

Retail CBDCs

The next
payments frontier

Frequently used terms

Blockchain: a digital database containing information, such as records of financial transactions, that can be simultaneously used and shared within a large decentralised, publicly accessible network.

CBDC, central bank digital currency: a digital asset issued by a central bank for the purpose of payment and settlement, in either retail or wholesale transactions. A 'retail' CBDC would be used like a digital extension of cash by all people and companies, whereas a 'wholesale' CBDC could be used only by permitted institutions as a settlement asset in the interbank market.

Cryptocurrency: a digital currency that uses cryptographic encryption techniques to regulate the issuance of new units, record transactions and attempt to prevent fraud.

Cryptography: the act of protecting information by transforming it into an unreadable, unintelligible format.

Digital cash: a system that permits users to pay, anonymously and electronically, by transmitting a unique digital certificate similar to a banknote number, without the intermediate involvement of a commercial bank.

DLT, distributed ledger technology: a consensus of replicated, shared and synchronised digital data geographically spread across multiple sites, countries or institutions, without a central administrator or centralised data storage.

Proof-of-work: an arduous process used to validate transactions in a cryptocurrency that typically comes in the form of an answer to a mathematical problem. Later consensus protocols – such as proof-of-stake – have built on this method.

SDR/eSDR, special drawing right and electronic special drawing right: the International Monetary Fund reserve asset made up of a basket of currencies, and its digital counterpart.

Stablecoin: a variant of cryptocurrencies typically pegged to the price of another asset (such as the dollar), designed to maintain a stable market value.

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| 6 Executive summary | 14 Section 2: Rationales and use cases Central banks' policy objectives regarding digital currencies are many and various. For policy-makers, specifying the use cases in which a CBDC may apply is paramount. |
| 35 Conclusions | 22 Section 3: Technology Central banks' policy goals will determine the technology used. Policy-makers would require a retail CBDC to be accessible, secure and operate for all payments transactions. |
| | 28 Section 4: Policy and implications The particular design of a CBDC, such as whether or not it would bear interest, will determine its effectiveness as a monetary policy instrument and whether any financial stability implications may arise. |
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Central banks respond to digital currency reality

DEVELOPMENTS in the application of new technologies to financial services, the desire of monetary authorities to address perceived weaknesses in payments infrastructures, and the emergent challenge of privately-issued digital currencies are rapidly transforming the prospects of central bank digital currencies from a theoretical abstraction to a practical proposition. This report on retail CBDCs draws on extensive research over the summer of 2019 by OMFIF and IBM, involving the contributions of 23 leading central banks, among others.

The first OMFIF-IBM report on CBDCs, published in October 2018, focused on wholesale applications and outlined how a permissioned blockchain-based token could offer distinct benefits to the backend infrastructures which underpin modern payment systems. Notably, faster speed and better efficiency, lower counterparty risks, and better overall system resilience could be achieved through a wholesale CBDC solution. These benefits could also extend to a retail CBDC.

The payments landscape has changed significantly in the light of dramatic technological developments in the financial sector and changing consumer preferences. As these unfold, the front-end arrangements that provide consumers with the ability to pay, save and transfer value have experienced the greatest improvements.

Private sector institutions, both incumbent and nascent, have so far been able to develop solutions that overcome some existing shortfalls in the payments system. The proliferation of apps and devices that support mobile payments, including in emerging markets that lack traditional banking infrastructures, showcases the private sector's agility and ability to innovate and tailor services to various types of consumer and markets. Facebook's plans to issue

its own digital global reserve currency, Libra, is only the most recent and conspicuous manifestation.

Whether or not central banks like the sight of these developments – which generate an inherent threat to their senior position in the financial system and to their monetary sovereignty – they must remain alert to shifts in payments habits. The discourse on CBDCs and related trials has accelerated in recent years. Central banks are responding to the reality that digital currencies, either privately- or publicly-issued, will be an unavoidable part of the global monetary system. It is in central banks' best interest that they are neither left behind nor displaced.

In this report we consider the prospect of a retail CBDC. We consider the varied policy objectives considered by central banks for their implementation of a possible retail CBDC. An essential component concerns the underlying technological design of the CBDC. Any prospective universal CBDC must function in all the venues and circumstances that cash currently does. Other permissioned CBDCs could be developed specifically for country-specific and policy-driven use cases.

The particular design of a CBDC – chiefly whether or not it bears interest – would determine its effectiveness as a monetary policy instrument and any consequential financial stability implications. Practically, the operation of a CBDC is likely to rely on some sort of public-private partnership. Central banks could outsource the distribution of the CBDC to private financial institutions, which could also be involved in the onboarding of users. Difficult questions of interoperability, regulatory demands and cross-border use must also be answered.

We hope readers will find much in this study to engage them and welcome comments, contributions and challenge. ■

Retail CBDCs take centre stage



Philip Middleton
Deputy Chairman
OMFIF

IN 2018'S OMFIF-IBM report on central bank digital currencies, we concluded that the most significant and imminent developments were likely to be seen in wholesale financial services, especially in uses based around stablecoin-backed electronic tokens. Although there have been encouraging initiatives in this field, progress has not been as spectacular as anticipated. Instead, the concept of retail CBDCs has moved rapidly from being the thought experiment of technical experts and philosophers to the subject of boardroom debates. When senior central bankers speculate publicly about the possibility of a universal digital currency, it is a happy endorsement of the timeliness of this latest report.

There are many reasons why retail CBDCs are taking centre stage and being exhaustively studied by an abundance of central banking and monetary policy institutions. The continuing decline in the use of cash in many developed countries and the growing costs and logistic difficulties of handling cash everywhere have spurred much pragmatic thinking about the ability of emergent technologies allied to digital currency – including but not limited to blockchain – to enhance materially the cost-effectiveness, resilience and security of both national and international payments infrastructures. The prospect of significant challenge to financial stability and to the dominance of national fiat currencies posed by potential currency issuance by non-bank private companies – global social media giants; telecommunications companies; technology specialists – has stimulated a great deal of new thought.

OMFIF has been delighted to work with IBM on this report that we hope makes a worthwhile contribution to the debate. We would like to take this opportunity to thank those central banks, industry participants, scholars and commentators who shared their expertise with us. ■

Public-private undertaking



Saket Sinha
Global Vice-President
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BEYOND THIS report's in-depth assessment of the various technological avenues down which central bank digital currencies could venture and the numerous monetary policy implications that such developments may raise, one element of particular interest concerns the relationship between the private and public sectors.

It was advances brought forward by private sector innovators that first impelled central bankers to examine more closely the opportunities offered (and threats posed) by financial technology. Public policy-makers are intrigued by how CBDCs could overcome weaknesses in retail payments systems. But they fear the potential loss of monetary control that the unregulated expansion of private digital currencies could present.

Through scores of experiments and ambitious pilot programmes, central banks and regulators around the world are becoming closely acquainted with digital currencies. Some, in both advanced and emerging economies, whose policy objectives and motivations differ markedly, will soon be in a position to launch their own retail CBDCs, as the findings of this report make clear.

When that happens, the private sector is all but certain to be invited into the fold. For all their expertise in monetary policy, there are some capabilities that central banks do not possess and have no desire to cultivate. As some respondents to our survey suggested, private companies could fulfil important intermediate services, including onboarding, customer-facing, security provisioning, and distribution functions.

Large banks and technology companies like IBM will undoubtedly have a major role to play in these new public-private partnerships, and we are very glad to have contributed to this essential piece of research. ■

THIS REPORT examines central bank approaches to and perceptions of retail central bank digital currencies. It explains issues and shortcomings in the existing monetary system that policy-makers are trying to resolve, and describes the use cases where CBDCs can be applied. The report illustrates central banks' preferred form of CBDCs, underlying technological requirements and practical considerations for implementation. Finally, the report addresses several policy and financial stability concerns emphasised by central bankers. The report findings were informed by 23 central banks, which participated in an OMFIF survey conducted between July-September 2019. The report presents a holistic picture of approaches to setting up a retail CBDC and offers guidance to institutions on how best to tackle the expected challenges.

Section 1

Context

ADVANCES IN financial technology are impelling central banks to react to emergent challenges from the private sector and address weaknesses in payments systems. Policy-makers are concerned about the potential loss of monetary control, and there is momentum in their institutions to examine the potential effects of introducing retail CBDCs.

Three major developments since the 2008 financial crisis have shaped the discourse on the nature of money. First, consumer distrust of financial institutions has grown dramatically. Second, trust in central banks has broadly declined in developed economies. Third, the use of cash continues to fall.

Private sector players are developing solutions to the shortfalls in the monetary system, and have proved flexible in tailoring their services to changes in consumer trends. These innovations in cross-border transfers, micropayments and new payment instrument offerings are profoundly affecting the way people pay, save and transfer value.

In response, central banks are reviewing national and international payment architectures. CBDCs have significant potential in upgrading incumbent centralised payments and settlement systems. In the retail sector, efficiency gains and policy benefits may accompany the uptake of a digital version of sovereign fiat currency – one that adopts and exceeds the technical benefits of a cryptocurrency, but inherits all the underlying trust of a sovereign currency.

Facebook's Libra has enlivened the CBDC debate. Policy-makers' implementation trials are producing positive results, and a handful of central banks are setting precedents by trialling fully-functioning digital currencies. Central banks say technology is less of a determinant for CBDC implementation; it is policy that should drive the decision to adopt a CBDC and specify the technology used.

Section 2

Rationales and use cases

CENTRAL BANK research into digital currencies is driven by a range of potential use cases, from maintaining competitive payments systems to enabling better anti-money laundering enforcement. Indeed, the former was ranked by central banks as by far the most significant factor motivating their efforts. Concerned about the decline of cash and parallel rise of private, decentralised digital currencies, central banks seek to maintain an open public means of payment.

Central banks raised many reasons for researching digital currencies, including financial inclusion, the potential of CBDCs for cross-border payments, and fostering trust in monetary authorities. Across all central banks in our sample, this latter point was identified as the second-most important reason, being mentioned by 69% of respondents. In the words of one respondent, people with a 'lack of trust in financial institutions' may be brought back into the fold 'if the retail CBDC can exhibit advantages in these areas'.

The use cases are variously applicable to disparate types of economies, the needs of a small island economy central bank being very different from those of a major advanced economy. Representatives of the former suggested that boosting seigniorage revenue was an important potential motivation for CBDC issuance, a view not shared by developed economy central banks.

There are several key policy objectives that central banks might consider when discussing CBDC implementation. Even the most practically holistic CBDC solution cannot achieve all these objectives concurrently. Central banks must be selective with their policy choices and use cases in which they employ CBDCs.

Section 3

Technology

CENTRAL BANK respondents report that there is an intimate link between the eventual design of a retail CBDC and the policy goals sought by its issuance, stating that it must be accessible, secure, convenient and operate for all transactions.

Among central banks, 64% prefer a value-based system to an account-based one. The remainder are either undecided, prefer an account-based system, or suggest a combination of the two. Additionally, central banks state CBDCs should be available offline and function wherever cash is currently used, with 73% of respondents requiring CBDCs to be available under all circumstances. More than 20% prefer decentralised systems to improve resilience.

Advances in enterprise-grade blockchain protocols are leading to greater resilience, scalability and transaction privacy. Scalability and higher speeds can be achieved through batching and sharding-based consensus mechanisms. Newer methods of introducing channels and separating smart contract execution, ordering and validation allow users to send transactions securely off-chain, facilitating near-instant, high-volume and fee-free payments. Security and verification are enhanced through validation processes using zero-knowledge proofs. However, CBDC designers face a trade-off between anonymity and supervision.

Smart contracts will facilitate 'programmable money' and can be used to execute liquidity savings mechanisms and enhance interoperability between systems. Potential interest-bearing CBDCs could charge negative rates and pay differentiated positive rates.

Although change will be gradual, the distributed ledger technology need not replace existing technologies or vendors. By exerting competitive pressure, DLT is already causing legacy solutions to evolve.

Section 4

Policy and implications

WHILE LAST year's OMFIF-IBM report on wholesale CBDCs concluded that there would be very few policy implications from their implementation, this report into retail CBDCs produced markedly different results. While central banks were careful to insist that the implications would depend on design choices, they were almost unanimous in their assertion that a retail digital currency would have far-reaching policy consequences.

The implementation of a retail CBDC could alter fundamentally the limits of conventional monetary policy by setting a firm lower bound on interest rates, should the CBDC be non-interest bearing. This would potentially weaken demand management capacity and curtail the influence of the current toolkit of unconventional monetary measures, including negative interest rates. An interest-bearing CBDC, on the other hand, would alter the composition of the overnight rates complex, changing the transmission mechanism of monetary policy. Respondents to our survey did not consider the latter to be an option worth pursuing.

Central banks expressed serious concern about the potential impact of a retail CBDC on financial stability, specifically around the likelihood of a 'digital bank run'. Respondents expressed further unease about the degree to which a CBDC would change the composition of bank funding; if the introduction of a digital currency resulted in a permanent reduction in retail commercial bank deposits, banks could face disintermediation. The Swedish Riksbank, for example, has estimated that the adoption of an e-krona could raise the cost of bank funding by up to 25 basis points.

The ultimate policy effects of a CBDC regime, however, would depend to some extent on the reaction of financial institutions, design choices and regulatory responses.

Section 5

Practicalities

THERE ARE several practical details that would accompany the implementation of a retail CBDC. We sought to identify how central banks envisioned such a scheme being managed and distributed. While much would depend on crucial design choices, central banks were almost unanimous in their view that third-party intermediaries would have to be involved for the system to run successfully, resulting in a kind of public-private partnership. This might involve contracting licensed wallets of similar platforms to share the CBDC, or using private sector participants to onboard users. Central banks highlighted the risks inherent in this approach: it may breed competition for deposits with private sector banks, for example.

Central banks also raised other practical questions, including regulatory queries emanating from possible CBDC implementation and prospects for cross-border interoperability. While central banks were broadly confident that regulatory changes from a CBDC would be manageable, respondents viewed the question of interoperability with more urgency: CBDCs would not be able to fulfil their potential absent cross-border use. Some central banks said they had already settled regional agreements for creating interoperability frameworks, but most continued to express concern that interoperability questions would impede progress on CBDC issuance.

