptocurrencies or crypto-assets for payments is increasing or decreasing?

- For domestic payments
- For cross-border payments

For each, the following options were proposed:

    - increasing
    - staying the same
    - decreasing
    - Do not know

11. In your jurisdiction, are banks or non-banks experimenting or issuing private digital tokens as part of their payment services? *[Yes / no / don't know]*

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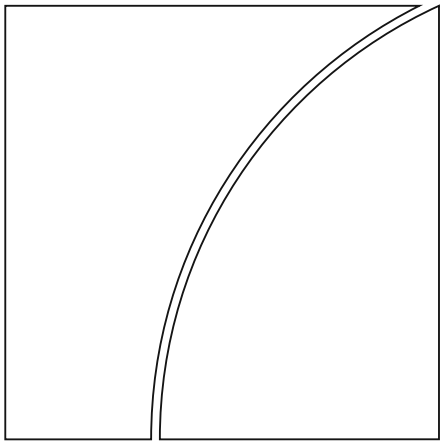

BIS Papers

No 107

Impending arrival – a sequel to the survey on central bank digital currency

by Codruta Boar, Henry Holden and Amber Wadsworth

Monetary and Economic Department

January 2020

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Contents

Impending arrival – a sequel to the survey on central bank digital currency[1]

Our survey shows that central banks are undertaking extensive work on central bank digital currencies. Globally, emerging market economies are moving from conceptual research to intensive practical development, driven by stronger motivations than those of advanced economy central banks. Central banks representing a fifth of the world's population say they are likely to issue the first CBDCs in the next few years.

Introduction

While cash is still king (Bech et al (2018)), innovations are pushing central banks to think about how new central bank digital currencies (CBDCs) could complement or replace traditional money (CPMI-MC (2018)). In 2018, the Bank for International Settlements (BIS) and the Committee on Payments and Market Infrastructures (CPMI) asked central banks about (i) their current work on CBDCs; (ii) what motivates that work; and (iii) how likely they are to issue a CBDC. The survey showed that the majority are researching CBDCs but that much of this research was conceptual (Barontini and Holden (2019)). Few thought it likely that they would issue a CBDC in the short or medium term.

One year on, the survey has been re-run.[2] Most central banks are still working to understand the implications for their jurisdiction and a significant minority representing a fifth of the world's population look likely to issue a CBDC very soon. This survey gives a global overview of work under way, showing that emerging market economies (EMEs) report stronger motivations and a higher likelihood that they will issue CBDCs. At the same time, so-called cryptocurrencies remain a niche means of payment.

Central bank digital currencies

CBDCs are new variants of central bank money different from physical cash or central bank reserve/settlement accounts (CPMI-MC (2018)). Money can be divided into its four different properties: (i) issuer (central bank or not); (ii) form (digital or physical); (iii) accessibility (wide or narrow); and (iv) technology (peer-to-peer tokens, or accounts) (Bech and Garratt (2017)). A CBDC is, by definition, a central bank-issued digital money. Different levels of accessibility demarcate two broad types of CBDC: *general purpose* and *wholesale*.

A "wholesale", "token-based" CBDC, is a restricted-access digital token for wholesale settlements (eg interbank payments, or securities settlement). Experiments

[1] We thank Morten Bech, Stijn Claessens, Jenny Hancock and Tara Rice for valuable comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS.

[2] Another similar, but smaller-scale and unpublished, survey was conducted by the Committee on Payments and Market Infrastructures in 2017. Results are included where relevant.

in this field generally focus on replacing current technologies with the aim of realising efficiency gains.

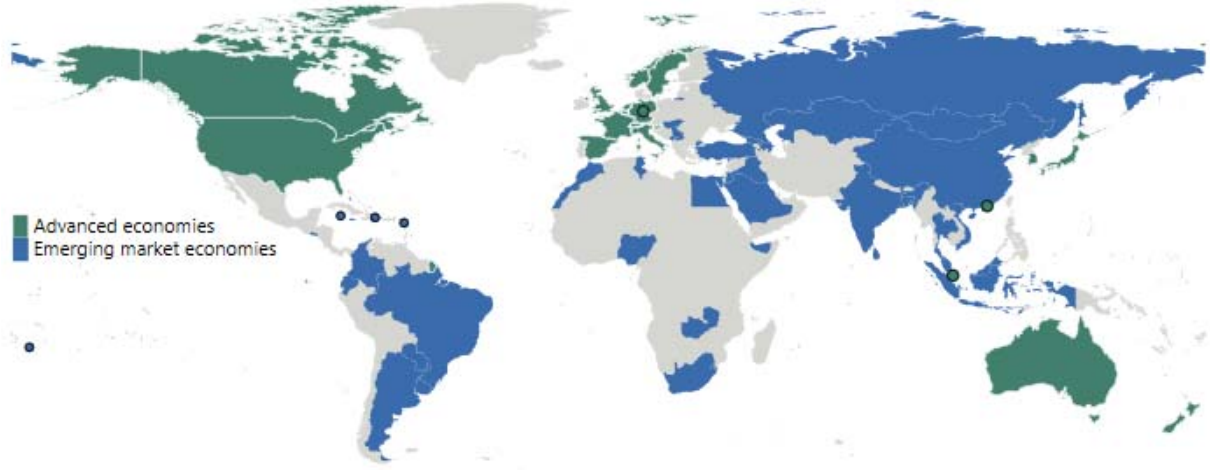
A general purpose variant (ie a CBDC available to the general public) can be based on tokens or accounts.[3] This would be widely available and primarily targeted at retail transactions (but would also be available for broader use). A token-based variant would resemble a type of "digital cash" which could be distributed to the general public in different ways to a more direct account-based variant.

The survey

Geographical coverage

Some 66 central banks replied to the survey, with the vast majority taking part for the second time (63 central banks replied to the 2018 survey) (Graph 1 and Annex A). Respondents represent 21 advanced economies and 45 EMEs, covering 75% of the world's population and 90% of its economic output.

Respondents to the survey — Graph 1



The black circles represent the Cayman Islands, the Dominican Republic, islands represented by the Eastern Caribbean Central Bank, the European Central Bank, Hong Kong SAR, Singapore and Tonga. "Advanced economies" and "Emerging market economies" as defined by the IMF *World Economic Outlook* country classification. The boundaries and names shown and the designations used in this map do not imply endorsement or acceptance by the BIS.

Questions

The survey was carried out in the latter part of 2019, reused the 2018 definitions and only changed a small number of questions. It starts by asking central banks if they work on CBDCs or not and, if they do, it further enquires about the type of CBDC and how advanced the work is. Motivations and current expectations for potentially issuing a CBDC are queried, as well as whether central banks have legal authority to

[3] In payment economics, a key difference between tokens and accounts is in their verification: a person receiving a token will verify that the token is genuine, whereas an intermediary verifies the identity of an account holder (Green (2008) and Kahn and Roberds (2009)). "Token-based" is also referred to as "value-based" in some CBDC discussions (eg Sveriges Riksbank (2018)).

issue. In this survey, some additional questions asking about cash use in a jurisdiction were added for the first time.

Questions about "private digital tokens" and their use for payments were also included. Private digital tokens encompass the wide variety of digital tokens not issued by central banks. The survey differentiated between so-called cryptocurrencies and other private digital tokens (eg "stablecoins"). All questions are listed in Annex 2.

Results

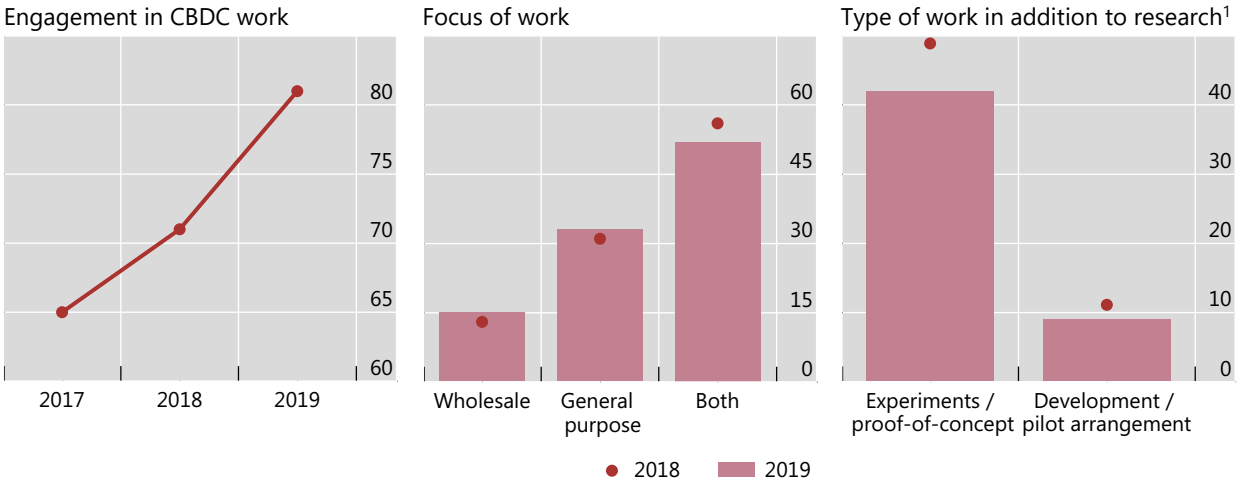
The survey corroborates the findings from last year's exercise, especially that a wide variety of motivations drives extensive central bank research and experimentation on CBDCs. Only a few EME central banks have progressed to intensive development (eg developing the operational arrangements for a CBDC and/or amending laws to allow the central bank to issue one) or pilot projects and have firm intentions to issue a CBDC soon. Nonetheless, their plans appear to be accelerating compared with earlier expectations.

Work under way

Ever more central banks are currently (or will soon be) engaged in CBDC work. Some 80% of central banks (up from 70%) are engaging in some sort of work (Graph 2, left-hand panel), with half looking at both wholesale and general purpose CBDCs (Graph 2, centre panel). Some 40% of central banks have progressed from conceptual research to experiments, or proofs-of-concept; and another 10% have developed pilot projects (Graph 2, right-hand panel). Every central bank that has progressed to development or a pilot project is an EME institution.

Central banks continue to work on CBDC

Share of respondents — Graph 2



[1] Share of respondents conducting work on CBDC.

Source: Central bank survey on CBDCs.

As in the previous survey, central banks currently not looking at CBDCs are typically from smaller jurisdictions and/or report that they face more pressing

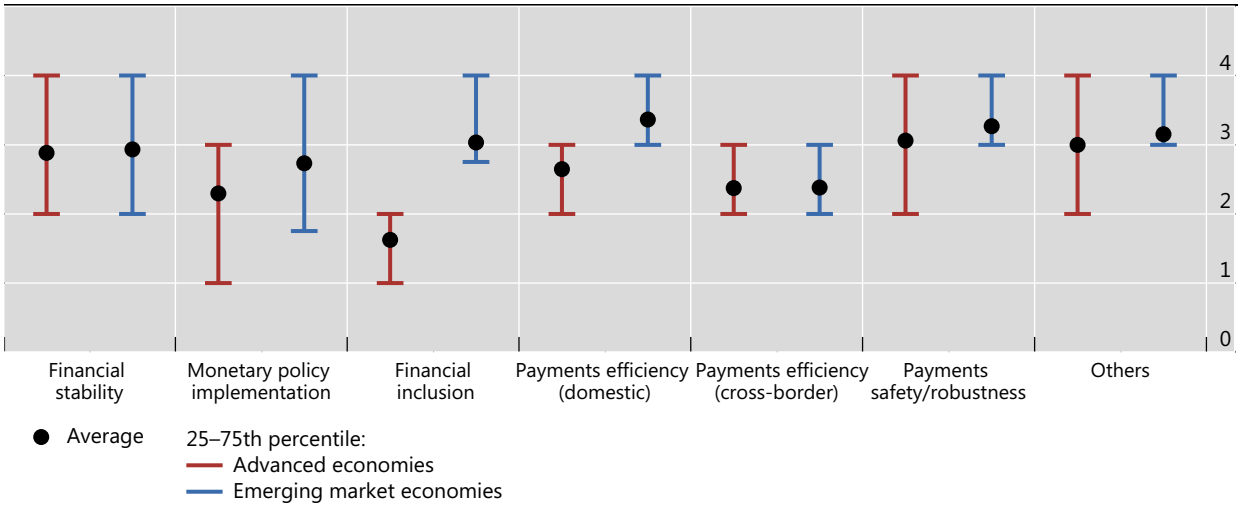
priorities. Nonetheless, many central banks continue to rely on research conducted by international organisations (in particular the BIS and the IMF) or regional networks.

Motivations

There are a large and diverse number of potential reasons why central banks are investigating CBDCs. To understand these motivations, central banks were asked to rank predefined potential factors from "not so important" to "very important" for work on general purpose and wholesale CBDCs. The same factors were used in last year's survey and the results were broadly comparable. However, EMEs have generally stronger motivations than advanced economies (Graphs 3 and 5), especially when a CBDC is being designed as a complement or replacement for cash.

Motivations for issuing a general purpose CBDC[1]

Distribution[1] Graph 3



[1] Not so important" (1); "Somewhat important" (2); "Important" (3); and "Very important" (4).

Source: Central bank survey on CBDCs.

General purpose CBDCs

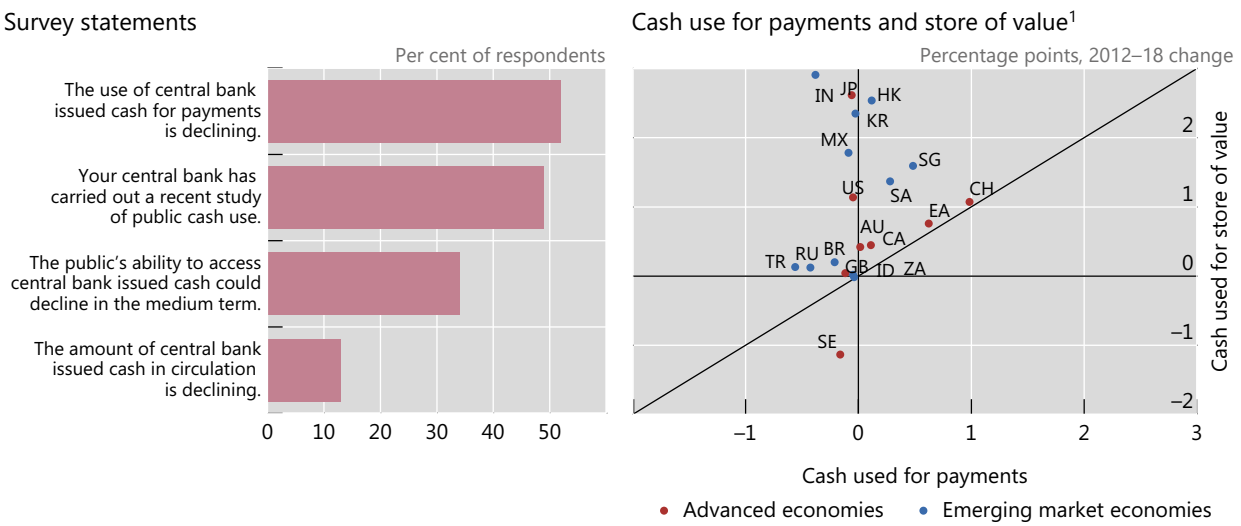
EMEs have generally stronger motivations than advanced economies to work on general purpose CBDCs (which can act as a substitute or complement to bank notes). Domestic payments efficiency, payments safety and financial inclusion were, on average, all considered "very important" in this respect for EMEs. For advanced economies, the only motivation ranked as very important was payments safety (Graph 3).

Cash-related challenges differ by central bank. Some central banks reported a high reliance on cash and are motivated by reducing costs and improving know-your-customer and countering-the-financing-of-terrorism ("KYC/CFT") arrangements. Other central banks have the opposite challenge: a low or declining use of cash for payments motivates research into a CBDC that would maintain public access to central bank money. New survey questions on cash use shed further light on this trend. Our survey shows that just under half of the world's central banks are investigating the public's use of cash and a third are concerned that access to cash

could decline in the medium term (Graph 4, left-hand panel). This corroborates other studies that show cash in circulation is increasing (eg Bech et al (2017)) but that much of this is in high-denomination notes used as a store of value rather than as a means of payment (Bech and Boar (2019)) (Graph 4, right-hand panel).

Cash use for payments is declining

Graph 4



[1] Graph based on CPMI Red Book data. "Cash used for store of value" is the two largest-denomination notes for each jurisdiction. "Cash used for payments" is the rest of the notes and coins in circulation. Banknotes no longer issued are not included in the calculations.

Sources: CPMI Red Book and Central bank survey on CBDCs.

Wholesale CBDC

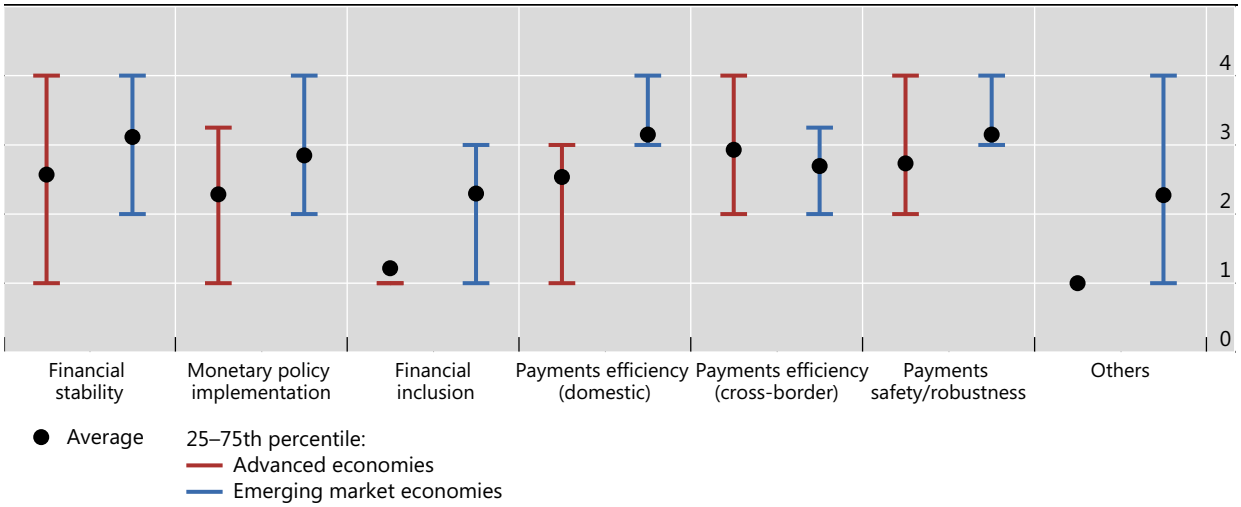
Motivations for researching wholesale CBDCs are generally weaker than those for general purpose CBDCs. Nonetheless, EMEs again have stronger motivations than their advanced economy peers (Graph 5). In particular, motivations to improve domestic payments efficiency, payments safety and financial stability are all very important to EMEs. This potentially reflects the fact that some of the smaller respondents have no wholesale, real-time gross settlement system for their currencies.

For advanced economies, increased efficiency for cross-border payments is the most important motivation, consistent with international work (FSB (2019)) and recently published experiments (eg a joint project by the Bank of Canada, the Monetary Authority of Singapore and the Bank of England (2018)).