Upheaval in retail payments systems



Advances in financial technology are compelling central banks to address weaknesses in the payments systems they regulate and manage, and react to challenges from the private sector. Policy-makers are concerned about the potential loss of monetary control, and there is momentum in their institutions to analyse and better understand the potential effects of introducing central bank digital currencies. A retail CBDC could provide an almost costless medium of exchange, a stable unit of account and secure store of value, all while maintaining the trust that sovereign issuers accord fiat currencies.

The proliferation of new technologies, modernisation of payments infrastructures and increasing number of fintech solutions offer new capabilities to consumers. The greatest changes have occurred in the front end of payments systems, where user experiences have changed significantly. Competition-driven innovations in cross-border transfers, micropayments and new payments instrument offerings are profoundly affecting the way people pay, save and transfer value.

Cryptocurrencies have challenged the traditional pillars of the financial system. Central banks are faced with the possibility of individuals being able to store, spend and move value en masse without relying on fiat currency. Policy-makers and regulators will not simply sit on the fence and watch as incumbent structures face these new threats.

Most central banks view cryptocurrencies not as money but as speculative assets, and regulators and governments are approaching them as such. Even in situations where cryptocurrencies are used like money, they represent a small fraction of the volume of fiat currencies in circulation and will remain the preoccupation of a minority of outsiders.

More recently, Facebook's Libra – a prospective privately-issued stablecoin that could challenge the traditional global reserve currency system – has enlivened the CBDC discourse. Some policy-makers' implementation trials have shown promise for their specific use cases, and a handful

‘The fragmentation of the payments landscape resulting from the issuance of (non-interoperable) “digital currencies” is a risk that we consider real. We are ready to take appropriate measures to prevent such developments if they were to threaten the effective exercise of our mandate.’
Advanced economy central bank

of central banks are setting precedents by attempting to establish fully-functioning retail CBDCs.

Central banks are responding to the reality that digital currencies, either privately or publicly issued, will soon be part of the global monetary system, and that it is in their interest to ensure they are neither left behind nor displaced.

Changing payments landscape

Three key developments since the 2008 financial crisis have shaped the discourse on the nature of money and the role of private and public institutions in its creation.

First, consumer distrust of major financial institutions has grown dramatically, as persistent scandals have ravaged the sector. According to analytics group Gallup, only 30% of Americans expressed confidence in banks in June 2018, down almost 30 percentage points from the 2004 peak.

Second, trust in central banks has broadly declined in developed economies. In the euro area, net trust in the European Central Bank has declined dramatically and is virtually in negative territory according to the Eurobarometer survey (though a significant majority of citizens express satisfaction with the euro itself).

Third, use of cash has declined precipitously in most advanced economies, and in some emerging markets as well. The ratio of cash in circulation to GDP has merely remained stable, if not fallen, in most developed countries, while the value of withdrawals from automated teller machines has similarly stagnated.

These three trends may appear contradictory at first. If trust in the traditional monetary system and commercial banks has fallen, why not rely on decentralised public money in the form of cash? Likewise, if faith in the state’s ability to protect the value of money has fallen, why not use privately issued monies, via commercial banks? In combination, these variables may help explain the emergence of various private monies (decentralised, permissionless cryptocurrencies) since the financial crisis. Permissioned alternatives

produced by financial institutions for wholesale use, such as JPMorgan’s JPM Coin and the UBS-led Utility Settlement Coin, have arisen largely in the name of efficiency gains.

These fit a line of thinking first sketched by economist Friedrich Hayek in the late 20th century around the ‘denationalisation of money’. Hayek purported that competition between currencies issued by private banks would ensure that only currencies guaranteeing a stable purchasing power would continue to exist, as alternatives that failed to do so would be driven out of business. As he might have assumed, competing and private (crypto)currencies have begun to emerge as confidence in governments’ ability to maintain purchasing power has fallen post-crisis and post-quantitative easing.

Yet these proposals contain inherent flaws, and the experience of cryptocurrency investors since 2015 has only raised problems. As Otmar Issing, chief economist at the ECB between 1998-2006, noted in remarks about Hayek in a 1999 ECB speech, non-sovereign currencies would probably result in an uncertain discovery process, a deterioration in coordination across the economy, and accelerating inflation through Gresham’s law, which states that ‘bad money drives out good’.

Trust in private alternatives is similarly frail, as the legacy of the crisis and the inability of cryptocurrencies to fulfil key functions of money – such as serving as a store of value – mean they have failed to take hold. Thus, citizens in developed economies increasingly find themselves without a universally reliable and stable means of payment, as public and private institutions alike have not fulfilled their responsibility to supply legal tender. This endangers payments systems in advanced economies.

It is a central task of government to provide adequate payments systems as they are uniquely public goods. Means of payment in contemporary economies are based on trust, are fundamentally non-rivalrous and produce benefits enjoyed simultaneously by all citizens. Facilitating and securing the

operation of payments systems is part of a central bank’s mandate, for good reason: a smoothly functioning payments system is critically important to the performance of an economy. Payments connect buyers and sellers, borrowers and lenders. The ability to make payments securely and irrevocably is fundamental to sustaining confidence in the financial system. The nature and form of the methods consumers use to transact have changed significantly, requiring central banks to remain alert to shifts in payments habits.

Opportunity for CBDCs

In response to these shifts and to changing consumer behaviours, central banks are reviewing national and international payments architectures.

There is significant potential for CBDCs to play a powerful role in upgrading incumbent centralised payments and settlements systems. Central banks should grasp the opportunities presented by emerging technologies.

CBDCs can be defined as a digitalised instrument issued by the central bank for payments and settlements. They can be described simply as an electronic extension of a form of cash. It is different from money held in central bank accounts, as the public may be able to access the CBDC, which remains a liability on the central bank balance sheet.

To date central banks have been unconcerned with the threat of being rendered obsolete by cryptocurrencies. In their view, privately-issued cryptocurrencies are not currencies, but crypto-assets. The usability thereof diminishes as they become speculative vehicles with volatile purchasing powers. CBDCs, denominated in an established fiat currency, could resolve these problems. The marginal costs for issuing such liabilities by central banks are low, since they are considered to be the most credit-worthy institutions in a country’s financial system.

In the retail sector, efficiency gains and policy benefits may accompany the uptake of a digital version of sovereign fiat currency – one that

adopts and exceeds the technical benefits of a cryptocurrency, while inheriting all the underlying trust of a sovereign currency.

Cash has distinct properties. It is legal tender, offers finality of settlement of debt and does not involve any counterparty risk. It also does not require parties to trust one another since access is permissionless, and transactions can be anonymous. It represents, in relative terms, the safest and most liquid means of payment within a jurisdiction's regulatory remit. A CBDC must exhibit the same properties.

There are two main models for providing CBDCs, those being account- and value-based. An account-based CBDC will furnish the public with access to direct accounts with the issuing central bank. A value-based one concerns the issuance of a digital currency or tokenised cash for which the prepaid value can be stored locally, such as on a card or electronic device.

Multiple forces may persuade a central bank to issue its own digital fiat currency. The growth of lightly regulated private money and monopolistic payments companies may engender risks for governments. A CBDC can increase government seigniorage – the revenue generated by monetary authorities through the process of money creation – in the face of declining use of cash by reducing the distribution and management costs thereof. These savings would be especially helpful for emerging markets, where low financial inclusion hinders growth. Since CBDCs can integrate national identity, they could reduce the cost of remittance by alleviating concerns about money laundering and terrorist financing. These improvements in the reach and stability of money, along with potential digital features that enable negative interest rates and smart contracts, could dramatically enhance monetary policy implementation.

Policy-makers must make the most of the opportunities offered by technological innovation while bearing in mind related risks. The flashiest innovations are not always the most promising. Facebook's Libra, for example, has generated concern for central banks and public policy-makers as it attempts to officiate a new global reserve currency for domestic and cross-border payments.

The Libra announcement highlights the opportunity available to central banks to address the failures in existing payments

'A material change could occur in market structure and stakeholder profile as a result of which bank deposits in the domestic currency and a domestically controlled payments system are no longer dominant. A CBDC could function as a "safety valve" in case of developments in the payments system that reduce the central bank's room to perform its tasks.'
Advanced economy central bank

systems for consumers, understand how digital currencies may address these shortcomings, and take the initiative to deliver their own digital currencies. Policy-makers are tasked with protecting the sovereignty of the monetary system and preventing a key part of the future of payments from being appropriated by a small number of global corporations that may be incentivised to establish their own 'profit-maximising and control' agendas.

Regulatory response to Libra

Regulators have pointed out that Libra is effectively a pooled investment vehicle similar to an exchange-traded fund. Securities disclosure requirements could help the market supervise the programme sponsor, Calibra, while identification requirements would address anti-money laundering and know-your-customer concerns. Libra must abide at least by current controls, and it is unclear to what extent payer and payee data will be trapped and used by Facebook or Calibra members.

However, since the Libra system requires deposit taking, earning interest, issuing tokens and investing in interest-bearing activities, some suggest it should be regulated like a bank. Moreover, the network effects that Facebook and cofounders hope will increase financial inclusion may exacerbate financial stability concerns.

The Bank for International Settlements has acknowledged the benefits of fintech in enhancing efficiency and financial inclusion, but has specified that regulators must level the playing field between big technology companies and banks, taking into account the former's wider customer base, their access to information and broader business models.

US regulators have expressed the most concern, particularly in the light of Facebook's data privacy issues. Requests have been made of Facebook to halt developments until the US congress and regulators have had the opportunity to examine these issues. Russia's

regulators will not legalise the use of Libra and are researching their own potential gold-backed digital currency. The ECB and Reserve Bank of Australia have also voiced scepticism about the scheme.

Bank of England Governor Mark Carney has been more enthusiastic. He has said that Libra has some genuine use cases, especially in lowering transaction costs and improving financial inclusion, as long as it conforms to regulatory demands. In a speech at the Jackson Hole economic symposium in August, Carney challenged the dollar's position as the world's reserve currency, arguing that a digital alternative could replace it. However, he has also highlighted the policy and regulatory issues with Libra, and suggested that a publicly-issued version could lead to better outcomes through a network of CBDCs. In mid-October, several Libra payments partners pulled out, as the project drew further scrutiny from US regulators and politicians.

Bridging the payments gap

Private sector players are developing solutions to the shortfalls in the monetary system, particularly in respect of digital mobile payments in emerging markets. They have proved flexible in tailoring their services to changes in consumers' behavioural trends. Visa's new service, Visa Direct, is one such example. Using VisaNet, the world's largest payments network, the service promises global real-time push payments.

Advances in private money in the digital sphere are especially significant. According to the ECB, a virtual currency can be defined as a 'type of unregulated, digital money, which is issued and is usually controlled by its developers, and is used and accepted among the members of a specific virtual community.' The US Treasury defines them as a 'medium of exchange that operates like a currency in some environments, but does not have all the attributes of a real currency.'

While it is true that cryptocurrencies are



Libra

backed merely by trust in the issuing party, a genuine, privately-issued digital currency could have greater monetary attributes if it served as a digital representation of an asset. It can be denominated in sovereign currency or government-backed assets and be issued by an institution that enables redemption of the digital currency into cash at any time. Therefore, digital currency is a form of electronic money. It is monetary value that is privately issued, and it is stored electronically on receipt of funds. Such money can be stored on cards, devices or on a server. Examples include pre-paid cards, electronic purses such as M-Pesa in Kenya, or web-based services like PayPal.

A key difference to commercial bank money is that their redemption is not backed by the government. Instead, they rely on prudent management and legal protection of assets available for redemption and transfers are usually centralised.

Fintech companies have sought to build on these projects, designing affordable products and services to promote digital savings, lending and investments to unbanked customers, often in collaboration with existing payments service providers. Some of these products and services include online payments platforms, mobile banking services, quick response codes, money transfer services, deployment of point-of-sale devices, termination of inward remittances into mobile wallets, and agency banking. More recently, mobile money processes have been integrated with the interbank payments systems infrastructure.

Mobile money is the fastest growing source of income for wireless-network operators like MTN and Vodafone's Safaricom unit. As a region, sub-Saharan Africa has the most mobile-money accounts globally, with 396m registered users. A service that allows people to withdraw or deposit cash by text has become indispensable in Africa. With many ATMs and bank branches out of reach or too costly to access and operate, kiosks – which service mobile money ledgers – are bridging the gap.

In China, the use of mobile payments has grown exponentially over the past five years. The People's Bank of China reported a 36-fold increase in the volume of mobile transactions between 2013-18, to 61bn from 1.7bn. China's two dominant mobile payments platforms, Alipay and WeChat Pay, account for 93% of

FACEBOOK announced Libra on 18 June 2019. As described in its whitepaper, Libra's aim is to 'enable a simple global currency and financial infrastructure that empowers billions of people'.

The coin's value will be stabilised through the backing of a reserve of real assets comprised of a basket of bank deposits and short-term government securities. The basket of currencies to which Libra's value will be tethered is much like the International Monetary Fund's special drawing right, based on five global reserve currencies: the dollar, euro, renminbi, yen and pound.

With this reserve of assets, Facebook says it will create a coin which is a 'global, digitally native currency that brings together the key attributes of the world's best currencies: stability, low inflation, wide global acceptance, and fungibility.'

It is possible, since Libra is tied to major stable currencies, that it will qualify as a store of value, allowing it to be a haven from inflation. As it would be borderless, Facebook hopes Libra can increase financial inclusion in economies where there is little or no access to a stable store of value. This would endow Libra with the qualities of being a medium of exchange and unit of account. However, the currency presents risks to financial stability and is currently untenable from a regulatory perspective.

According to the policy trilemma, an economy can only exhibit two of the following positions at any given time: the free flow of capital; a fixed exchange rate; and independent monetary policy. When capital flows freely, it is not possible for developing economies to maintain fixed exchange rates and low inflation over the course of an economic cycle.

Developing economies have relatively lower capital bases and are attractive to international investors looking for short-term returns. This money supply is procyclical and attracted to low wages and natural resources. So low interest rates in the developed world lead to higher capital flows towards and credit booms in the developing world. As inflation is high and convertibility options are low, people from these countries would be most likely to want to use Libra. Free flow of Libra would decrease domestic money demand relative to the money supply and boost inflation by reducing the demand for the local currency. This cycle would gradually decrease the effectiveness of the central bank's operations in the domestic currency.