Motivations for issuing a wholesale CBDC[1]

Distribution

Graph 5



[1] Not so important" (1); "Somewhat important" (2); "Important" (3); and "Very important" (4).

Source: Central bank survey on CBDCs.

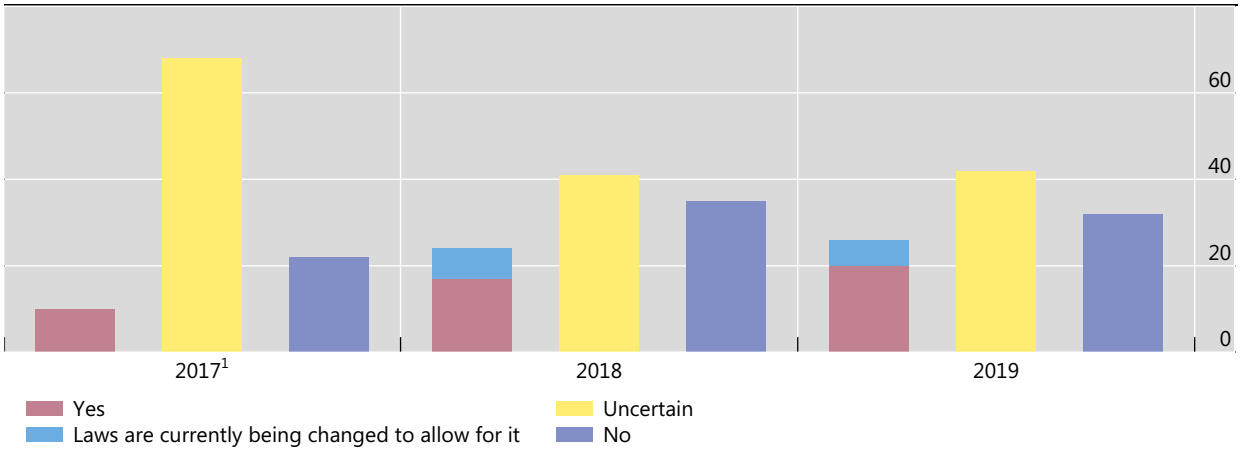
Legal authority

A central bank issuing a CBDC needs the legal authority to do so which, as in the previous survey, about a quarter of central banks have, or will soon have, such authority. A third do not have authority and about 40% remain unsure (Graph 6). The continued high level of uncertainty is not surprising, given that most central bank mandates predate many forms of electronic money. Additionally, in the absence of any plans to issue a CBDC, central banks may not be able to prioritise a clarification of their mandates.

Legal authority to issue a CBDC remains uncertain

Share of respondents

Graph 6



[1] There was no option for "laws are currently being changed to allow for it" in the 2017 survey.

Source: Central bank survey on CBDCs.

Intentions

For most people around the world, a general purpose or wholesale CBDC is still unlikely in their jurisdiction in the medium term. The survey measured this likelihood by asking central banks to predict the possibility of issuing a general-purpose and wholesale CBDC over the short (up to three years) and medium (up to six years) term on a five point scale. That scale ran from "very likely" to "very unlikely".

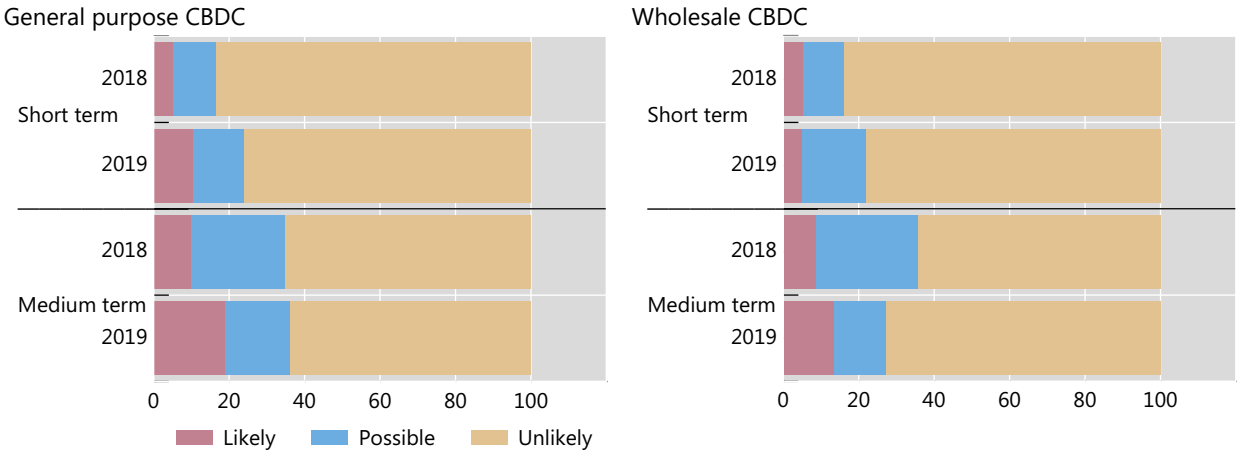
Compared with the previous survey, the likelihood of issuing any type of CBDC has increased but is still low (Graph 7). About 70% of central banks still see themselves as unlikely to issue any type of CBDC in the foreseeable future. At the same time, the number of central banks choosing "possible" (ie neither "likely" nor "unlikely") is falling, potentially indicating that research and experiments is helping to clarify a firmer stance on issuing a CBDC in the near term.

Nonetheless, 10% of central banks say they are likely to issue a general purpose CBDC in the short term (twice as many as last year) and 20% in the medium term (Graph 7). In global population terms, the larger impact is likely to be in the short term. Central banks collectively representing a fifth of the world's population are likely to issue a general purpose CBDC in the next three years. Although they equal them in number, central banks that are likely to issue in the medium term represent only 2% of the world's population.

Fewer central banks plan to issue wholesale CBDCs, in either the short or medium term (Graph 7). This could be down to a revision of central banks' plans; half the central banks that said in 2018 they were likely to issue a wholesale CBDC in the short term said they were less likely to do so in 2019. This is consistent with published experiments that show distributed ledger technology still faces steep challenges if it is to improve on current arrangements (eg Bank of Canada (2018) and Bank of Thailand (2019)).

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.

Consistent with their stronger motivations, EME central banks consider themselves more likely to issue a CBDC than do their advanced economy peers. For general purpose CBDCs, every central bank reportedly very likely or likely to issue in the short term is an EME institution. Over the medium term, 90% are in EMEs. The difference is also stark for wholesale CBDCs, where all advanced economy central banks consider issuance unlikely or very unlikely over the short and medium term.

Other digital currencies

As well as questions on CBDC, the survey asked central banks about private digital tokens, encompassing the wide variety of digital tokens not issued by central banks. "Cryptocurrencies" are defined in the survey as decentralised digital tokens without an issuer that are not representative of any underlying asset or liability. Central banks were asked about the use of cryptocurrencies for domestic and cross-border payments, their judgment on whether that use would rise or fall, and if they were analysing the impact of other private digital tokens.

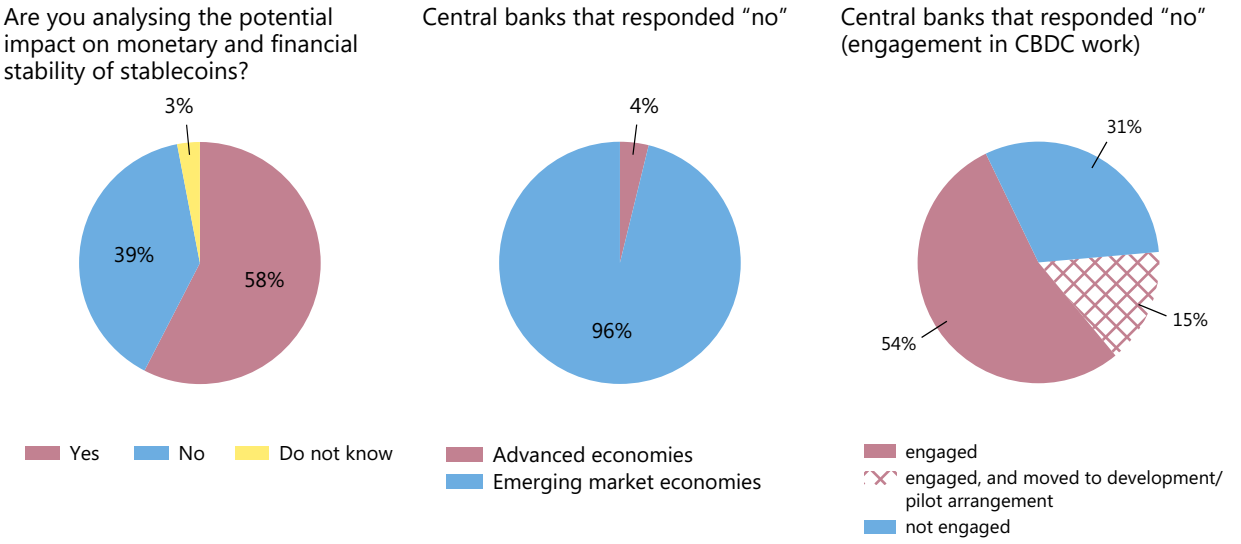
For cryptocurrencies, the results are almost exactly the same as in the 2018 survey: no central banks reported any significant or wider public use of cryptocurrencies for either domestic or cross-border payments; and the usage of cryptocurrencies is considered either minimal ("trivial/no use") or concentrated in niche groups. The one difference to highlight is that, in 2019, one central bank that did not contribute in 2018 and whose jurisdiction is facing serious civil unrest, considered cryptocurrency use significant domestically and saw wider public use for cross-border payments.

Beyond cryptocurrencies, the survey found that only about 60% of central banks are considering the impact of monetary and financial stability of "stablecoins" (Graph 8, left-hand panel). The survey defined these tokens as those with an identifiable issuer or that represent a claim and/or underlying asset (unlike a cryptocurrency). These tokens pose a number of risks, especially when available globally (G7 (2019)). Central banks not considering their impact almost entirely represent EME jurisdictions (Graph 8, centre panel). For the majority of those jurisdictions, remittances represent a significant proportion of GDP. Yet despite this, the majority are also engaged in work on CBDCs, some of which is very advanced (Graph 8, right-hand panel). Globally, only a handful of central banks responded that concern about cryptocurrencies or other private digital tokens was motivating work on CBDCs.

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

In per cent of respondents

Graph 8



Source: Central bank survey on CBDCs.

Conclusion

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. However, a few central banks with sufficient motivation are proceeding to pilot various designs (Box A).

Motivations for CBDC research continue to be diverse. Cash use is the key to driving many central banks' plans, with 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.

Although motivations are fairly stable, central banks with firmer plans to issue CBDC are now imminently close to doing so. Some 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. Cross-border spillover effects are possible (CPMI-MC (2018)). Collaboration through international vehicles such as the BIS Innovation Hub will be necessary to avoid any unforeseen international consequences.

Finally, collaboration on understanding the impact of private digital tokens may also need to intensify. Stablecoins could find widespread adoption where cryptocurrencies have failed. Our survey shows that more central banks could be looking at the risks outside the financial system while also exploring ways to improve the system with CBDCs.

Box A

Caribbean central bank digital currencies

The island nations of the Caribbean have a long history of monetary innovation and diversity (Bulmer-Thomas (2012)). Living on relatively small islands presents a challenge for their citizens, many of whom face issues accessing financial services despite broad access to digital technology (CEMLA (2015)). To improve financial inclusion, and explore benefits such as a lower cost of cash and improved know-your-customer (KYC) controls, central banks in The Bahamas and the Eastern Caribbean (among others) are engaged in central bank digital currency (CBDC) projects (Central Bank of the Bahamas (2019) and Eastern Caribbean Central Bank (2019)).

Bahamas – a central bank account

The Bahamas are chain of more than 700 islands, cays and islets spread over nearly 14,000 km^2 but with a population of fewer than 400,000. The Bahamian dollar is pegged one-to-one to the US dollar. Banking and offshore financial services make up about 15–20% of GDP, yet many citizens on some Bahamian islands lack access to traditional financial services.

The Central Bank of The Bahamas' "Project Sand Dollar" is the pilot for a general purpose, account-based CBDC for domestic use only. A digital currency holder would have a direct claim on the central bank, legally equivalent to an account. The pilot will run for six months in 2020, with regulation and legislation for a potentially wider rollout potentially following at a later stage.

Remote communities who rely on cash and need to meet KYC requirements could benefit from a safe digital currency, especially since an estimated 93% of the population owns a mobile phone. To improve wider non-discriminatory access to financial services and domestic payment efficiency, the central bank is also sponsoring a centralised KYC register, supporting a public education strategy and maintaining a ledger of all currency held. To avoid disintermediating the banking system, limits will be placed on the amount of digital currency that citizens and businesses can hold, and no interest will be paid.

Eastern Caribbean – a token on a distributed ledger

The Eastern Caribbean Central Bank is the monetary authority for a currency union comprising the island economies of Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Anguilla and Montserrat. The islands have a combined population of around 620,000 people, served by 21 licensed commercial banks, 17 of which are locally incorporated. The Eastern Caribbean dollar is pegged 2.70 to one US dollar.

The central bank is running a pilot of its general purpose, token-based CBDC through 2019 and 2020. The central bank issues, redeems and verifies all tokens through established financial institutions, which provide services directly to wallet-holders and to non-banks, which can also offer wallet services. Tokens are treated as digital cash, and represent a claim on the central bank. The distributed ledger on which tokens are recorded and transferred is permissioned and private, and all parties are identifiable.

Motivations driving the pilot include payment efficiencies, financial inclusion and the promotion of innovation and inclusive business growth. Motivations and design choices are similar to those of the Central Bank of the Bahamas in reducing cash use and its associated costs. Improving KYC and anti-money laundering controls are additional anticipated benefits. As in the Central Bank of the Bahamas project, limits on the amount of non-interest bearing digital currency will be in place, to avoid substituting for savings or deposits.

Design in context

Sweden's and Uruguay's central banks are also currently developing or running similar pilot projects for a general purpose CBDC motivated by complementing cash (Barontini and Holden (2019)). Each of the pilots have similar policy choices and are trialling (or anticipate trialling) non-interest bearing, non-anonymous CBDCs that are available 24/7 with restrictions on the values that can be held and distributed through intermediaries. Yet their technology differs. The Bahamas are opting for an interoperable account-based model, while the Eastern Caribbean is exploring distributed ledger technology, and Sweden and Uruguay are employing different technologies.

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Annex 1: Central banks participating in the survey

66 central banks participated in the survey from the following jurisdictions:

- Argentina
- Australia
- Azerbaijan
- Bahamas*
- Bahrain*
- Bangladesh
- Belgium
- Brazil
- Brunei Darussalam*
- Canada
- Cape Verde
- Cayman Islands
- China
- Colombia
- Dominican Republic
- Eastern Caribbean*
- Ecuador
- Egypt
- El Salvador
- Eswatini*
- Euro area (ECB)
- France
- Georgia
- Germany
- Hong Kong SAR
- Hungary
- India
- Indonesia
- Iraq
- Israel
- Italy
- Jamaica
- Japan
- Jordan
- Kazakhstan
- Kosovo
- Kuwait*
- Malaysia
- Mongolia*
- Montenegro
- Morocco
- Netherlands
- New Zealand
- Nigeria
- Norway
- Paraguay*
- Russian Federation
- Saudi Arabia
- Serbia
- Singapore
- Slovenia
- South Africa
- South Korea
- Spain
- Sri Lanka*
- Sweden,
- Switzerland
- Thailand
- Tonga
- Tunisia*
- Turkey
- United Kingdom
- United States
- Uruguay
- Vietnam
- Zambia

* not a participant in the 2018 survey

Annex 2: Survey questions

1. Has your central bank engaged, or will engage, in any kind of research, experiments or development work related to the development and use of CBDC? *[Yes / No]*

2. Is your work related to:

- *wholesale CBDC:*
- *general purpose CBDC*
- *both*

3. What type of work is being, or will be, conducted? Please check all that apply.

- research/ study
- experiments / proof-of-concept
- development / pilot arrangement

4. How important are the following aspects to your motivations in issuing a:

- General purpose CBDC
- Wholesale CBDC

  The following aspects were proposed:

  - financial stability
  - monetary policy implementation
  - financial inclusion
  - payments efficiency (domestic)
  - payments efficiency (cross-border)
  - payments safety / robustness
  - others (please specify below)

For each: *very important / important / somewhat important / not so important*

5. How likely is it that your central bank will issue a CBDC in the:

- General purpose CBDC
- Wholesale CBDC

  For both, two time horizons were proposed:

  - short term (within the next three years)
  - medium term (four to six years)

For each: *very likely / somewhat likely / possible / somewhat unlikely / very unlikely*

6. Does your central bank have the legal authority to issue a CBDC?

- *Yes / no / uncertain / laws are currently being changed to allow for it*

7. Please provide any other details about CBDC and the thoughts and work in your jurisdiction, including your key motivations.

8. For your jurisdiction, please tick "True" or "False" for the following statements:

- The amount of central bank issued cash in circulation is declining.
- The use of central bank issued cash for payments is declining.
- The public's ability to access central bank issued cash could decline in the medium term (within 6 years), assuming no action is taken by the central bank or public authorities.

- Your central bank has carried out a recent study of public cash use (eg a payments diary).
    - If "true", please provide a link.

9. In your jurisdiction, how significant do you think consumer use of cryptocurrencies or crypto-assets for payments is?

- For domestic payments
- For cross-border payments

For each: *significant use / wider public use / use by niche groups / trivial or no use / do not know*

10. In your jurisdiction, do you think consumer use of cryptocurrencies or crypto-assets for payments is increasing or decreasing?

- For domestic payments
- For cross-border payments

For each: *increasing / staying the same / decreasing / do not know*

11. In your jurisdiction, are you analysing the potential impact on monetary and financial stability of private digital tokens that are not cryptocurrencies (ie those tokens that have an identifiable issuer or represent a claim and/or underlying assets, sometimes referred to as "stablecoins")? *[Yes / no / don't know]*