Additionally, during the initial buy-in of Libra, non-Libra reserve currency holders, especially those with volatile domestic currencies, will encounter continual weakening of their domestic currencies against Libra. It would be increasingly expensive for those people having to frequently purchase Libra to carry out daily transactions on Facebook's platform.

Facebook intends to build Libra on a blockchain, although it will be permissioned. While a permissionless blockchain is purely decentralised with no central authority to edit the ledger or change the rules of the game, a permissioned system will be closed. The Libra blockchain will be managed by the Libra Association (a Swiss foundation), comprising a number of large global corporations working with some smaller technology companies. They will be able to decide the system's level of decentralisation, transparency, anonymity and governance. Libra's whitepaper states the blockchain will become more permissionless within five years.

Holders of Libra will have only a non-secured claim to exchange their Libra for domestic fiat currency at a value reflecting the value of assets of its reserve. Users will not have a direct claim on the reserve; if the reserve were to be liquidated, users will lose out.

Lastly, as Libra is a private currency, large governments may become answerable if it at some point becomes unconvertible to fiat money and the entire system loses stability.

As with Greece during the euro area crisis, the inability of sovereigns to add liquidity back into the financial system can ravage the economy. If Libra were to reach wide-scale adoption in some jurisdictions and experience a run, the sovereigns whose assets make up the Libra reserve would face the choice of allowing the system to collapse or offering a bail-out. However, since developed countries bear the supervisory burden, while the benefits of the store of value and medium of exchange accrue to developing nations, it is unclear whether a positive outcome is, on balance, possible.

these transactions. Their ubiquity, ease of use and convenience, coupled with their integration with other in-app services, has established them as key players in the Chinese payments system.

The hierarchy of money

It is important to define the convention of currency (or money, used interchangeably) and the payments systems in which it operates. In some cases these are not mutually exclusive – cash is money, but its method of payment is intrinsic, coming through its physical exchange.

A currency must satisfy the criteria of being: a medium of exchange, where it is universally accepted for payment of goods and services; a unit of account, which provides a standard monetary unit of measurement of value or cost for goods, services or an asset; and a store of value, where it holds a certain level of purchasing power over a period of time.

Money exists in many forms and its value can be created and maintained in different ways. Fiat money for example is an obligation, and trust plays a crucial role in underpinning its value, while the value of commodity money is intrinsic. There are many different forms of money in a system with different issuers. It can be publicly issued by the central bank or created privately, most commonly existing through commercial bank deposits.

Payments systems differ from money as they are a means to which this value is transferred. A payment is therefore a transfer of funds that discharges an obligation on the part of a payer with a payee. Traditionally

such a system consists of a complete set of instruments, intermediaries, rules, procedures, processes and interbank fund transfer systems that enables the circulation of money in a particular jurisdiction. The infrastructure that underpins these processes, such as real-time gross settlement, has changed significantly over the past few decades. A wholesale CBDC supported by blockchain has the potential to overhaul current frameworks by removing some intermediary processes and adding greater functionality.

The different forms of money and payments systems are distinctly hierarchical. Only some forms of money have legal tender status, while others are merely convertible into legal tender: cash is the former, convertible bank deposits the latter. Shares in a money market mutual fund, while nominally equivalent to 'deposits', are far down in the hierarchy of money, as they are subject to liquidity risk and their convertibility into cash is more uncertain.

Public access to cash – the top of the hierarchy – is at risk, given the gradual disappearance of the requisite management and distribution infrastructure in advanced economies. Nascent forms of money, such as digital currencies or cryptocurrencies, are plagued by uncertainty about their 'moneyness', or the ease with which they can be converted into legal tender.

In issuing a CBDC, central banks across the world have the ability to guarantee digital access to the top of the hierarchy. This would provide to the public a digital, cash-like asset that would circumvent the convertibility and credibility concerns of other money-like assets.

Despite an increase in electronic options over the past few years, cash remained the most widely used form of payment globally in 2018 according to G4S's 'World Cash Report'. Habits differ between regions: cash accounts for 80% of point-of-sale transactions in Europe, but only 31% in North America. Despite the ecommerce boom in Asia, cash still plays a major role in online transactions, where more than 75% of online purchases are paid for in cash on delivery.

Cash falls under the sovereign's remit and is generally issued by a country's central bank, or in other cases by monetary authorities. Its value is underpinned by both a legal and technical structure. It is legal tender, meaning it is lawfully recognised as valid for meeting a financial obligation, especially taxation by the sovereign.

Cash forms part of the central bank's balance sheet liabilities and is considered to be 'in circulation', either held by commercial banks in vaults or ATMs, or held privately by the population. Cash enters circulation through commercial banks, which draw on banknotes in exchange for reserve balances held at the central bank. The general population obtains cash via direct withdrawals from commercial banks in exchange for a reduction in their commercial bank deposits.

Cash as a means of payment is limited by its physical properties: both parties to a transaction must be present to confirm payment and settlement. Cash must be stored (which bears costs), there is risk of counterfeit, and it is impractical for high-value purchases. Additionally, cash is used less in developed places and more in poorer ones – the paradox being it is cheaper to distribute cash in developed locales given their economies of scale in distribution and management costs, despite low demand, while in poor places it is expensive and demand for cash is higher due to lower financial inclusion rates.

Yet cash has crucial benefits. Transactions happen in real time, with delivery and payment occurring simultaneously. There is also less ambiguity with confirming settlement finality or which leg of the transaction occurred first. It does not rely on any digital infrastructure and therefore is not subject to any outages causing non-availability of services. This is particularly important for rural populations, who may not have adequate access to digitalised payments infrastructure.

Commercial bank deposits make up most of money by value in an economy. It is different to central bank money as it is an obligation denominated in the sovereign currency that exists as a liability on commercial banks' balance sheets. It is generated by bank lending and the creation of deposits in customer accounts. Depositors can then claim this liability for the purpose of either payment, transfer or withdrawal into central bank money.

Commercial bank money is accessed for payments through deposit holder requests. These requests that initialise bank transfers can be authenticated through, for example, debit cards, mobile payments applications or in person with proof of identification. When consumers make a payment to another agent (such as a retailer), their respective commercial banks settle these transactions against each other through the wholesale

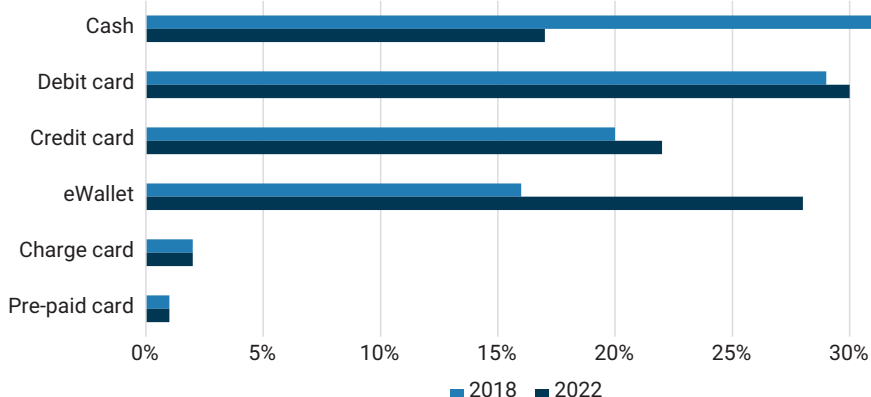


61bn

The number of mobile payments transactions reported by the People's Bank of China in 2018, up from 1.7bn in 2013

Cash use expected to decline as eWallets preferred

Share of global point-of-sale payment methods, %, 2018 v. 2022 forecasted



Source: Worldpay, OMFIF analysis

payments system, in some cases via central bank reserves. Commercial bank deposits are not backed one-to-one with central bank money, although they are convertible at par.

People and businesses continue to trust commercial bank money for their regular economic activity. Partnering with regulated payments service providers and technology companies, such as Visa and Mastercard, facilitates easier electronic payments and settlement of commercial bank money given the ubiquity of their point-of-sale systems among merchants and small retail businesses. Card transactions will continue to dominate point-of-sale transactions.

In addition, commercial banks are regulated and supervised by their respective country's financial stability authority and central bank. Deposit insurance and guarantee schemes ensure additional protection for deposit holders, and the central bank's role as lender of last resort extends credit to these institutions in the interbank market during times of illiquidity.

Trust in sovereign currencies

Technology companies treat Facebook's old mantra, 'Move fast and break things', as a call to arms as they go about disrupting traditional industries, such as banking.

Privately-issued money is neither new nor rare. Banks create private money, including commercial paper, bankers' acceptances, bills of exchange, and sale and repurchase agreements. There have been more than 60 cases of notes issued by private banks and backed by loans and bonds.

The risk with private money, however, is that people may lose trust and question the value of their money. The classic image of a 'run on

the bank' by people to claim safe government money was translated to the digital age when people started questioning the value of repos and rushed into US Treasuries. Such runs are costly. During historical episodes of financial crisis, policy uncertainty rose strongly, polarisation intensified, and government majorities shrank as the vote share of far-right parties increased by 30% on average. This is why deposit insurance exists – to make bank debt insensitive to information about the bank as their deposits are protected.

One can argue that publicly-issued money, specifically cash, is the most trusted form of money. This is most visible during crisis times – when customers and investors shift money into liquidity and risk-free assets, cash is often the general population's first choice. As such, demand for sovereign paper currency in times of financial instability produces a sustained need for public access to cash.

The degree of convertibility of other forms of currency into fiat sovereign currency – their position in the hierarchy of money – adds to their trustworthiness and enhances their use. In the real world it remains difficult to transact in other forms of currencies, such as for cryptocurrencies that fail to act as a unit of account as they carry their own unique denomination. Sovereign currency is still required to purchase goods, especially for high-value goods such as property, as well as a means to pay taxes. Additionally, the tendency of users (usually speculators) to reference a cryptocurrency's value in terms of sovereign currencies, into which they ultimately convert as they 'cash-out' of the market, underlines how important sovereign currencies remain to these alternatives.

Yet the trust that people place in a banknote is merely a reflection of their trust in the issuing sovereign. This is evident from the adoption from Argentina to Zimbabwe of the dollar during currency crises. People in those countries placed trust in the US currency to maintain its purchasing power and operate as a medium of exchange while their own experienced hyperinflation.

Regulations and laws underpin the use of sovereign currency for certain transactions, such as those in financial markets in the contracts enforcing trade and in insolvency frameworks. Furthermore, institutional investors are mandated to buy sovereign currency-denominated assets, government fiscal expenditures are underwritten by sovereign currency-denominated public bonds, and the banking sector is greased by interbank lending of central bank money. This in turn supports the distribution of sovereign-denominated money to the wider population.

Because CBDCs would inherit trust from their sovereign issuers, credit risk would be removed and stability of value provided. This is crucial if a CBDC is to act as medium of exchange and store of value. Liquidity risk would be removed, as the central bank could issue new CBDC through the traditional means of purchasing securities to increase the money supply. This contrasts to private digital currencies, where liquidity cannot be injected unless the underlying asset is purchased. In the case of Libra, this could be an issue if its underlying basket incurs supply shortage or becomes negative or zero yielding.

Blockchain has become increasingly prominent as the underlying technology featured in CBDC trials. One question put forward frequently by central banks is whether this technology is truly a disruptive innovation, or just a solution looking for a problem. Central banks are at the forefront of testing these new technologies. There have been successful experiments with wholesale systems, and, more recently, central bank trials for high-volume, low-value retail payments have shown positive results.

However, central banks state that technology is less of a determinant for CBDC implementation; it is policy that should drive the decision for CBDC adoption and specify the technology used. Technology should not determine the use cases for CBDCs. These motivations will be explored in the next section, which uses our survey to outline the policy objectives highlighted by central banks. ■

Policy objectives dictate CBDC use cases



The use cases identified by central banks as important to their research reflect the tension between private and public development of digital currencies. As the previous section outlined, there is growing concern around the privatisation of payments systems, in addition to other, secular trends such as the declining use of cash in advanced economies.

The use cases are often country specific, as payments infrastructure efficiency, cash usage and financial inclusion rates differ. As such, the technical design of a CBDC is particularly significant, as will be addressed in the next section.

Central bank mandates also influence the development and issuance of possible CBDCs. While there are central banks tasked with providing legal tender to the public, others, such as Norges Bank, have a specific obligation to issue banknotes and coins. The specific mandate of each central bank will determine whether and how they issue CBDCs. This section examines the rationales for central bank development of a CBDC.

Maintaining competitive and efficient payments markets

At present, cash is the only universally accessible public money. Alternative forms, such as bank deposits or cryptocurrencies, rely on private infrastructures in some shape or form.

Yet the popularity of cash is declining. Consumers are shifting towards digital payment methods, most prominently card payments, as cash is considered less convenient and safe than its digital counterparts. Additionally, governments' seigniorage has experienced a secular decline attributed to a fall in global real interest rates.

Many governments are likely to reach a point at which the issuance, distribution and acceptance of cash becomes uneconomical, for monetary authorities and retailers respectively. This may result, eventually, in the widespread phasing out of cash and the infrastructure required to sustain it, leaving

Sweden



IN APRIL 2019, the Riksbank submitted a proposal to the Swedish parliament suggesting that a group of experts from different fields review the role and importance of legal tender (central bank money) in the Swedish economy.

Cash use in Sweden has declined significantly over the past decade, leading to concerns about access to state-backed money and the safety and efficiency of the domestic payments system. In response, the Riksbank launched in 2017 its e-krona project, intended to evaluate the possibility of granting public access to a digital equivalent of cash. Initial reports concluded that the central bank has a clear mandate to issue a retail digital currency; further study has delineated the precise legal standing of a CBDC in the Swedish system. Riksbank reports on the e-krona have elaborated on how to straddle the difficult line between anonymity, public backing and compliance with anti-money laundering and combating-the-financing-of-terrorism legislation. They note that the possibility for anonymous payments is largely dependent

on developments at the European Union level.