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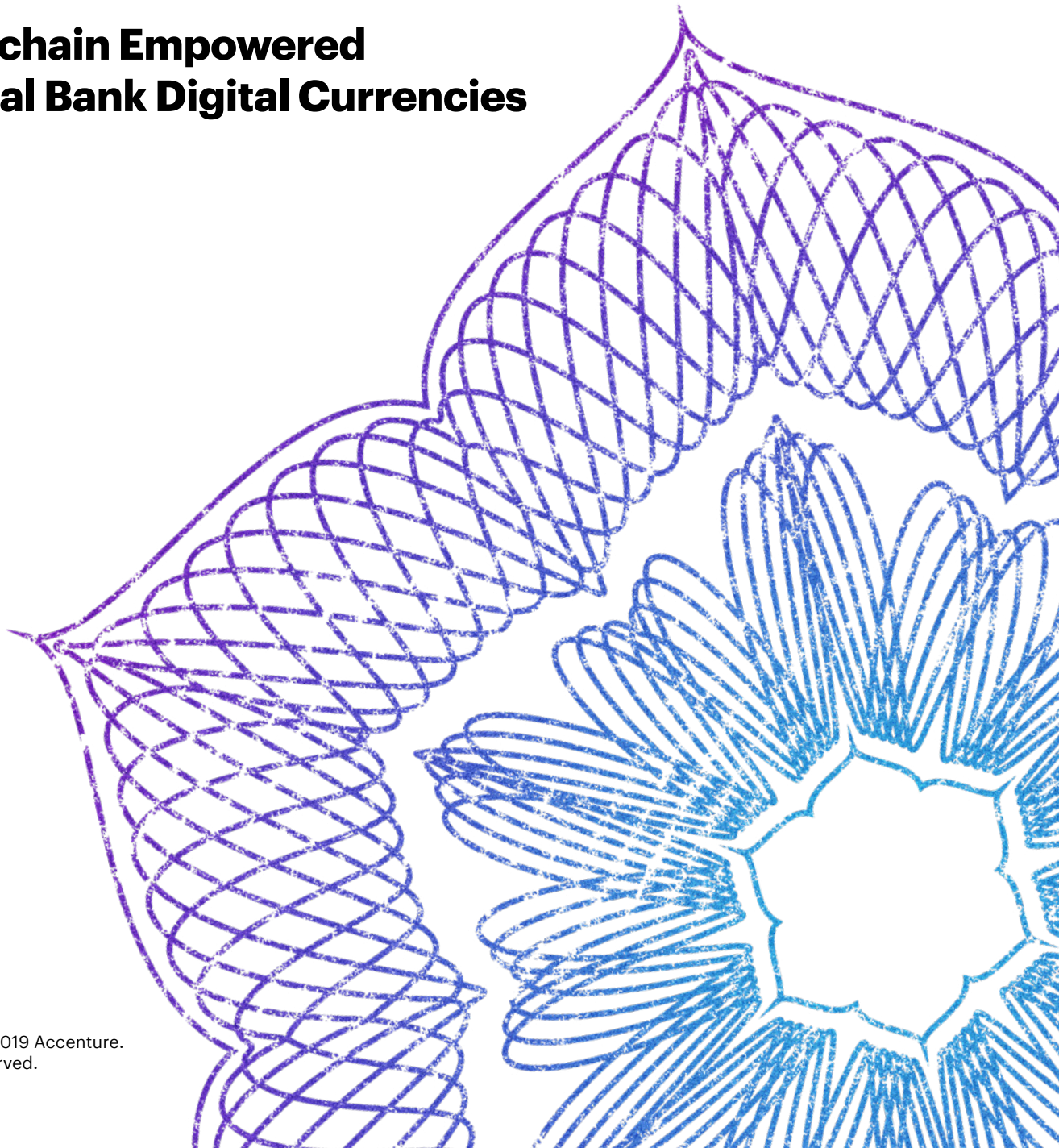
accenture

THE (R)EVOLUTION OF MONEY II

Blockchain Empowered Central Bank Digital Currencies



CONTENTS

FOREWORD

What is the future of central bank money?

The needs for central bank money are evolving. The emergence of new financial ecosystems requires new media of exchange. Central bank money remains the preferred settlement medium for large value transactions, but a new format of money is required.

The financial architecture is strained. National payments infrastructures are siloed, excessively concentrated and exhibit high barriers of entry. International payments are hindered by important friction amid undue reliance on correspondent banks, use of a narrow set of currencies and high transaction costs. This risks creating financial fragmentation and instability, producing liquidity blockages and inducing inefficiencies in payment relations.

Accenture believes that the future of money likely rests in the broad-based adoption of both tokenization and decentralization. Both may be critical to meet new demands for money and establish more direct, transparent and efficient payment relations for national and international financial transactions.

Central banks may have the unique catalytic power to facilitate those changes with the introduction of blockchain-enabled central bank digital currencies (CBDC).

The present report invites central banks and commercial banks to consider the introduction of CBDC. It represents a complementary document to The (R)evolution of Money report of 2017.[1]

INTRODUCTION

The requirements of what money does are changing.

Money as medium of exchange has seen little innovation since the introduction of paper currencies and cashless transfers in the nineteenth century. The emergence of new financial ecosystems necessitates new money functionalities. Technology determines largely what money can do. Changes in technology now offer new money uses. A new money format is needed.

Monetary and payment relations are strained. The global financial and economic crisis has reinvigorated concerns about large concentrated financial risks, elevated barriers to entry and transaction costs and increasing vulnerability to security breaches and outright failures. Inefficiencies in securities clearing and settlement impose undue risks. Persistent high exchange rate volatility seems indicative of the fact that financial liquidity does as needed. It is quite possible that we are nearing the end-of-life of large value payment systems, which in turn offers an opportunity to revisit whether existing payment technologies remain best adapted to address prevailing payment challenges.

The (R)evolution of money addresses the considerations of what money should do next. It is not about a mere substitution of money but to broaden the functionality and utility of money.

Tokenization emerges as a new format to represent goods, assets and rights. It offers new financial utility and attributes and promises greater flexibility and liquidity of the underlying. To transfer tokens, a simple token swap is performed. This requires a tokenized settlement medium. Since central bank money remains a preferred and for large value transactions, the preferred settlement medium, a central bank issued digital currency (CBDC) or tokenized central bank money is needed in token-based exchanges.

CBDC leverages the advantages of blockchain. Blockchain is a fitting technology to administer tokens and is set to enable new payment relations through a combination of tokenization, decentralization and secure information sharing. This enables peer-to-peer transactions, offers a more resilient payment infrastructure, reduces transaction costs, enhances information sharing capabilities and facilitates data reconciliation.

The emergence of private currencies, crypto-assets, as media of exchange has projected scope for payments innovation and fostered the debate towards change. While the proliferation of crypto-instruments remains uncertain, the co-existence of private and official currencies appears to be a high probability outcome. The proliferation of stable coins, and utility settlement coins, both exhibiting shortcomings, indicates that there is demand for tokenized currencies.[2, 3, 4]

Central banks have a historical opportunity to define new standards for digital currencies.

Similar to their role at the beginning of modern central banking to harmonize notes and coinage, central banks can provide needed support for new token-based financial ecosystems.

Many central banks have engaged in central bank digital currency projects. Safety and efficiency are cited as main motivations to consider digital currencies. Among emerging markets, central banks payment efficiencies in cross-border transactions and financial inclusion are additional motivators.[5] The typical interdependence between large value payment systems, in particular real-time gross settlement (RTGS) systems, and central securities depositary-securities settlement (CSD-SSS) systems implies that the impact of central bank digital currencies extends to immediate and intermediate payment applications.

Recent advances in blockchain technologies allow to largely refute residual concerns about maturity, privacy, inter-operability and scalability. Successful pilot projects have demonstrated that blockchain can meet performance of existing technologies in payments, clearing and settlement. Privacy concerns can mostly be addressed with the design and configuration of the blockchain and recent breakthroughs in inter-operability enables communication and connection of different blockchains with one another.

Central banks can act now as catalysts to help shape a new emerging financial architecture.

Central banks have facilitated key innovations and new standards of money in the past. The adoption of CBDC now offers the opportunity to set the standard for digital currencies and helps to ensure central bank money remains future-proof. While considerations for CBDC will differ amid various use cases for retail, wholesale and cross-border transactions, national preferences and international arrangements will be critical.

RECENT BLOCKCHAIN DEVELOPMENTS

The readiness of blockchain enabled payment solutions has made significant progress during the past 6 months.

Blockchain can now address residual concerns about scalability and inter-operability and therefore offers the foundations for advancing towards select real-life applications and implementation plans.

Bank of Japan and European Central Bank (Jun 2019)[6] – A joint project (Stella) to conduct cross-border payments concluded that the safety of cross-border payments could potentially improve using DLT-enabled payments with synchronized settlement and locking of funds.

Bank of Canada and Monetary Authority of Singapore (May 2019)[7] – A joint (Jasper-Ubin) project to show that tokenized central bank money can safely be exchanged in cross-border payments across different distributed ledger platforms.

Norges Bank (Feb 2019)[8] – Norges Bank reiterated that it considers introducing a public central bank digital currency similar to cash.

Swedish Parliament (Feb 2019)[9] – The Swedish Parliament in response to a decline in the use of physical money pressed for moving the e-krona project one step further.

Switzerland stock exchange (SIX) (Dec 2018)[10] – SIX reiterated that it founded a new company, SDX to develop a fully integrated trading, settlement and custody platform for digital assets based on blockchain-enabled technologies.

Bank of Canada, Bank of England and Monetary Authority of Singapore (Nov 2018)[11] – The cross-border payment project concluded that tokenization can help overcome prevailing inefficiencies and constraints in cross-border payments.

Australian Securities Exchange (ASX) (Oct 2018)[12] – ASX reaffirmed that it will proceed with implementing a blockchain based system to become operative by the first quarter of 2021. It will replace the current clearing house electronic subregister system (CHESS) that processes clearing, settlement and other post-trade services of cash equities.

Depository Trust and Clearing Corporation (DTCC) (Oct 2018)[13] – The DTCC showed that blockchain can support peak trading volumes in U.S. equity markets.

Accenture (Oct 2018)[14] – Accenture provided a solution to allow synchronization of business processes across blockchain platforms from different technology providers, offering corporations the possibility to operate in a broader ecosystem not bound by a specific choice of a blockchain platform. In addition, it demonstrated inter-operability in a cross-border environment.

Deutsche Börse and Deutsche Bundesbank (Oct 2018)[15] – Deutsche Börse and Deutsche Bundesbank successfully tested securities settlement based on a blockchain-enabled system including executing security settlement delivery versus payments (DvP), free of payment transactions, coupon payments while preserving needed confidentiality of data in a permissioned blockchain setup. The study concluded that the blockchain-enabled system in principle fulfilled the performance requirements and could therefore be considered a candidate for building a production grade system.

MONEY AND PAYMENT CHALLENGES

The existing monetary architecture exhibits significant pain points.

Money and payment relations are not operating as intended based on the repeated incidence of:

- financial crises
- liquidity shortfalls
- high transaction costs in cross-border payments
- elevated exchange rate volatility
- undue delays in securities clearing and settlement
- security breaches
- market manipulation

The prevailing financial architecture relies on large financial institutions that provide the foundations of financial intermediation. This poses undue concentration risk and distributive inequities and inefficiencies.

Financial crises impose considerable economic and societal costs. The notion of "too big to fail" remains a fundamental concern to address systemic risks in finance amid considerable concentrations of financial institutions' activities including for custodial services nationally and internationally.

The establishment of new financial institutions like central counter party clearing houses have reinforced concentration of financial risks.

The significant expansion of central banks' balance sheets amid policies of quantitative easing in several advanced economies has not led to the intended increase in broader monetary aggregates. Banks have been hoarding large reserves as credit expansion and inter-bank lending have remained impaired undermining effective financial intermediation.[16]

Cross-border payments are marred by long delays and high transaction costs. The importance of correspondent banking has remained while international claims of banks have been declining significantly since the global financial and economic crisis. The reliance on the dollar to conduct international transactions reinforces dependence on dollar-based financial institutions and dollar-denominated financial assets. This risks creating undue bottlenecks in the distribution of international liquidity. Persistent high exchange rate volatility illustrates the asymmetries in international liquidity distribution.

The securities life cycle offers considerable scope for improving efficiency. T+2 or T+3 clearing and settlement delays remain the norm in many exchanges. The reduction in clearing and settlement times would allow shortening risk exposures and freeing-up collateral tied-up to secure transactions.

Compared with T+3, T+1 would reduce counter-party exposure in a stress scenario by up to 70 percent and clearing fund requirements by up to 25 percent in average periods and 37 percent in high volatility periods.[17] Prevailing financial market infrastructures are siloed, hierarchical and impose undue transaction friction.

The analytical exploration of data from payment transactions has remained constrained amid limited data content. The lack of data analysis despite seemingly vast amounts of data points generated from payments may unduly hamper economic policy formulation, oversight and supervision.

The concentration of financial activities by institutions create large attack surfaces. The significance of security breaches, cyber-attacks and system failures multiply with financial concentration and increase generalized financial vulnerabilities.

Market manipulations like the LIBOR fixing and tax evasion scandals highlight flawed consensus market mechanisms. Market rigging is possible because a narrow set of large participants can corner the market or conduct transactions without requiring broad-based consensus.

The shortcomings of the current financial architecture are evident:

- Large financial concentration risks amid "too big to fail"
- Ineffective financial intermediation through bank channel
- Elevated transaction costs in cross-border payments
- Inefficiencies in securities life cycle
- Limited payments data content
- High vulnerabilities due to large attack surfaces
- Heightened susceptibility to market manipulation

These shortcomings are expected to prompt a broad-based response to seek alternative approaches to changing incentives and mitigating prevailing constraints and vulnerabilities. Blockchain-enabled solutions can help meeting those challenges offering important social gains.

CENTRAL BANK DIGITAL CURRENCY (CBDC)

Blockchain-enabled CBDC is a tokenized form of central bank money allowing token-based exchanges and enhancing transparency and security in payments.

CBDC should be considered as a new central bank money format and another central bank liability as part of the monetary base. CBDC would be fully fungible with reserves and bank notes. Any alteration in the monetary base would be a monetary policy decision.

CBDC is to serve financial ecosystems that require tokenized central bank money for settlement.

The innovation of CBDC rests on the combination of tokenization, decentralization and secure information sharing.

Tokenization

Tokens are digital representations of an asset good, right or currency with properties sufficient to attest and transfer ownership. Tokenization records assets, goods, rights or currencies on a blockchain-enabled ledger. In the securities life cycle, for example, this would allow for a stock to be sold by a simple exchange of an asset token for a currency token in true delivery versus payment. It also offers the possibility that only part of an asset is sold. The latter could significantly increase the liquidity of assets that are currently immobile or indivisible.

Decentralization

The possibility of a peer-to-peer exchange enables new possibilities to reducing delays and costs associated with intermediaries.

The decentralized nature of blockchain can bring significant resiliency benefits and efficiency gains and reduces single points of failure. It also implies that networks can expand or contract seamlessly allowing for flexibility in network relations.

Secure information sharing

The nature of blockchain greatly facilitates secure access and administration of access to data while ensuring only needed information is shared. Blockchain also enables information consistency and facilitates reconciliation of data and ascertains every permissioned participant in the network sees the same information.

Blockchain offers new opportunities to obtain relevant payments data content bringing data analytics to payments and enhancing sophistication for payment tracking, transaction disputes, AML, ATF and KYC compliance.

Central banks should be technology neutral and not favor one payment format over another. The issuance of CBDC can be a critical catalyst to facilitate broader-based tokenization. CBDC would enable exchange of tokens in central bank money, lending support and confidence in tokenization. While stable coins and utility settlement coins may offer substitutes for CBDC as representations of cash legs in payments, they have been subject to undue speculation and may give rise to counterparty and credit risks and not offer the possibility of settlement with finality.

Central bank money history

CBDC is grounded in the beginnings of central bank money. Starting in the nineteenth century, central banks were established to assume critical roles in the adoption of monetary innovation.

The implementation of unified coinage, cashless or giro transfers and issuance of paper currencies advanced payments transformation from metal coin based exchange. Bank notes significantly facilitated exchange and were essential to support rapid economic development. Under the classical gold standard, bank notes were mere tokens representing an unconditional claim of convertibility into gold.

Central banks were catalysts for needed monetary innovation in the past

Central banking evolved from decentralization in bank note issuance to centralization. The shape of central banks was largely determined by a perceived conflict between monetary policy effectiveness and monetary stability. The emergence of single central banking systems followed in large part the example of the Bank of England with the adoption of the 1844 Bank Charter Act with sole bank note issuance rights granted to e.g. in 1848, the Bank of France; in 1882, the Bank of Japan; in 1888, the Bank of Portugal; in 1897 the State Bank of the Russian Empire; in 1907 the Swiss National Bank. During the nineteenth century, decentralized central banking models persisted in Canada, Mexico and Scotland and to a lesser extent in Germany.

The establishment of the Federal Reserve system in the U.S. highlighted concerns about centralization in central bank money. The 1913 Federal Reserve Act established 12 Federal Reserve Banks that maintained broad-based independence in bank note issuance and policy rate settings. The decision to adopt a decentralized or "sectional" approach was based in large part on the assumption that a single institution could not effectively respond to the varying liquidity needs that prevailed in the U.S. largely amid its spatial differences.

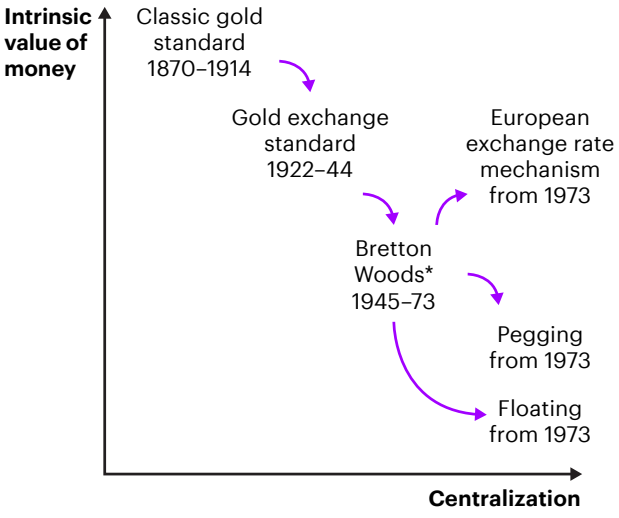
During the deliberation to establish a central bank in the U.S. Senate in 1913, Victor Morawetz, a period leading voice in favor of a decentralized system argued:

"The reason it seemed to be advisable to have in this country what practically amounts to five central banks or reserve banks [...], is that in this way you are able to avoid the conflict which arises from the great difference in the requirements of the different sections of the country for credits and for currency."[18]

Money and central banking evolved from central banking decentralization under the classical gold standard to increasing centralization under different monetary policy standards (Figure 1). Money evolved from exhibiting high intrinsic value and being highly decentralized to representing no intrinsic value and being highly centralized. The value of money shifted from money itself to the institutions managing it.

The historical concerns about centralization remain. The distribution of money can be hampered if intermediation is impaired by undue concentration, restricted access to payments and high transaction costs. Reconsideration for decentralization therefore seems largely warranted in particular for international payments.

Figure 1. Monetary policy and centralization[19]



CBDC use cases

The greatest benefits of CBDC are to be found in the broader context of reshaping payments relations and rests in the integration of assets and currency on a single ledger in the combination of tokenization, decentralization and secure information sharing. CBDC attracts payment applications in retail, wholesale and cross-border transactions. Considerations differ largely dependent on local circumstances and preferences. The adoption of CBDC will depend on set policy objectives.

Retail

The substitution of physical bank notes and coins with CBDC would address increasing digitalization in retail payments and expedites distribution of currencies to the non-bank public. The former responds to public choice concerns that the absence of digital central bank money may unduly restrict the non-bank public's ability to use and convert assets into central bank claims amid the decline in the use of physical cash. The latter allows central banks to assume the distribution of currency directly, for example using mobile phone technologies. The distribution of digital currencies could play a critical role to advance financial inclusion where the public is significantly underbanked or altogether unbanked. CBDC facilitates peer-to-peer exchange, allowing to conduct autonomous transactions replicating a physical cash environment.