The next steps include mapping out in greater detail potential implications (especially for monetary policy and financial stability) and collaborating with Swedish political authorities. However, as noted in this report and in the Riksbank's two e-krona studies, the consequences of digital cash issuance are largely design-dependent. For instance, whether a CBDC is interest-bearing will decide the extent of its impact on monetary policy.

The Riksbank case highlights the needs of developed market economies that are considering CBDCs. These demands typically revolve around the decline of cash, as well as a desire to maintain public access to state money and maximise the efficiency of domestic payments. It underscores the need for careful design selection, and the inevitable interconnectedness of global CBDC issuance, as interoperability and regulatory cohesion depend on international co-operation.

households and businesses without an alternative to the use of private money and the payments systems with which it is associated. In the words of one central bank, this could lead to the 'fragmentation of the payments landscape and entrenchment of market power'.

This is best exemplified by the dominance of WeChat Pay and Alipay in China. This mobile payments market is worth \$5.7tn, roughly 50 times greater than its US counterpart. The entrenchment of these two players has come about as cash has become an increasingly unpopular means of payment. At the same time, it raises concerns about competitiveness in the Chinese payments sphere. In the summer of 2018, the PBoC determined it was illegal for a merchant to refuse payment in renminbi notes or coins, which at the time was regarded as a move to limit the power of Alipay and WeChat Pay.

Without cash providing an important competitive alternative to private money, the likelihood of oligopolistic structures emerging in advanced economy payments system markets would rise significantly. Ensuring continued competitiveness in these critical markets is a key motivation for the central banks that are trialling or designing a CBDC: 69% of respondents to our survey highlighted 'providing an alternative to cash and other payment instruments' as their main motivation.

A CBDC designed to resemble cash in most respects could serve a critical function in

future payments landscapes. One emerging market central bank survey respondent stated explicitly that their aim is 'ensuring that the payment market remains competitive in a sustainable manner'. Maintaining widespread access to a public, central bank-backed payments instrument in the absence of cash and its infrastructure should be a priority for policy-makers. This appears to be by far the most important rationale identified by the central banks we surveyed and would probably be the most simple and persuasive case to make to stakeholders.

Ensuring systemic resilience

Contemporary payments systems are designed to be resilient. Their decentralised nature and independence from other systems of cash leave them well placed to withstand shocks. Thus, an additional consequence of the gradual decline in cash usage is the disappearance of a virtually indestructible, decentralised and intuitive payments system; a cash-like CBDC may be able to take the place of public paper money in the future. Among respondents to our survey, 29% mentioned 'resilience' or 'financial stability' among their rationales for exploring the development of a CBDC.

There are two dimensions to the systemic stability issue. First, the disappearance of genuinely public money may undermine financial stability itself. In the words of one central bank, 'Access to a risk-free, universally accepted, instant settlement payment

instrument is an important component of the financial safety net... [and] especially important for promoting confidence during a crisis.' The lack of such an instrument would undermine confidence in the stability of the financial system, an effect which could be dangerously exacerbated during crisis times, when private, commercial institutions may find their ability to convert deposits at par is under pressure.

Even if the use of cash remains widespread, a CBDC would provide a powerful buttress for systemic resilience. It could serve as a backup to other, existing systems, should it be designed in a secure and decentralised manner (though this may, to some degree, impede ease of use). One central bank respondent underscored the importance of this function, noting that 'a CBDC could function as a contingency solution in case of failures in bank payments systems... [this] may grow in importance if payment infrastructure becomes increasingly internationalised.'

Second, digital cash would assist in the transmission of financial stability policy. Several central banks highlighted that they were concerned about the adoption of private, decentralised digital currencies as an alternative to existing forms of money. The widespread adoption of these alternatives 'will erode the central bank's ability to conduct... financial stability policy,' one respondent noted. As such, the provision of a credible, digital public alternative would allow for the continued and smooth transmission of central bank financial stability policy, rather than

furthering the fragmentation of the payments system.

Cost efficiencies

Although developing a CBDC would inevitably involve high costs, the resultant efficiency gains would probably far outweigh the expense.

As one central bank noted, 'If a [retail] CBDC is implemented the cost will be lower compared to cash management.' The cost of issuing and distributing paper money is steep and has risen continuously in some jurisdictions, such as the US. Meanwhile, in smaller economies, issuing and distributing paper money has always been expensive on a per-capita basis (part of the reason some, such as the Marshall Islands, have chosen to

dollarise). Reducing these costs is one of the key benefits of a potential CBDC. Estimates for the euro area and Canada suggest the total cost of cash distribution and maintenance is around 5% of GDP. A CBDC could diminish this, though the cost of new cybersecurity requirements would have to be weighed against this.

Cash levies similar burdens for the private sector. Retailers must keep a certain amount of cash in-house for everyday transactions. This must be securely stored to protect it from theft, and some must be regularly transported to or from a bank. Lastly, private agents that use cash must first withdraw it from an ATM or bank branch, which requires time for travel and possibly withdrawal fees.

CBDCs can also reduce costs through the

provision of 24/7 access to payments with instant final settlement. This would remove the counterparty risk associated with many transactions and release a significant amount of collateral. Many economies have already set up similar, around-the-clock payments systems. However, for countries yet to do so, this may be another motivation for issuing a CBDC.

This point makes particularly glaring the discrepancy in rationales between emerging and advanced economy central banks. For the latter, there is limited marginal utility in adding to existing instant payments systems (such as the euro area's Target Instant Payment Settlement), while front-end private sector options, such as Apple Pay, are proving satisfactory. Hence, for some advanced economies, there is limited utility in using many resources to increase only marginally the efficiency of payments.

However, for emerging economies the implementation of CBDCs would allow for far greater improvements. In the words of the director general of the Cambodian central bank, Serey Chea, the use of DLT and possibly the issuance of a CBDC 'opens the window for experimentation to improve (the system) and potentially leapfrog traditional wholesale interbank processes', which currently are neither efficient nor widely used. The importance of the use case depends on the existing development of payments systems in relevant countries, and the extent to which consumers and other front-end users are satisfied with available options.

Fighting financial crime

Issues around money laundering and terrorist financing have been central to digital currency debates.

In developing countries, central banks are considering CBDC as a means to stem the flooding of forged paper currency into their economy. India, for example, has demonetised certain values of paper currency.

Since anonymity is their central feature, how could regulators and authorities track transactions to ensure their legality and authenticity? Such questions arise in spite of the presence in most jurisdictions of strict anti-money laundering and combating-the-financing-of-terrorism rules. For example, the EU's Fifth Money Laundering Directive

Need for speed

A SIGNIFICANT change since the introduction of real-time gross settlement systems in the 1980s is the arrival of faster systems for retail payments. These include those systems that, per the Committee on Payments and Market Infrastructures at the Bank for International Settlements, provide retail funds transfer in which the transmission of the payment message and the availability of final funds to the payee occur in real- or near-time on a 24/7 or almost around-the-clock basis.

These are open systems in which end-users can utilise any number of intermediaries, such as payments service providers and banks, to access the payments system. Monzo and Revolut, two digital banks, and TransferWise, a borderless e-money account provider, are examples of new institutions taking advantage of the UK's Faster Payments Service.

These systems require immediate clearing between payments service providers of the payer and payee, but the settlement of funds between providers does not necessarily have to occur immediately for every payment. Payee funds' availability and interprovider settlement can occur either through real-time or deferred settlement.

In real-time settlement the debiting and crediting of funds from the payer to the

payee occur at the same time as the debiting and credit of the respective payments service providers. Credit risk is removed, but providers are required at all times to hold sufficient liquidity to settle in real time. Examples of such systems include Mexico's Sistema de Pagos Electrónicos Interbancarios and Sweden's Swish and Bankgirot programmes.

A deferred system works by batching and executing the associated settlements of the payments service providers at a specified time while still allowing for real-time debiting and crediting for the payer and payee. In this model, credit risk arises for the providers, as they would advance funds to the payee before interprovider settlement takes place. The UK's Faster Payments Service and India's Immediate Payment Service are examples of a deferred model.

Emerging markets have been early adopters of faster payments systems. These countries lack mature legacy retail payments systems and so the marginal benefit of adoption is likely to be higher and the decision to invest may be easier in the absence of well-established infrastructures. DLT holds promise in changing wholesale systems, as discussed in OMFIF's 2018 report with IBM entitled 'Central Bank Digital Currencies', which may enable countries to leapfrog faster payments systems.

Cambodia



ACCORDING to the World Bank, just 22% of Cambodians have a bank or mobile money account. The National Bank of Cambodia is using blockchain technology in an experiment to upgrade its payments infrastructure. It already employs its National Clearing House, as well as the Fast and Secure Transfer payments system and domestic card payments for its retail payments. The objectives of the central bank's new Bakong system include improving payments efficiency, promoting financial inclusion and creating interoperability across payments channels.

Bakong is a peer-to-peer fund transfer service available to retail customers of participating banks. It will facilitate money transfers and payments (including across national borders), targeting the unbanked and rural areas especially.

The pilot programme, launched in July 2019, sets a foundation for

real-time retail payments, allowing transfers in local currency and the dollar, and connects financial intermediaries and payments providers. This mitigates fragmentation, and therefore inefficiency, in the payments market. The programme will enable participants (intermediaries, payments service providers) to service end-users directly, therefore enabling customers to make transactions through the generic Bakong app or through a participant's app. Currently, four institutions are participating – Acleda Bank, Foreign Trade Bank, Wing Specialised Bank, and Vattanac Bank.

Separately, in February 2019, the central banks of Cambodia and Thailand signed a memorandum of understanding to create a payments system based on quick response codes, with the aim of facilitating cross-border exchanges in local currencies.

builds on the strengths of its predecessor by enhancing access to information powers and bolstering transparency around ownership information and trusts.

Most survey respondents believe CBDCs would enhance governments' and central banks' ability to enforce these regulatory frameworks. Several respondents noted that a CBDC would improve their capacity to perform anti-money laundering checks. In the words of one central bank, 'A CBDC can help improve on anti-money laundering enforcement compared to cash.' Several noted that they assumed a CBDC would be required to meet the same stringent demands as private sector payments providers.

Crucially, this capacity would depend on design and implementation choices. If the CBDC takes a token-based form, with truly cash-like offline payments access, transactions would be more difficult to trace. As such, offline payments necessarily involve some degree of risk. If neither user has a functioning network connection, it would not be possible to check the transaction in real time to, say, prevent double spending.

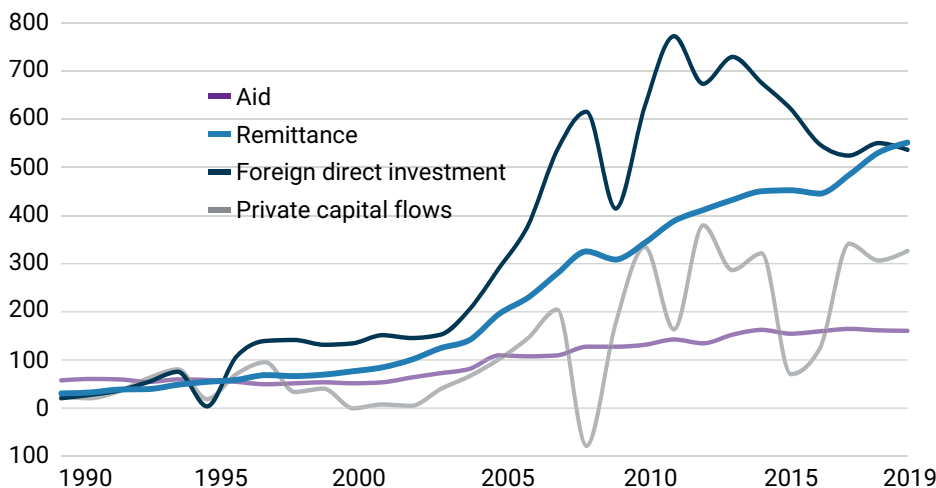
However, there are regulations that would credibly balance this offline functionality and anonymity with traceability, which is fundamentally required by European money laundering directives. Existing rules governing card payments, for example, can be used to

limit risk from offline payments. Similarly, respondents suggested it would be possible to create third-party anonymity while ensuring that the movement of money could be tracked if necessary. One idea floated by a respondent was that CBDC transaction records could be stored with the central bank and anonymity could be lifted through the decision of a court if sufficient evidence of suspicious activity were presented. One respondent summarised their philosophy on this, noting that 'it is necessary to balance the potential need for a private payment instrument with anti-money laundering requirements'.

In a broader sense, replacing truly anonymous, untraceable cash with a cash-like CBDC, which might be traceable in the event of reasonable suspicion of criminal activity, would empower regulators and authorities to perform anti-money laundering and combatting-the-financing-of-terrorism duties. This would strike an important and delicate balance between user integrity, anonymous payments and traceability. This is a critical use case for potential digital currencies.

Remittances largest inflow of capital to emerging economies

Annual capital flows to emerging markets, \$bn



Source: World Bank, International Monetary Fund, Financial Times

Cross-border payments and remittances

Over the past two decades, domestic retail payments in economies across the globe have become more rapid and efficient, with many countries providing 24/7 payments with minimal settlement time. The picture is bleaker for cross-border payments, which remain cumbersome, expensive and slow. The development of CBDCs in different jurisdictions may ameliorate this, as 62% of our survey respondents noted.

Interoperability of CBDCs between different jurisdictions could yield significant efficiency gains, for instance by reducing reliance on costly correspondent banking networks and pre-funded nostro and vostro accounts. The transfer of remittances is a case in point. According to the World Bank, global remittances were valued at \$689bn in 2018, the largest type of person-to-person cross-border retail payment. More than three-quarters of total remittances went to low- and middle-income countries, representing a substantial source of revenue. In some countries, such as Haiti and Kyrgyzstan, remittance inflows make up more than 30% of GDP.

Currently, retail cross-border payments such as remittances go through banks or slow money transfer services like Western Union or MoneyGram that charge high fees, using Swift messaging. Swift benefits from

‘Our research shows that, in the long term, efficiency gains exist for cross-border payments provided that our CBDC would be interchangeable with other forms of electronic money. These new “rails” would reduce the reliance on correspondent banks.’
Emerging market central bank

its network, scale and reliability, but still uses correspondent banking networks, which derisking has weakened.