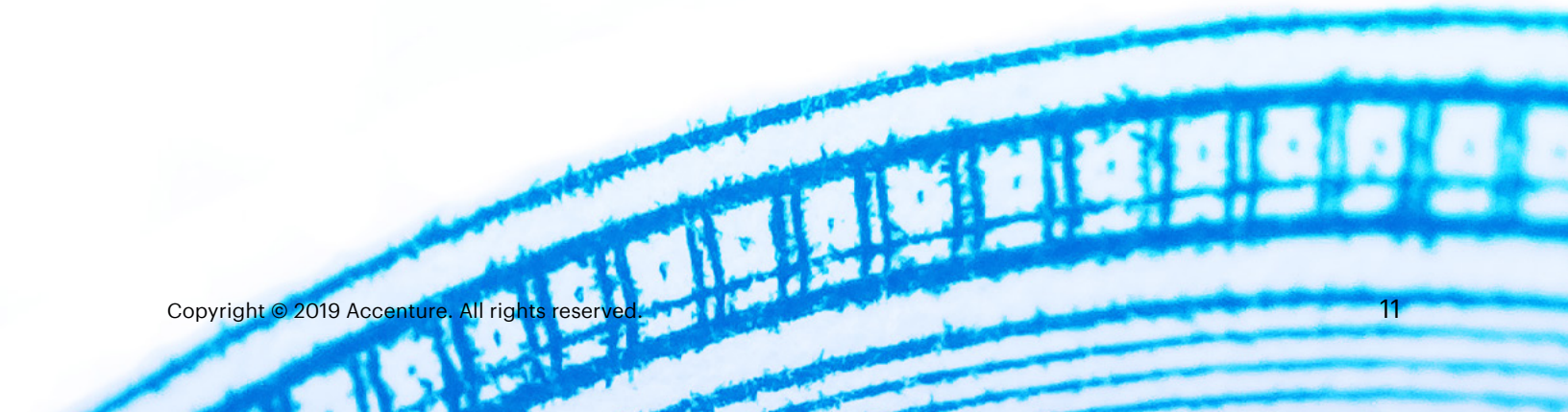
Wholesale

The adoption of CBDC offers the possibility to conduct end-to-end settlement in central bank money in token-based exchanges. CBDC providing the cash leg, can bring true DvP in the securities life cycle by allowing token for token exchange and offering the possibility of instantaneous clearing and settlement.[20] This lowers barrier of entry to payments enabling greater participation and competition in payments which in turn advances payment efficiency and ultimately more equitable access to payments. Due considerations need to be given if certain market entities require to retain end-of-day netting and settlement provisions.

Many RTGS systems are due for modernization. The relationship between RTGS and CSD-SSS implies that considerations for CBDC requires an integrated approach.[21]

Cross-border

The use of CBDC in cross-border payments would enable instantaneous payments irrespective of location. The current correspondent banks-based system imposes several transaction layers that cause numerous delays and costs.[22] CBDC facilitates establishment of direct payment relations reducing the need for intermediaries and greatly lowering transaction costs. The blockchain enabled environment greatly simplifies sharing of information and reconciliation through continuous updating and sharing of records. The availability of CBDC may attract non-residents into holding CBDC and conduct cross-border and off-shore transactions.



CBDC concerns

The CBDC has the potential to change the operating environment of central banks, but it is important that it does not. The facilitation of decentralized exchange should in principle not affect central banks' ability to pursue price and financial stability.

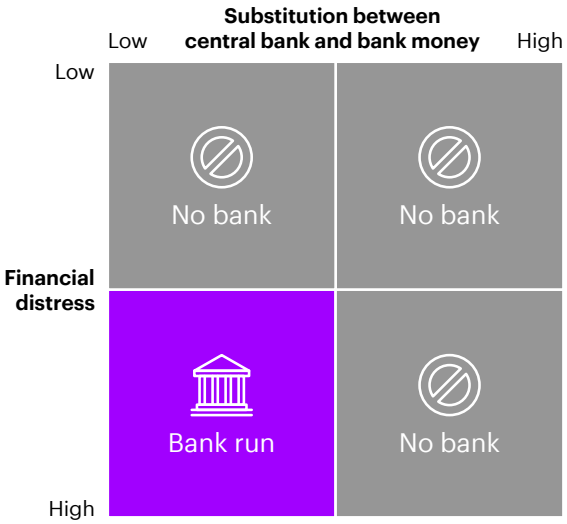
The effect of CBDC on set monetary policy objectives will depend on the CBDC design. While a simple substitution of existing notes, coins and reserves may not have any impact on monetary policy, additional features like the possibility for CBDC to pay interest to the non-bank public (see below), may alter the propensity to hold central bank money. The impact of CBDC on price stability may in large part depend on the propensity to hold CBDC.

CBDC that is interest bearing (see below) may broaden the channel for the transmission of monetary policy. The possibility to pay negative interest would also allow mitigating restrictions when the policy rate is near the effective lower zero bound and allow establishing symmetry between positive and negative policy rates. Indirect effects may arise if improvements in liquidity distribution reduce leverage in the economy and affect the price of collateral.

The possible perceived substitutability between central bank and bank money may make the non-bank public recalibrate its holdings of central bank money. This could reduce the non-bank public's desire to hold bank deposits. It will also depend in large part on the ability of banks to differentiate bank money from central bank money and, while there is the potential, it must not lead to a reduction in bank deposits (Figure 2).[23] In wholesale transactions, non-banks may similarly develop preference to settle in CBDC, increasing the amount of central bank liabilities.

The desired relative holding of central bank and bank money may be state-of-the-world dependent. While in tranquil times, the non-bank public may consider bank and central bank money to be close substitutes (substitutability between central bank and bank money is high), in situations of financial distress, the non-bank public may proceed towards rapid conversion of bank for central bank money (substitutability between central bank and bank money is low) given the low transaction costs to do so (digital bank runs). At the same time, the central bank could always replenish possible deposit withdrawals and in a digital environment can do so instantaneously where the lending rate could become a policy variable. The latter may instill confidence among the non-bank public reducing the actual probability of runs (Figure 2).

Figure 2. Bank intermediation



The increase in the propensity to hold CBDC will naturally affect the size of the central bank's balance sheet. This may incur additional and at times unwanted risks for the central banks. The risks would depend on the assets the central banks would acquire from CBDC issuance.

The control of monetary aggregates may be altered if non-residents increase their holdings of CBDC. While the central bank will always know the location of CBDC it may not be able to control its off-shore use. Very large net cross-border movements of CBDC may complicate the conduct of monetary policy and undermine financial stability. Prudential regulation may be contemplated if undue large net movements of CBDC complicate monetary management. CBDC may also be equipped with features constraining off-shore use.

The transparency of blockchain implies that all transactions are recorded. While transactions can be made anonymously or configured to a varying degree of pseudonymity, all transactions are traceable. At the same time, blockchain offers important safeguards to administer dissemination and access to information that help protect privacy. Central banks will have to weigh privacy concerns against transparency gains in view of money laundering, terrorism financing and other illicit transactions.

International CBDC

The properties of CBDC may increase its attractiveness relative to other currencies and alter the propensity by non-residents to hold and use a given CBDC. This could affect the demand for blockchain enabled currencies relative to conventional ones.

CBDC of a given country could become a currency of choice to conduct international transactions. The properties conducive to conduct digital financial transactions could divert use away from conventional currencies.

The properties of CBDC may be conducive to establishing more international currencies. This would ease prevailing reliance on a narrow set of international currencies to conduct international transactions.

The greater variety of international currencies (establishment of a basket of highly liquid instantly transformable reserve or trading currencies) could create a more diversified and equitable international payment infrastructure.

The role of CBDC may be particularly relevant to promote regional local currency payments integration. The substitution of local currencies with a common multi-central bank CBDC would further reduce transaction costs and minimize foreign exchange exposure in international transactions.

Finality in payments

CBDC would need to enable certainty and be consistent with the notion that currency parity is maintained. CBDC would need to represent or be convertible at par into central bank money. The singleness of CBDC is a necessary condition to serve effectively in payments and to settle payments with finality.[14] Regulation may need to be adjusted to allow CBDC to qualify towards settlement finality.

Crypto-currencies

The emergence of crypto-assets may to some extent indicate new use cases for currencies. Crypto-assets that exhibit currency-like functions—crypto-currencies—have raised important financial stability concerns.

The notion of private monies denominated in a unit of account unrelated to a central bank issued currency is novel though historically not new. The utility of such monies will depend on credible alternatives and use cases. The use of blockchain technologies may offer certain advantages relative to conventional currencies. The lack of a regulatory framework for crypto-currencies remains a significant constraint to broader based acceptance.

Stable coins

The proliferation of stable coins reflects a desire for tokenized currency as a stable unit of account. The coins are intended to be used as cash legs in exchanges and support in particular trading operations of crypto-assets.

Stable coins exhibit features akin to a currency board and represent a collective investment scheme. The scheme accumulates high quality assets funded by the issuance of tokens. Reserved tokens represent an unconditional claim on the reserve pool.

Stable coins are normally fixed to national currencies, a basket of national currencies or commodities. Stable coins can also be reserved with crypto-assets or tied to a net issuance algorithm set to maintain stability against a given numeraire.

The substitutability of stable coins and central bank money rests in the reserve portfolio and legal certainty of convertibility. A token that conveys unambiguous convertibility certainty and is reserved by central bank money should be considered "as good as" central bank money.[25] Stable coins to date do normally not exhibit convertibility certainty.

Utility settlement coin

The issuance of utility settlement coins serves mostly to conduct monetary transactions with tokenized currencies within a consortium of banks. The coins feature properties similar to stable coins and are used to settle inter- and intra-bank transactions as a substitute for central bank money. Utility settlement coins are normally pegged to a national currency or a basket of national currencies.

Figure 3. Digital media of exchange

Crypto-currencies	Privately issued token denominated in non-official currencies
Stable coins	Privately issued tokens backed by reservable assets and/or official currencies
Utility settlement coins	Token issued by a consortium of private banks to serve as vehicle to intermediate intra-consortium flows. Can be backed by central bank money
CBDC	Tokenized central bank money

CBDC DESIGN

The properties of CBDC can vary significantly. Possible design features include interest-bearing and encompass distribution, technology and information and can vary from a simple digital representation of central bank notes and reserves to more complex instruments.