Since the financial crisis, banks have been reducing the number of their correspondent networks. This squeezes efficiency in cross-border payments. Money transfer organisations subsequently face greater costs, which carry through to the customer. There are concerns that derisking has fostered the creation of new, informal channels through which money is flowing.

A CBDC would lower costs and reduce significantly the number of intermediaries involved. Payments into a country using a CBDC would go from the payer’s account or wallet to the central bank of the receiving country and then directly to the payee or directly to payees’ wallets if it were peer-to-peer, without having to go through a network of commercial banks. If both countries were to issue an interoperable CBDC, payments would only need an exchange market to function across borders.

Increasing the number of cross-border payments systems could fortify financial stability by creating multiple levels of redundancies. Any form of failure of one payments system would not be harmful to the others.

However, there are several preconditions and steep obstacles to achieving this interoperability and to improving the flow of money across borders using a CBDC. These fall into three broad categories: legal and regulatory barriers, technological incongruities, and monetary risks.

First, a divergence in regulatory strategies in different jurisdictions may impede a CBDC’s ability to improve cross-border payments. For instance, the transfer of a CBDC between two countries would require the currency to comply with the legal requirements (such as money laundering, terrorist financing, and others) of both, which may vary dramatically. Achieving smoother cross-border transfers would require significant harmonisation across various legal and regulatory domains.

Second, technical variables such as different blockchain standards and applications may reduce the efficiency of CBDCs across borders. Underlying blockchain systems would have to be interoperable, which may not be the case without harmonisation in design and implementation. As one respondent noted, ‘Considering this is a new technology, it may take some time for standards to emerge.’ Similarly, the presence of legacy systems and infrastructures

Bahamas

IN MARCH 2019, the Central Bank of The Bahamas announced ‘Project Sand Dollar’, a pilot programme for a blockchain-based CBDC. Its purpose is to modernise and streamline the country’s financial system, reduce service delivery costs, increase transactional efficiency and improve financial inclusion.

The CBDC solution will be paired with a national identity system and nationwide roll out of point-of-sale systems to all businesses.

The digital currency is intended to complement existing banking services and is likely to be used in remote communities to establish and maintain deposit accounts, among other services. Funds stored in central bank wallets will not bear interest. However, the bank is exploring plans that would allow mobile wallet holders to invest in government securities. The central bank intends to impose a ceiling on how much digital currency could be maintained in mobile wallets.

The CBDC would be available for use across all payments platforms and within the existing or proposed wallets of private services providers and financial institutions. Its use will extend to any product developed by regulated private wallet providers. The central bank is expected to eventually play a diminished role in providing front-end solutions and focus on maintaining the digital ledger for the currency.

At the policy level, the bank is putting emphasis on a cyber-resilient system that would uphold financial stability and maintain safeguards to ensure aggregate stability in the deposit base of commercial banks. It aims to protect consumers’ data privacy and data sovereignty.



in various countries contributes to the technological divergences at play.

Third, the use of CBDCs in cross-border payments would not eliminate exchange rate risks, and costly processes inevitable in currency exchange would remain in place. One central bank noted that 'even if systems become interoperable, currency conversion and cross-currency rates would still pose' obstacles. Several respondents highlighted that this cross-border use contains a key risk to monetary sovereignty. As one put it, 'The global use of a retail CBDC denominated in a certain (major) currency may have far-reaching implications' for monetary and financial policy independence. This may obstruct domestic payments use and reduce the CBDC's functionality as an easily accessible store of value.

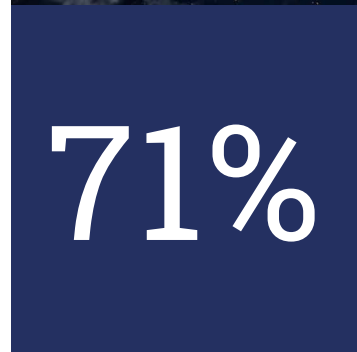
Additionally, CBDCs must be fully fungible and convertible to and from fiat currency to solve frictions in end-to-end payments and remittance networks.

Bearing these issues in mind, several respondents noted that the most effective solution to ensure a CBDC could improve cross-border payments processes would be for potential issuer countries to come together and jointly devise harmonised, interoperable solutions. Some noted that their regions already had operability frameworks in place. Yet most appeared pessimistic about the possibility of genuinely coordinated efforts in the near and medium term. Indeed, 43% of respondents said they were only looking at strictly domestic use cases.

Warding off private digital currencies

The previous section highlighted the emergence of sophisticated, entirely private digital currencies, and the potential they hold to disturb the global financial system and undermine the sovereignty of monetary authorities. For the central banks we surveyed, this is a key use case for issuing a CBDC: 50% of them expressed distinct concern about the possibility that 'a material change could occur in the market structure and stakeholder profile'. This may result in the widespread use of decentralised, private digital currencies as an alternative to public money.

This causality works both ways, as central bank respondents noted. It would be possible that the disappearance of cash forces citizens to turn to decentralised stores of value out of desperation or an innate mistrust of large



Share of respondents who indicated that adding new or strengthening existing monetary policy tools is not a major motivation for their CBDC plans

financial institutions. On the other hand, the disappearance of cash may be driven by the emergence of 'either traditional sector payment innovations as well as, possibly... alternative digital currencies.' In either case, central bank autonomy would suffer, posing financial stability risks. 'Fragmentation via widespread issuance of non-fungible digital currencies could discourage adoption of digital payment and create inefficiencies in the payment markets,' said one respondent.

Yet several suggested it would take a while before this threat would be taken seriously, if at all. One advanced economy central bank said they 'don't see any prospect of privately issued digital currencies gaining widespread adoption as currency that competes with domestic fiat currency'. Nonetheless, this is a rapidly changing, unpredictable and new space, and developments may yet unfold that force central banks to reconsider their stance.

Fostering trust

While not explicitly concerned about private sector digital challengers, most of the central banks we surveyed identified CBDCs' ability to foster trust in monetary authorities and the financial system as their key strength, featuring in some shape or form in 69% of responses to our survey. One highlighted

that 'offering central bank money in a digital form [would] maintain trust in the monetary system in a future where cash is not generally accepted as a means of payment'. CBDCs are regarded as crucial to ensuring public demand for an efficient, reliable and trustworthy payments instrument is satisfied.

Cash currently fills this role. But if it gradually disappears, reliance on private means of payment such as commercial banking or decentralised cryptocurrencies may produce a lack of trust in payments systems. Building the right public infrastructure to mitigate this will be essential.

Examples from around the financial crisis, when many countries registered a spike in cash use, illustrate this well. When trust in the solvency of commercial banks weakened, demand for safe assets like cash increased. While in advanced economies banks are generally regarded as safe, this perception is subject to change. New and incalculable risks could arise, such as cyber threats or private digital currencies that capture a portion of the market previously serviced by banks. The stability of the financial sector could waver, with private deposit money becoming correspondingly riskier. In these circumstances, it is important for the public to have access to publicly backed, safe legal

tender. One respondent indicated that people with a 'lack of trust in financial institutions' may be brought back into the fold 'if the retail CBDC can exhibit advantages in these areas'. A CBDC could play this part in the absence of cash, providing consumers with a secure store for their wealth during periods of monetary or financial instability.

However, some respondents expressed concern that a potential CBDC might have the opposite effect, reducing rather than bolstering trust in monetary authorities. One central bank noted that CBDCs would 'have to meet the highest cybersecurity standards, as even minor cyber-incidents may pose severe reputational risks to central banks and undermine the public's trust in the currency.'

Financial inclusion

Financial inclusion is intimately linked to the

question of trust in the monetary system – people distrustful of the system are unlikely to participate in it. While advanced economy respondents were not concerned about financial inclusion, in our sample of emerging economies, all respondents stated that inclusion was a major motivation for pursuing a CBDC.

In these economies, concerns revolve around the fact that significant portions of the population remain un- or underbanked. According to the World Bank's Global Findex database, 46% of all unbanked adults live in just seven economies (Bangladesh, China, India, Indonesia, Mexico, Nigeria and Pakistan).

Almost one-third of all unbanked individuals globally are between 16-25 years old, and recent progress made around financial inclusion should only be met with muted

enthusiasm. Of the 515m who achieved financial inclusion between 2014-17 in emerging markets, 30% of these new accounts have not been used for digital payments or transactions.

For a CBDC to improve financial inclusion it must be designed correctly and account for local regulations, a jurisdiction's culture and specific needs of the people. A CBDC must not be exclusive if it is to be considered legal tender, so must be as near as possible to being frictionless and costless to use.

Many unbanked individuals are discouraged by high bank fees on accounts and transfers. Making digital payments infrastructure publicly available through a CBDC would offer a cost-efficient alternative and, by increasing competition in the retail payments market, potentially reduce the prices banks charge for their services.

Additionally, many of the unbanked are unable to provide the proof of identity required to open a bank account. While an account-based CBDC would probably require unchanged levels of identity control, a token-based version would presumably be easier to access and could thus be a way of facilitating access to payments services.

However, some central banks expressed concern that any potential development of a CBDC would in fact promote financial exclusion by accelerating the pace of decline in cash usage and distribution. Some countries, while highly inclusive financially, are still home to rural enclaves that have little access to digital payments, rely heavily on cash and are not fully integrated financially. While this applies only to a small subset of countries, central banks should be careful not to marginalise these communities further. In the words of one respondent, there are 'certain demographics [in advanced economies] for which inclusion is still a problem. Ensuring that a CBDC does not isolate these communities further is an important part' of developing a CBDC.

Seigniorage and dollarisation

Seigniorage forms an important part of some central banks' budgets. As the Bank of Canada has noted in its studies, the decline of cash usage in advanced economies has meant some central banks have seen their seigniorage revenues dwindle. A similar problem faces countries that have chosen to adopt a foreign currency (most often the dollar) as their domestic means of payment,

Uruguay

IN NOVEMBER 2017, the Banco Central del Uruguay launched a digital currency pilot project. For six months the 'e-peso' was available to the public as a complement to cash. In total, 20m e-pesos (around \$650,000) were issued as the digital version of the Uruguayan peso. The digital currency was issued through the Global e-Note Manager platform, which also registered the ownership of a digital bank note. Redpagos, a third-party payments service provider, gave out 7m e-pesos. Using a mobile app, individuals could cash in and out via

Redpagos. The e-pesos were distributed on a first come, first served basis.

Users could exchange real pesos for digital ones, and then transfer e-pesos to other users or use them as means of payment in registered stores and businesses. Individuals could store up to 30,000 e-pesos in their digital wallets and businesses up to 200,000. Payments could be conducted using the app or mobile messages, and were instantaneous and worked offline. At the end of the project users could exchange their e-pesos for real pesos with the central bank. The e-pesos were then destroyed.

E-pesos were anonymous but traceable. Each was unique to prevent double spending. They were stored in encrypted digital wallets at the Global e-Note Manager, securing them even if users lost their password or phone. The project did not use DLT, instead using existing mobile technology.

The pilot ended successfully in April 2018. The Uruguayan central bank is considering how a CBDC could be implemented, including whether the digital currency should bear interest, what degree of anonymity it should provide, and what impact it would have on monetary policy and the role of banks in the economy.



'We view the policy debate around CBDCs as being more about making sure not to promote financial exclusion (possibly by driving out cash) than it is about promoting financial inclusion.'
Advanced economy central bank

foregoing significant potential revenues. A CBDC may be a way to tackle these twin problems. Dollarised economies may be able to recapture some seigniorage, while other, advanced economies may boost their revenues.

Our respondents differed in their answers to what a potential CBDC should do for seigniorage. One from a small island economy stated that a CBDC should be designed to raise seigniorage revenue, while another from an advanced economy believed the impact should be neutral. Most respondents (66%) expected that there would be minimal impact, and that further research would be necessary to discern the precise effects.

As with other use cases, the possible return of seigniorage also depends on design decisions. For instance, if the proposed CBDC bears interest, central banks will find themselves in a position where they must routinely compensate holders of the digital cash, presumably meaning their revenues would be reduced. However, if it does not bear interest – the preference of most of our respondents – then one might expect it to boost seigniorage revenues. In the words of one respondent, if the CBDC 'becomes larger than cash and doesn't pay interest', seigniorage 'might increase'.

For dollarised economies, however, CBDCs offer a means to regain greater control of their domestic monetary system. Dollarisation is typically justified on the grounds that issuing and managing a physical currency in small countries is prohibitively expensive. But it is considered an impediment to financial development and long-run growth. Some countries are rebelling against this order. The Marshall Islands, for instance, are developing their own digital currency called the 'sovereign' to regain monetary sovereignty.

Developing and issuing a CBDC would provide a low cost, public alternative to the dollar, avoiding the expenses of cash management and allowing the relevant monetary authority to conduct an independent monetary policy. This could prove particularly successful in highly financially inclusive

dollarised economies, where there would be few problems in accessing digital wallets or accounts. However, small dollarised economies when introducing a CBDC would need to be careful not to inadvertently strengthen the role of the dollar, as the introduction of a CBDC may have negative competitive effects on the domestic payments market.

Monetary policy

Most of our survey respondents (71%) indicated that adding new or strengthening existing monetary policy tools is not a major motivation for their CBDC plans, though several did mention that there may be interesting long-run developments to the use of CBDCs in monetary policy. Only two central banks indicated any exceptions to this rule.

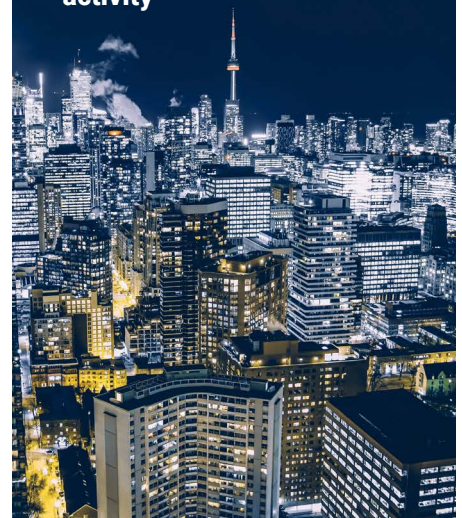
One noted that 'increased monetary policy space may be an argument for introducing a CBDC', though it would not help to convince the required constituencies from a political economy perspective. Another noted that a CBDC could 'potentially open up new policy options to central bankers that may become useful in a lower interest rate environment where central banks regularly face the constraints of the zero-lower bound'. Beyond this, however, it did not appear that monetary policy implementation was a meaningful use case for central banks' CBDC plans

The picture that emerges from these results underscores the importance of tailoring the CBDC's design and purpose to a central bank's individual needs. While maintaining an efficient public payments system and fostering trust in monetary authorities emerged as the principal factors, other variables such as financial inclusion or monetary policy were important for some.