Bank notes, within well-known limitations, allow autonomous, anonymous and decentralized peer-to-peer exchange whereby the payment infrastructure is completely atomized. Bank notes are generally immune to failure and undue manipulation, offering instantaneous settlement any time anywhere.

CBDC would normally represent tokenized money issued on a permissioned blockchain to enable DvP exchanges while preserving privacy at the highest security standards.

Accounts-based CBDC

CBDC based on book entries, accounts-based issuance, is limited to processing reserve balances at the central bank by holders of reserve accounts and do not allow DvP transactions and peer-to-peer transactions in assets and currency exchanges. An account-based system for the general public requires they have an account at the central bank and must also allow off-line transactions.

Tokenized CBDC

The issuance of central bank money into an account at the central bank as a token, also referred to as value-based issuance, allows digital asset for currency exchanges in retail and wholesale transactions and enables autonomous peer-to-peer transactions. The tokenized currency would be held in an electronic wallet on a wallet-enabled device that would have to be enabled for off-line transactions.

Tokenization may represent central bank money or a claim on central bank money. The former would be an unambiguous substitution of and fully fungible with existing central bank money. The latter would represent a digital twin of central bank money.

Permissioned and public blockchain

The data to process transactions can be stored on a private or permissioned or public blockchain. The former would restrict access to the blockchain to select parties including with differential access and editing rights. The latter allows broad-based participation in line with the original intent of the bitcoin blockchain, is normally open source and allows public interaction with the network. The participation in the blockchain network needs to be broad enough to offer sufficient decentralization in network validation. CBDC would normally be based on a permissioned blockchain.

Information sharing

Blockchain applications exhibit advanced information sharing and data reconciliation facilities. A critical feature of blockchain is the establishment of a common set of shared data to ensure all needed parties can share the same information. The blockchain facilitates greatly the continuous validation and exchange of data.

The information capabilities of blockchain allows to record and mobilize valuable transaction data amid the universal record of all payments transactions.

This will provide unprecedented access to trade payments, liquidity and economic transactions and help enhance the formulation of monetary and economic policies.

Smart contracts

The blockchain allows to embed self-executing or smart contracts to pre-determine certain transactions without the intervention of a third party. This may facilitate strict rules-based decisions in financial regulation and other applications.

Delivery versus payment

CBDC enables tokenization of currency and assets on a shared ledger. This allows direct interactions for all financial market infrastructure participants with assets and facilitate DvP. CBDC enables immediate finality of settlement and reduces the amount of liquidity and collateral needed in securities clearing and settlement and reducing or eliminating credit extensions normally used to meet currency requirements in settlement.

Figure 4. Blockchain

	Permissioned	Permissionless
Crypto-currencies	X	X
Stable coins	X	X
Utility settlement coins	X	
CBDC	X	

Interest bearing

CBDC offers the possibility to make positive and negative interest payments on currency. This would significantly alter the fundamental functionality of central bank money in the hands of the non-bank public and could broaden the channels for the transmission of monetary policy. The possibility to pay negative interest may ease the constraints for monetary policy at the lower zero bound.[26]

The introduction of interest-bearing central bank money in the hands of the non-bank public would establish a direct relationship between monetary policy and the non-bank public. Holders would see their central bank balances increase or decrease with changes of the central bank policy rate, irrespective of location affecting residents and non-residents alike. While as a direct instrument it could in theory broaden the transmission channel of central bank policy, it would represent a significant departure from current central bank practices.

Resiliency

Token based financial ecosystems would diversify the financial market infrastructure and bring greater resilience. It would also broaden and make more equitable the delivery of central bank liquidity. The decentralized nature of blockchain reduces systemic vulnerabilities. Blockchain-based applications rest on the co-existence of various data sites. This ensures there is no single point of failure. Breakdown of an individual network node may exclude that node from participating in the network but does not preclude the rest of the network to operate.

Privacy

The recording of all digital transactions implies that transactions are traceable. However, transactions can be private by using pseudonyms. The provisions for privacy can follow permission in some jurisdictions to enable small amounts to be conducted without revealing the identity of the exchange parties. The blockchain can enable select information sharing such that only the parties to an exchange can view the relevant information underlying the exchange.

The flexibility of the blockchain enables certain entities to view most or all transactions net of transactions classified as private. The possibility to introduce special nodes to allow specific network participants to monitor or authorize certain transactions enables the building of a tiered information structure that facilitates monitoring and select access.

Identity

The relationship between identity and financial transactions offers the opportunity of a simultaneous solution for identity and payments transactions. Blockchain supports management of needed standards to identify customers unambiguously and maintain customer records to be shared with authorized parties enabling a seamless infrastructure between identity and payments. This may be particularly relevant where the payment infrastructure is characterized by a low banking ratio amid a high under or unbanked population.

KYC, AML and ATF

Standards of know-your-customer and anti-money-laundering and anti-terrorism financing provisions are essential for a safe payment infrastructure. In payment infrastructures where banks maintain customer standards, CBDC would rely on existing standards. Where central banks engage directly in the distribution of CBDC, they may set minimum amount-based standards to limit needed customer checks.

CBDC PROJECTS

Central banks have embarked on a number of CBDC-related projects.

Around 70 percent of surveyed central banks are currently or will soon be engaged in central bank digital currency work.[27] The projects have typically performed proofs of concept to assess the use of blockchain in a banking environment to address scalability, resilience, privacy, securities settlement and cross-border transactions.

E-krona – Central Bank of Sweden (2019)[28]

The Central Bank of Sweden (Riksbank) is procuring suppliers to develop proposals for a digital currency (E-krona) for the non-bank public. An earlier E-krona project in 2018 concluded that E-krona is compatible with the Riksbank's task to promote a safe and efficient payment system.[29]

Stella – Bank of Japan, European Central Bank (2019)[30]

The Stella project in phase 3 attested that improvements can be obtained in cross-border payments in terms of safety by using distributed ledger technologies.

Project Jasper-Ubin – Bank of Canada, Monetary Authority of Singapore (2019)[31]

The project successfully tested that distributed ledger technology can be used to make safe cross-border payments by an exchange of wholesale CBDC across different distributed ledger platforms.

ECCB CBDC pilot – Eastern Caribbean Central Bank (2019)[32]

The Eastern Caribbean Central Bank (ECCB) embarked on a pilot to introduce a digital version of the EC dollar (DXCD) based on blockchain to be used as generalized medium of payment to reduce cash usage by 50 percent, promote greater financial sector stability and support economic growth and development.

Cross-Border Interbank Payments and Settlements – Bank of Canada, Bank of England, Monetary Authority of Singapore (2018)[33]

The project reviewed root causes of the problem of cross-border interbank payments to identify "future-state capabilities". The initial results of the project show that blockchain-enabled platforms extend availability and payment tracking and offer the possibility of a shift away from the existing correspondent banking model.

Jasper III – Bank of Canada, Payments Canada, TMX) (2018)[34]

The proof of concept demonstrated that a blockchain-based system can perform an irrevocable settlement of equities against central bank currency including successful implementation of a DvP settlement flow of currency and equities on a shared ledger. The set-up enabled immediate finality in settlement and resulted in the ability to instantly reuse cash and equity tokens reducing liquidity needs.

Project Aber – Saudi Arabia Monetary Authority, Central Bank of the United Arab Emirates (2019)[35]

The project is a proof of concept for a common digital currency between the Saudi Arabia Monetary Authority (SAMA) and the Central Bank of the United Arab Emirates (CBUAE) to conduct cross-border settlement with the opportunity to reduce remittances costs.

Khokha – South African Reserve Bank (2018)[36]

The proof of concept was aimed at wholesale settlement and affirmed that blockchain systems can process the typical volume of the South African payment system using ISO 20022 standard messages across geographically distributed nodes. The SARB was able to view all transaction details to ensure regulatory oversight.

Ubin II – Monetary Authority of Singapore and Association of Banks in Singapore (2017)[37]

The proof of concept showed that blockchain is able to satisfy key functionality of a RTGS in terms of volume, liquidity savings mechanisms, gridlock resolution and resilience and mitigated the risk of a single point of failure. The project showed that fund transfers, queue prioritization and gridlock resolution can all occur in a decentralized manner while preserving the privacy of the transactions. The project also gave rise to considerations that participation in a decentralized network must not be equal across participants as needs differ. The possibility to deploy a blockchain enabled system that operates 24x7 had been confirmed even when not all network participants are active.

CONCLUSION

Recent advances in blockchain technology demonstrate that blockchain is ready for select real-life applications.

Central banks have an opportunity to enable a better payments architecture that connects with broader blockchain-based applications. CBDC represents a critical element in the evolution of money to facilitate this architecture and provide a level playing field with conventional platforms that can settle in central bank money.

CBDC supports essential central bank policy objectives by offering enhanced payments efficiency and resiliency. The design of CBDC may also enable greater scope for the implementation of monetary policy. The changing architecture may offer important liquidity saving that facilitates national and international financial transactions. The enhanced information capabilities provide additional critical input for the formulation of economic policies.

Central banks naturally maintain different policy priorities. CBDC can help address financial inclusion and be an effective substitute for physical currency; it can support a compression of the securities life cycle; it can facilitate regional or international payments integration by reducing transaction friction including information cost and possibly offering a greater variety of currencies conducive to conduct international exchange thereby mitigating undue concentration and dependence on a narrow set of international currencies.

CBDC offers unique payment features in the combination of tokenization, decentralization and secure information sharing. The relationship between tokenization and decentralization allows to establish new payments relations that offer more diversified and equitable access to payments.

The proliferation of private sector payment initiatives illustrates the perceived gap in money developments. The changing functional requirements of money and new expected user experiences reveal that the scope for change in money is significant.

Central banks have the opportunity to enable a better performing and more resilient payment architecture. They have been key money innovators in the past. CBDC can help ensure central bank money remains relevant and future-proof.

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