The next section describes central banks' preferences for how the system should look and how it would run. Central banks note that the technology must meet and exceed existing requirements for payments systems. It should facilitate central banks' ability to use their monetary policy tools effectively and serve their mandates. ■

CENTRAL banks are considering multiple key policy objectives, listed below, for their implementation of CBDCs. It will not be possible for even the most practically holistic CBDC solution to achieve all these concurrently. Central banks must be selective with their policy choices and specific use cases in which they employ CBDCs.

- **Ensuring financial stability**
- **Anti-money laundering and combating terrorist financing**
- **Efficiency gains through reduced payment and transaction costs**
- **Enhancing security, reliability and resilience**
- **Improving financial inclusion**
- **Exercising monetary policy, in existing (transmission mechanism) and new methods (interest-bearing CBDC, digital helicopter money)**
- **Promoting economic growth and well-being**
- **Increasing seigniorage revenues**
- **Enhancing transaction monitoring for tax purposes and to identify criminal activity**



The promise of technology



As respondents to our survey noted, there is an intimate link between the eventual design of a CBDC and the policy goals sought by its issuance, adding that it must be accessible, secure, convenient and operate for all payments. Bearing these overarching goals in mind, this section covers what technology and design a CBDC can entail.

Account- and value-based systems

While account-based systems – such as bank deposits – are commonplace, they are imperfect. Transfers using such systems can take a long time and are laden with intermediaries’ fees, making micropayments expensive. This can distort commerce and force consumers to pay for bundles rather than what they actually want. Payments platforms that use accounting rather than actual movement of value – such as Alipay in China – carry minimal fixed transaction costs, making microtransactions via mobile phones affordable. However, this may result in low competition and associated risks, such as single points of failure. Additionally, in situations where money must move across platforms – either jurisdictional borders or from digital to physical formats – transactions can be expensive, lengthy and opaque.

While account-based models resemble the current accounting structure for wholesale CBDCs, decentralised ledgers may facilitate the replacement of paper money with retail CBDCs. Tokenised cash is an alternative to account-based systems as it enables direct access to the network without intermediaries. In this value-based model, tokenised bearer assets are transferred peer-to-peer across a decentralised ledger. Tokenised cash transactions may be more cost-efficient, resilient to single points of failure by account managers, and retain cash-like anonymity.

Most central banks have developed national real-time gross settlement systems to implement monetary policy and create

‘The crucial point is that [the CBDC] would be a claim on the central bank and not a claim on nobody (cryptos) or a claim on a private institution.’

Advanced economy central bank

a platform for the interbank money market. But the associated operating expenses are high, meaning smaller jurisdictions without economies of scale are forced to subsidise or recover costs through higher fees. Moreover, these centralised systems are susceptible to accidental (power and connectivity outages) and malicious (cyber attacks) incidents.

Examples of computer failures include the damage from the 2001 terrorist attacks on the US that made it impossible for many banks to execute payments to one another and the 2014 computer failure of the UK’s clearing house automated payments system managed by the Bank of England. The system, which processes payments worth an average of £277bn per day (15% of annual GDP) failed for nearly 10 hours, with disruption spreading to the retail mortgage market. Since 2015, malicious actors have hacked into Bangladesh’s central bank and sent fake payments orders. Other examples include hacks of the correspondent bank network between Russia, Ecuador and Vietnam to send fake orders.

As our reliance on connected technology increases, a resilient clearing and settlements process is vital to support the implementation of monetary policy and ensure financial stability. Distributed ledgers that enable off-network transactions would add another contingency to legacy systems against lost connectivity. Such advances may shrink the divide between rural and urban populations in terms of energy, connectivity and financial inclusion. For money to be trusted, it must be dependable. While a ‘dropped call’ could be excused, a ‘no signal’ or complete blackout could lead to economic panic.

Examples of value-based technologies include DigiCash, CyberCash and Mondex stored-value cards in the 1990s, network-based e-settlement models, and 2012’s Canadian MintChip. However, these infrastructures were not widely adopted. The emergence of bitcoin and other cryptocurrencies in the wake of the financial crisis rekindled interest in DLT capable of

value-based payments systems.

Bitcoin and other cryptocurrencies

Bitcoin captured the public’s imagination with its nearly anonymous transactions and ability to operate without any trusted intermediaries. DLT means ledgers can be maintained and updated securely for an entire network of users by the users themselves, rather than a central agency. This gives bitcoin participants the ability to share a ledger that updates each time a transaction occurs through peer-to-peer replication. However, critics point to several technological hurdles that limit DLT adoption in respect of payments systems.

First, the scalability of DLT networks has not been demonstrated. It is unclear whether they can process a large volume of liquid markets transactions. Second, there are concerns about privacy protection. Most cryptocurrency networks have been abused by the dark economy for money laundering. However, the use of open, blockchain technologies in bitcoin has enabled the unravelling of darknet transactions long after the fact, leading to successful prosecutions. Moreover, DLT’s consensus protocols offer only probabilistic finality, not the absolute finality required for payments. Finally, smart contracts and interoperability with other DLT networks remain conjectural.

Purists and speculators have used blockchain technology to issue cryptocurrencies for a range of use cases. While few have proved fruitful, the open-source blockchain has led to theoretical breakthroughs as well as lower costs for those wishing to experiment with it. Regulators, too, have laid guidelines that draw borders between using the technology for raising equity and using it to perform particular industry functions.

Enterprise-grade DLT

These factors shifted DLT away from cryptocurrency speculation and led to large-scale investment by banks, technology providers, consultancies and industrial

consortiums. The result has been a variety of evolving, enterprise-grade blockchain protocols that meet the thresholds for privacy and permissions required of payments systems. These protocols include Ethereum, R3’s Corda, the Linux Foundation’s Hyperledger, and frameworks within these. Quorum, used by JPM Coin, introduced privacy features on top of Ethereum by allowing users to create private contracts, data for which is shared only between a subset of nodes.

DLT uses cryptography to ensure that network participants see only the parts of the ledger relevant to them and that transactions are secure, authenticated and verifiable. This architecture enables transactions conducted using the DLT to have the properties of provenance, immutability and finality. Using consensus mechanisms ensures all participants agree a transaction is valid. Provenance allows participants to know where the asset came from and how its ownership has changed over time. Immutability means no participant can tamper with a transaction once it has been agreed, and finality that there is one place to determine the ownership of an asset or completion of a transaction. This is the role of the shared ledger.

Using these protocols, designers can craft the system’s governance architecture along with an array of technical decisions for the distribution model. Moreover, theoretical advances continue to be made that ease the limitations of DLT for payments.

Why CBDCs need DLT

In the words of Jerry Cuomo, IBM fellow and vice-president of IBM Blockchain Platform, ‘Blockchain networks have revolutionised the internet with new economic models and business structures around movement of value, and derived benefits of transparency, disintermediation and asset tokenisation.’ Richard Brown, chief technology officer at R3, says DLT can enable entire markets to move to shared processes – a new generation of

business process management platforms on which entire industries rather than individual firms can operate. Vitalik Buterin, the co-founder of Ethereum, says, 'Smart contract code on one chain [may one day] verify the consensus finality of events on other chains directly, requiring no trust in intermediaries at all.'

However, the technology has yet to take off. Some pundits believe this is because it lacks a stable link to the real world. Projects funded by cryptocurrencies are prone to market whims and price volatility. Consequently, regulatory risk coverage levels are high, and few banks offer services to DLT-based businesses. In addition, there may be a lack of trust in public DLT networks, owing to instances of hacking and fraudulent activity to gain control of the network.

In lieu of central bank money, the private sector solution is 'stablecoins'. Their value can be pegged to existing assets, such as fiat currencies like the dollar or commodities such as gold, for transaction processing and settlement on a DLT-powered business network with fewer legacy infrastructure expenses and operational risks. Since 2017, developers have created around 120 stablecoins, but Tether, the largest among them, has a market capitalisation of barely 2% that of bitcoin.

Wholesale and retail CBDCs

Among respondents to our survey, 64% preferred a value-based system, stating that such a structure would be the closest form to cash and that it is not in central banks' remit to deal with individual customers directly. Only one respondent, from a small island economy, said their experiment was account-based, working through a private chain that could be held directly via central bank or commercial bank accounts.

The remaining 36% were either undecided, favoured an account-based model, or considering a combination of account- and value-based systems. One advanced economy respondent explained 'a variation of value- (through a register) and account-based solutions may offer necessary and desirable characteristics of a CBDC. However, a "pure" account system at the central bank without any frictions in the transfer of funds from customer accounts at commercial banks to central bank accounts could result in bank runs being more sudden

'There are some cases where the cost-benefit assessment favours decentralisation. Each country should assess their own infrastructure and needs to determine whether centralisation or decentralisation is the most appropriate. There is no one-size-fits-all preference that could work for all countries.'

Emerging market central bank

and larger, negatively impacting financial stability.' Economists argue, however, that a dynamic marketplace and good design will mitigate disasters.

In the meantime, the approach could be to offer a wholesale CBDC platform with which payments service providers could connect to the central bank's reserves and intermediate payments solutions to end consumers. The PBoC is exploring a two-tiered system with an account-based CBDC that only regulated banks can access. Such an approach does not risk disintermediating banks and protects the status quo of retail banks as pivotal to money distribution. It also promotes financial innovation without mandating a specific technology. With time, the central bank can offer a solution that is available for end-consumers directly, namely retail CBDCs.

Verification

A key distinction between account- and value-based money is the form of verification needed when it is exchanged. Verification of the tokens and settlement could be centralised or decentralised, depending on the technology used. The latter is possible using DLT.

Identity theft is a primary concern in account-based systems, and so the account holder must be verified. However, the centralisation of the account and authority over it places the system at risk of gaming and single-point failure. More than 20% of our survey respondents favour decentralisation to support system resilience.

With value-based systems, the worry is that the money may be counterfeit or permit double-spending. A 'Sybil attack' is a type of incident seen in peer-to-peer networks in which a node in the network operates multiple identities at the same time. One example is the 51% attack possible in some DLT networks; a group of miners controlling

more than half the network could double-spend by reversing transactions that were completed while they were in control of the network. The ability for the same single digital token to be spent more than once devalues the currency relative to other monetary units and diminishes user trust as well as the circulation and retention of the currency. Hence value-based systems rely on the ability of the payee to verify the validity of the payments object.

DLT can be categorised as 'permissionless' or 'permissioned' depending on who can participate in the consensus-driven validation process. Permissionless DLTs allow anyone to read, transact on and participate in the validation process. These open schemes could be disruptive if implemented. By contrast, in permissioned DLTs the validation process is controlled by a select group of participants or managed by one organisation, and thus serves more as a common communications platform. Trust can be devised using consensus protocols such as proof-of-stake, proof-of-work, and Byzantine fault tolerance, among others.

To prevent double-spending while maintaining anonymity, permissioned digital cash uses an authority's blind signature to certify transactions. The authority will not see the contents of any transaction it signs and will be unable to link the blinded transactions it signs back to the unblinded transactions it receives. To prevent centralisation, permission can be shared among competing authorities using secret splitting – as individual shares are of no use on their own and the secret can be reconstructed only when shares are sufficiently combined together. Hence government oversight, compliance and audit can be part of the same network.

Security

While physical commodities and cash can be completely anonymous, governments

must strike a balance between compliance and keeping the two parties to a transaction anonymous. That includes rules around anti-money laundering, anti-terrorism financing and tax evasion. Hence, privacy and decentralisation are opposing constraints in transaction visibility. CBDC designers face a trade-off between anonymity and supervision.

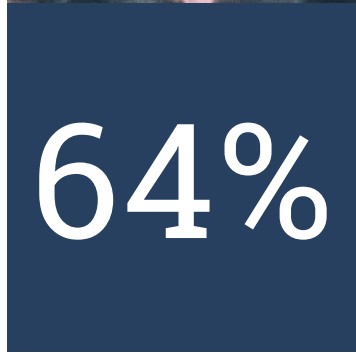
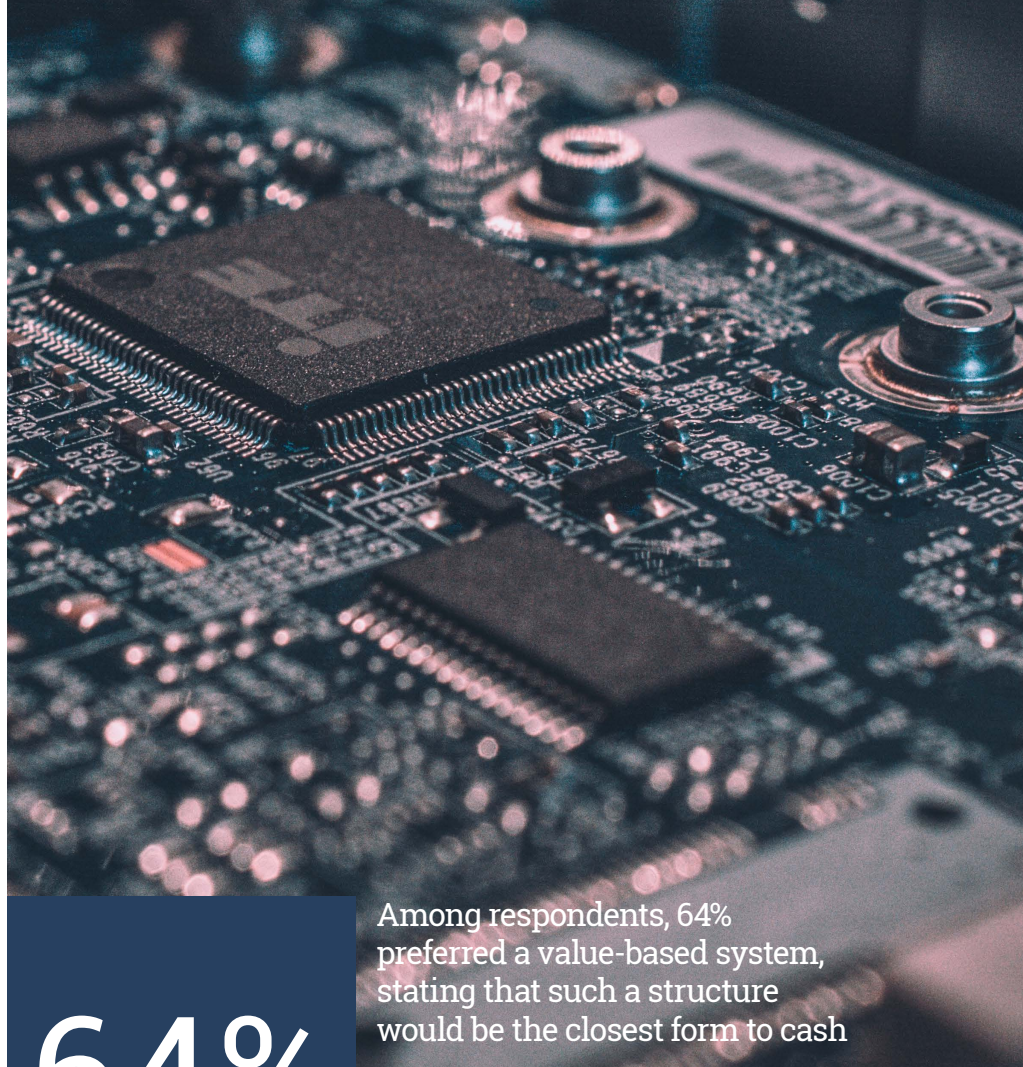
If a CBDC is an extension of cash, will people expect full anonymity of payments? Will the uptake of CBDCs suffer if there is full traceability? Probably not, as in both experiments and practice, people quickly abandon their stated privacy requirements if these require a small extra effort, or if a small incentive offsets any diminished privacy.

Still, that this technology may enable governments to monitor citizens' transactions is disquieting. Russia's central bank has previously pinpointed CBDCs' lack of anonymity as a key potential disadvantage. Zero-knowledge proofs facilitate verification using only the validity of the statement itself without revealing any crucial information about the endpoints or amounts. At the same time, such anonymity in the extreme would stymie the application of national and international law.

One central bank we surveyed emphasised that building trust in the system is of greater importance than the operational risks related to technology. Hence a centralised system with a governance body can add accountability.

A CBDC system based on real identities may comply with anti-money laundering rules and support more effective transaction monitoring. Another option is pseudo-anonymity of traceability only under certain conditions. For example, as only high denominations are associated with illicit payments or store of value, size limits on payments in, and holdings of, CBDC may reduce these concerns.

Benefits for financial inclusion may be extraordinary if security is properly implemented. In 2017, the United Nations' World Food Programme successfully tested 'Building Blocks', a pilot scheme in a Jordanian refugee camp to facilitate cash transfers for 10,000 Syrian refugees on a payments platform using the Ethereum protocol. The scheme saved the WFP \$150,000 per month while eliminating 98% of bank-related transfer fees by conducting anti-money laundering and know-your-customer



Among respondents, 64% preferred a value-based system, stating that such a structure would be the closest form to cash

processes using the UN's biometric identity management system.

Scalability

Fully centralised, account-based settlements infrastructure is more efficient, as it can check the validity of tokens' serial numbers, and then reassign numbers once tokens change wallets to avoid double-spending risk. Visa's 50-year-old VisaNet can process on an average day 1,700 transactions per second and up to 20,000 during peak periods. Peak online transactions in China have reached 92,771 per second. Bitcoin processes fewer than five per second and settlements can take up to an hour.

The restrictive and smaller nature of private, permissioned networks allows them to be more scalable and operate faster than permissionless networks in terms of transactional volume capacity. Of survey respondents employing DLT in their proofs of concept, around half found that in addition

to providing contingency, including avoiding single-point failures, a decentralised system could support the required speed and latency necessary for high transaction volumes. Only one survey respondent found their DLT experiment unable to handle high volumes and experience some unavoidable failures through a single point.

Advances in transaction privacy protocols are helping make bitcoin's public, permissionless network using proof-of-work a viable payments infrastructure. Batching payments reduces the size of a transaction and so increases transactions per second. However, batching together multiple wallets' transactions heightens privacy risks. Instead of requiring each node to be redundant, sharding-based consensus mechanisms enable parallel processing. Sharding is a way of dividing the system's workload across a peer-to-peer network so that each node isn't responsible for processing all transactions.

In 2017, all bitcoin nodes received an

upgrade that segregated the 'witness' role of each transaction from the actual transaction data. This enabled the safe deployment of the 'Lightning Network', which facilitates atomic (short-lived, all-or-nothing transactions) cross-chain trading and allows users to trade some amount of one cryptocurrency (such as bitcoin on the mainchain) for some amount of cryptocurrency on another subledger that is cryptographically linked with the main ledger (such as bitcoin on a sidechain). These sidechains, such as Liquid on Blockstream, are connected to the mainchain with a two-way peg, enabling users to move assets across ledgers.

As noted earlier, permissioned consensus mechanisms offer higher speeds and throughput than that possible from permissionless mechanisms. Introduced in 2011, the proof-of-stake consensus mechanism eliminated the need for miners to solve energy-intensive algorithms by establishing a random selection process for transaction validators. The delegated proof-of-stake modification added the ability for users to vote in their virtualised mining processors with transactions per second of around 4,000. Instead of proof-of-work and proof-of-stake, Ripple's XRP tokens poll a distributed network of nodes (servers) and reported transactions per second up to 50,000 in 2017.

Hyperledger Fabric V1.0 improved scalability by introducing channels and separating smart contract execution, ordering and validation. The channel-based architecture allows users to send transactions securely off-chain, facilitating near-instant, high-volume and fee-free payments between parties. Side channels enable participants to perform private transactions that can be audited efficiently while limiting visibility to other participants. Analogous are bitcoin's Lightning Network and the subledgers that are cryptographically linked with the main ledger in Corda and Quorum.

Beyond just a software-only layer, CBDCs can be multilayered with specialised hardware to support tokens' use offline or when the network is partitioned. Inexpensive, low-energy hardware can hash (a method of encryption that converts a series of letters and numbers into a unique output of fixed length) and mine (solving a computational problem that allows the system to chain

'Additional cybersecurity measures should be put in place to safeguard these new assets depending on their nature, size and complexity... The introduction of an electronic identification system might be required in certain circumstances.'
Emerging market central bank

together transactions) both online and offline to keep the network in consensus.

In addition to on-premise deployment using operating-system-level virtualisation to deliver software in container packages, DLT networks can be supported by hybrid cloud services and capabilities backed by secure mainframe technology. Designers can organise this infrastructure in a similar fashion to the content delivery network that currently increases the internet's efficiency by placing large-size content on servers close to populations to reduce the physical distance it must travel. Processes must be established to monitor off-chain transactions properly.

Offline availability

There are situations when it is inconvenient or impossible to use physical or digital currencies and contingency and alternative forms of money become necessary. One advanced economy central bank suggests a 'CBDC could function as a contingency solution in case of failures in bank payments systems and this contingency perspective may grow in importance if payments infrastructure becomes increasingly internationalised'.

Respondents acknowledged that a CBDC will substitute much more easily for cash in some use cases, such as for point-of-sale merchants with network connection. But applying CBDCs to offline peer-to-peer payments that demand robust and resilient network infrastructures raises challenges. Of central bank survey respondents, 73% require CBDCs to be available under all circumstances. Still, CBDCs should also have a disaster recovery plan, especially in jurisdictions where there is a higher frequency of weather-related power outages or network connection issues.

Secondary backup sites are a standard part of resiliency requirements, with one central bank explaining that such sites are already a core element of its payments systems as well as for the commercial banks

it supervises. As CBDCs are transferred peer-to-peer, an alternative form of redundancy to the grid is personal charging. Experiments have demonstrated the ability to power communication using electricity harvested from electromagnetism, heartbeats and light.

For telecommunication resilience, island nations such as the Bahamas are exploring 'TV white space' technology that would maintain connectivity in case natural disasters damage vital infrastructure. The system must continue to work during power outages across all inhabited islands in the Bahamas. The central bank's technology provider NZIA states 'retail CBDC is legal tender and it needs to provide cash-like payments capabilities regardless of geospatial, network or power limitations,' and offered a solution via a hybrid system of software and hardware working through a physically distributed network.

Another possible solution has been put forward by eCurrency, a Dublin-based CBDC provider, that could facilitate issuance of standalone, cryptographic fiat currency tokens embedded in phones or mobile devices. These devices can execute transactions of the secure tokens while offline. An enabled device can communicate and enact transactions with other similarly provisioned devices over short-range or peer-to-peer communications. Other solutions may include off-network linkages, such as mesh networks and distributed public devices.

Our respondents maintain that cash should be used as the primary back-up to any potential CBDC during offline periods, as any form of CBDC is only a complement to cash and not a direct substitute. Even in the presence of a back-up, policy-makers can charge negative rates through CBDC by levying conversion fees during times of economic crisis.

Smart contracts and interoperability

Digital cash could enable major innovations in monetary policy. One such tool would be

an interest-bearing CBDC that can charge negative and pay differentiated positive rates. While central banks are not yet ready to deploy this tool, the ability to 'flip the switch' may prove powerful in dire circumstances.

In other words, DLT allows for 'programmable money' such that the contract for asset transfer is embedded in the transaction database determining the conditions under which the transaction can occur.

Smart contracts can be used to execute liquidity savings mechanisms in batch payments processes without compromising privacy in a decentralised network. This was exhibited in phase two of the Monetary Authority of Singapore's Project Ubin. Smart contracts also enable interoperability – moving across blockchains – as demonstrated by the collaboration between Ubin and the Bank of Canada's Project Jasper. Across borders and using different protocols, the collaboration demonstrated settlement implemented by using a hash time-locked contract. Such a contract requires the receiver of payment to cryptographically acknowledge receipt thereof prior to a deadline, or forfeit the ability to claim the payment. The cryptographic proof of payment the receiver generates can then be used to trigger other actions and produce conditional payments.

Relatedly, the Bank of Thailand is collaborating with the Hong Kong Monetary Authority on phase three of Project Inthanon

to 'explore the interoperability amongst ledgers to achieve cross-border funds transfer which includes business modality and implementation of relevant foreign exchange regulations, aiming to reduce associated costs and enhance efficiency.' In the Middle East, the closely linked central banks of Saudi Arabia and the United Arab Emirates are exploring the use of tokens to promote liquid and efficient cross-border payments through Project Aber. Governor Carney from the Bank of England pushed this concept to the extreme by positing, in relation to possibly replacing the dollar's reserve currency responsibilities, whether 'a new synthetic hegemonic currency would be best provided by the public sector, perhaps through a network of central bank digital currencies.' Such a network would surely contain smart contracts.

However, there is a risk that smart contracts may add too much functionality to CBDCs and detract from monetary role of sovereign currencies.

In addition to these experiments, international CBDC guidelines published by the International Organisation for Standardisation weave the essential thread of stronger interoperability and promulgation of the technology. These will be explored further in section five.

What comes next?

Cryptocurrencies have increased public awareness of DLT, much more than past manifestations of digital cash. The increasing diversity of protocols and branches for governance architecture enable CBDC designers to programme money according to specific monetary, cultural and regulatory needs.

Moreover, design decisions need not be absolute. DLT can interact with alternative technologies – including hardware, real-world networks and interoperability with other DLT networks – and change as needs evolve. DLT may not be essential, but it is the tipping point at which newly networked value can be implemented to meet real-world needs.

Benoît Cœuré, chair of the committee on payments and market infrastructures of the BIS and member of the executive board of the ECB, has said, 'Expanding access to payments services is an integral part of our work and a key regulatory priority... Digital currencies are, however, only one way in which central banks

can foster financial inclusion. Modernising our existing retail and wholesale payments systems is another.' In the US, the Federal Reserve has announced the launch of the FedNow instant payments system. This account-based medium of exchange may disintermediate the large banks that built their own systems. Moreover, one key purpose of FedNow is to act as a payments platform for fintech companies.

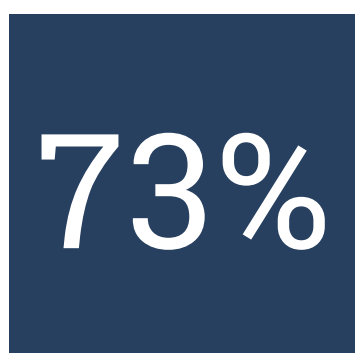
With global interest rates remaining at near record lows for prolonged periods, policy-makers will have little room to help during a future recession. One fund manager suggested the ECB should partner 'with the European Investment Bank and set up vehicles investing in start-ups vastly boosting such a nascent sector in the eurozone. It is crucial to boost productivity in the long run and increase the speed with which mature sectors adapt to the new economy.' The issuance of CBDCs and the funding of DLT projects that divide labour is one way to accomplish this.

Today's high cost of account-based, cross-border microtransactions prohibits the division of labour. CBDCs and their synthetic private versions (publicly-insured stablecoins) are the only options for contracts using DLT to be secured directly with highly liquid, legal tender.

Although change will be gradual, the distributional consequences of such disruption may threaten central bank independence and therefore requires a political mandate with clear communication of intent and supporting policies.

Moreover, DLT does not have to replace existing technologies or vendors. By exerting competitive pressures, DLT is already compelling legacy solutions to evolve. For instance, when Swift introduced its global payments initiative offering one-day settlement in 2017, Chief Executive Gottfried Leibbrandt said, 'I don't think we could have done this without the competition making it clear to the banks that they need to shape up their act.'

Intertwinement between developments in the private sector digital currency space and central banks' objectives is self-evident. Technological breakthroughs in the former have sparked CBDC considerations in the latter. The subsequent sections will focus on the implications of these choices, specifically through the lenses of regulation and policy. ■



Of central bank survey respondents, 73% would require retail CBDCs to be available under all circumstances and for all types of payments

Policy imperatives and implications



The gradual disappearance of cash in advanced economies is one of the key features of the discourse on CBDCs, and one of the main variables selected by respondents to our survey. On the other hand, monetary policy implementation was not a particularly prominent variable. In spite of this, it is clear that the implementation of a CBDC could result in significant changes to the current policy framework. This depends on crucial design choices.

If built to resemble cash, one might expect a CBDC to have a negligible effect on monetary policy and financial stability. But this is not the case. A CBDC's potential impact on monetary policy is vast. It could, for instance, improve existing monetary policy transmission mechanisms. However, CBDCs remain relatively abstract, and are often accompanied by significant risks to financial stability.

Design matters

The particular design of a CBDC will determine its effectiveness as a monetary policy instrument and whether any financial stability implications may arise. Design choices will determine the demand for CBDCs relative to bank deposits. One key consideration is whether CBDCs will be universally available without restrictions or limits.

Demand will depend on potential costs and fees, the value of the service provided by CBDCs against alternatives, and the difference in the credit and liquidity risks between CBDCs and other options. The most significant determinant for demand is the potential interest rate on a CBDC over a time horizon. However, for there to be substantial demand for non-interest bearing CBDCs, one of several options must hold true: the return on bank deposits (or alternatives) must be negative; the perceived value of services – such as payments – related to CBDCs must be higher than the interest rate of alternatives; or the lack of credit risk on CBDCs must be valued greater than returns at that particular point. Central banks must therefore decide whether or not CBDCs will be interest bearing. Each

option has its own implications for monetary policy and financial stability.

Other determinants of demand may include whether CBDCs assert greater control over domestic currencies as the technology undoes dollarisation, as well as over cryptocurrencies, whose technology makes them more difficult to control centrally. Additionally, if CBDCs foster greater financial inclusion, they will reinforce their monopoly as a monetary instrument.

In section two, central banks highlighted that enhancing monetary policy options was not a primary motivation for adopting a potential CBDC. Only 29% said there would be a material change in the real policy options available to central banks. One advanced economy central bank said monetary policy effects would be the by-product of a CBDC and not the main reason for considering its introduction. While most central banks conduct monetary policy by influencing a target short-term interest rate, in addition to other tools such as quantitative easing, this might change with the introduction of a CBDC.

The effective lower bound

All central bank respondents to our survey acknowledged that an interest bearing CBDC is feasible in principle, but that the ideal design of a CBDC would just be a digital extension of cash. If built to constitute the properties of cash, CBDCs cannot be interest bearing.

A non-interest bearing CBDC sets the effective lower bound to zero. In the current system, the deposit rate can fall below zero indefinitely, but may have limited impact on other interest rates in the economy. This is because if the deposit rate is negative, it is more advantageous to hold cash (which implicitly derives zero return regardless of the policy rate). However, there are costs attached to holding cash, such as secure storage and transport expenses for making payments, which could include additional fees and insurance costs. The corresponding negative yield of holding cash generates the lower bound on negative interest rates.

'As long as cash exists, and we assume it will in the near future, it will not be possible to set negative interest rates on CBDCs. In order for a CBDC to serve as a monetary instrument, it will have to bear interest.'
Advanced economy central bank

A CBDC would be virtually costless to hold compared to cash. It would be free from credit risk, like cash, but would not incur storage or transport costs, and would therefore be the preferred alternative in a negative interest rate environment. Commercial banks would be unwilling to pass on negative interest rates, especially to their larger corporate clients – something they can do now given the high cost to withdraw and hold cash in significant volumes – as their clients could easily move these deposits into a non-interest bearing CBDC. In this scenario, the interest rate on a CBDC (zero) would act as a hard floor to all interest rates in the economy. The effective lower bound would be pushed up to zero.

If a zero-lower bound is affirmed, this could restrict a central bank's interest rate manoeuvrability. It could affect demand management in the long term, possibly prolonging economic downturns if other monetary tools are insufficient to influence credit markets and liquidity conditions.

In some cases, the transmission of QE may be weakened. As part of asset purchase programmes, central banks purchase government and corporate bonds, putting downward pressure on their yields. In certain circumstances, as seen presently in Europe's sovereign debt market, (shorter-term) bond yields can turn negative. This would no longer be possible if there is the option to purchase a non-interest bearing CBDC in the market, as the interest rate floor is set to zero. When designing asset purchase programmes in a CBDC regime, central banks will have to consider that there is a much harder limit to the effectiveness of QE. While bringing yields down to low levels will be possible through the volume of purchases, the CBDC will preclude bringing low yields down into negative territory.

Some have suggested that unconventional 'helicopter money' forms of monetary policy may be more achievable via a CBDC. They reason that the digital currency and smart contract features could facilitate the direct transfer of central bank funds to stimulate firms and individuals. While true in theory,

simply making 'money drops' easier to implement is unlikely to sway central banks towards using this tool. Indeed, effective methods to implement helicopter money drops already exist. In 2012, authorities in Hong Kong distributed part of their fiscal surplus to the public through local bank transfers and cheques distributed by the post office.

If cash remains available in an economy – as most central banks in our sample expect – then introducing an interest bearing CBDC will have no effect on reducing the zero-lower bound on interest rates, as holders of a negative-interest bearing CBDC would turn to interest-free cash. The return on cash would set the effective lower bound on interest rates to zero, and central bankers would be able to conduct monetary policy in the same way as today.

In the case of an interest bearing CBDC, return would have to be set at the interest rate paid on reserves at the central bank, otherwise undue arbitrage opportunities would arise. If the interest rate on a CBDC was higher than the overnight rate (or policy rate) on reserves, then commercial banks would borrow reserves from other commercial banks and the central bank and reinvest the value into CBDC to earn the spread. This would eventually raise the overnight yield until it reaches parity with the interest rate on the CBDC. If the spread was reversed, with the overnight rate being higher than the rate on the CBDC, then the overnight rate must fall to remove arbitrage opportunities as the rate on the CBDC cannot rise organically.

In the improbable case that an interest bearing CBDC is available and cash is removed entirely from circulation, then it would be possible to administer monetary policy directly through the CBDC's interest rate, affecting firms, consumers and investors. This would make implementing negative interest rate policy easier. If cash continues to exist, fees and taxes on conversions from CBDC into cash could be useful, to an extent, to allow negative-interest bearing CBDCs to have a monetary policy impact. These frictions could create a discount between physical and digital cash,

since the former is more expensive to manage and store.

However, in practice, most central bank respondents are looking to complement cash with a CBDC, not replace it. If there was a possibility of a negative-interest bearing CBDC, then holders would turn to physical cash. If cash were entirely removed from an economy and replaced by a negative-interest bearing CBDC, people would probably use alternatives, such as the dollar or another stable foreign currency.

Instabilities in the exchange rate could arise if there are no restrictions on who can purchase CBDC across borders. Demand for this hypothetical ultra-safe government asset would not impact its yield, as the CBDC's interest rate would be exogenously set. This may produce more volatile outflows in and out of CBDC if an interest rate differential exists between a CBDC and other foreign safe assets bearing the same relative risk.

During normal conditions, when interest rates are positive and monetary policy has room to manoeuvre, it is improbable that there would be substantial benefits to the conduct of monetary policy and transmission compared to now. A CBDC may not have much material benefit compared to today's system, as central banks can mostly already provide a stable, predictable influence on consumer and market interest rates.

Interest bearing CBDCs

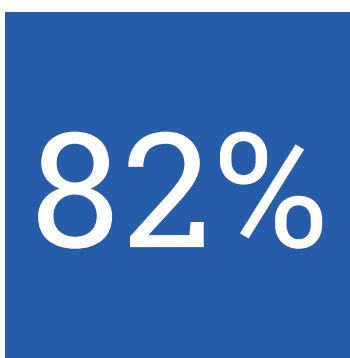
The implementation of an interest bearing CBDC would involve several difficult practical considerations. First, central banks would need to work out how interest will be paid. Would it be daily, based on each day's closing balance? When would this be credited? And how would it be credited to the corresponding wallet or account?

Anonymity would also be challenged, as interest must be paid to the legal owner of the CBDC. This also relates to taxation on interest earned. If interest is subject to income tax, the central bank (or institution managing CBDC accounts or wallets) would have to provide

information on the identity of the recipient of interest to the tax authority. This could erode the appeal of the CBDC if transaction privacy is a major desire for potential users. However, smart contracts and ledger history would facilitate greater optionality for anonymity while still allowing for transaction privacy.

Central bank respondents are not looking to implement interest bearing CBDCs in the near future, and stated that the potential effect on monetary policy of a non-interest bearing CBDC is not entirely clear. Respondents said the practical relevance of new unconventional monetary policy instruments would depend on a variety of factors, including policy considerations, a thorough assessment of their possible long-term effects, a wide range of legal and practical issues and, importantly, their solid legal footing with respect to central bank mandates.

One advanced economy central bank said they 'do not see a material change in central banks' real monetary policy options through developments that might merely be able to technically facilitate the execution of certain instruments'. On the other hand, a small island economy central bank said that 'the more direct ability to interact with the public in a CBDC environment might introduce additional policy options and may modify the transmission mechanism of monetary policy'.



Among central bank respondents, 82% noted that their greatest financial stability concern from CBDC implementation was the risk of digital bank runs happening at a higher speed than before

This is a unique set of circumstances, however, as most central bank respondents suggested they would outsource many of the public-facing tasks involved in CBDC management to third parties.

Financial stability risks

Central banks were asked to assess the potential ramifications of a CBDC on financial safety and stability. Several felt this question could only be addressed fully after design and parameters had been specified, but a notable share (29%) expressed concern about the potential impact on financial stability. Furthermore, 82% said their greatest financial stability concern from CBDC implementation was the risk of digital bank runs happening at a higher speed than before. This would hold if the process of conversion from commercial bank money into a CBDC is continuously available and without limit. The extent of the impact depends on the attractiveness of the CBDC in both normal circumstances and during periods of financial stress.

An interest bearing CBDC would compete directly with financial intermediaries offering conventional financial services, such as making payments or storing wealth. Almost 45% of central bank respondents suggested there would be a risk of reduction in commercial bank money and functions in the monetary system.

Banks could see their funding costs change. Traditionally, retail banks have used retail deposits – a short-term liability – to fund their long-term lending to households and companies. If deposit holders have the option of holding CBDC, the total level of bank deposits may fall.

During non-stressed times, the magnitude of potential outflows of retail deposits into a CBDC would be low, one reason being that banks could disincentivise outflows by adjusting deposit rates. Since deposit rates are typically less than the repo rate, while the cost of alternative market funding is greater, banks are incentivised to adjust their deposit rates to manage potential outflow.

In the face of moderate outflows, banks could rebalance their funding and reduce their dependence on retail deposits. They could replace this funding in a number of ways, many of which they already engage in, such as using their existing central bank reserves or borrowing more, or relying to a greater degree on secured funding markets.

However, if bank deposits fell more significantly, greater wholesale funding will have to compensate the shortfall leading to higher funding costs for the banking system and reduced bank profitability. This in turn could lead to a contraction in bank intermediation and lending.

In a recent study, the Riksbank estimated that the cost to bank funding under an e-krona regime would be up to 25 basis points. However, the central bank estimates the macroeconomic impact resulting from this increased funding cost to be limited, since non-bank funding sources would mitigate the bank's passthrough of this increased cost to their lending rates. Any increase in lending rates could be offset by more expansionary monetary policy.

Risk of high-speed digital bank runs

During crisis periods, a CBDC provides a risk-free alternative into which money can move. A CBDC would be perceived as a safer store of value compared to deposits offered by even relatively robust banks. In a typical bank run, deposit holders withdraw their money into cash, but this incurs high transport and storage costs. In addition, banks may stop or limit convertibility into cash, and deposit insurance might cover only a fraction of any given customer's deposits.

A CBDC, without restrictions, may offer a more convenient option than cash during a bank run. Since a CBDC would be explicitly state-backed, fully insured and less expensive to move and store than cash, it would be more favourable during times of unease than paper money or retail deposits.

This could make a run to CBDC more substantial and faster, which could turn an isolated bank panic to a systemic banking crisis. Consequently, without banks curtailing their reliance on retail deposit funding, the economy could become more sensitive to shocks as it becomes easier to move money out of the banking sector. As a result, the central bank balance sheet could become enlarged and more volatile. Foreign investors, if they had unrestricted access to the CBDC, could find it an attractive investment alternative if their own domestic economy faced financial stress. This could lead to greater international flows in the CBDC, which could affect the exchange rate, inflation rate and effectiveness of monetary policy.

It should be noted that digital bank runs

'A digital run out of deposits and into government liabilities such as T-bills is also already possible. With a cash-like CBDC and in the presence of deposit insurance, digital bank runs should not be a significant risk.'

Advanced economy central bank

are already a possibility: firms and individuals might run on one bank by moving assets to another. A CBDC would not change this. However, a CBDC could exacerbate the risk of a system-wide run, though mechanisms exist to prevent this and provide liquidity to a bank in crisis. For example, there is no upper limit to how much liquidity the central bank can provide, depending on the creditworthiness and collateral of the receiving institution.

Smart contracts could slow down a digital run by making conversions into CBDC more difficult. The system is also likely to evolve. CBDCs would be an easier store of value, and alternative lending may be created based on programmable money, reducing the need for credit scoring and other antiquated institutions plagued by discrimination.

Controlling CBDC demand

Adding frictions and limits such as CBDC quotas can reduce the demand for the digital currency, a design feature that several central bank respondents suggested to lower the risk of digital bank runs.

One respondent from an advanced economy said the supply of CBDC should be designed in such a way that a digital bank run could not happen, and that a range of possibilities exists between pure price and quantity rules that should be investigated further. Another central bank suggested that pricing should be time-varying for an interest bearing CBDC. A CBDC could be priced as a spread to the deposit interest rate, where the size of the spread is time varying. The spread could be lowered if the demand for CBDC needs stimulation and increased if demand must be reduced.

However, introducing friction could create inefficiencies of which central banks should remain aware. There is the chance that parity between other forms of money – cash, bank deposits, and reserves – could break down, leading to multiple exchange rates. The Riksbank says a secondary market could emerge where those who have not fulfilled their CBDC quota could offer these to others who may have met their quota limit or do not have

access to CBDC in exchange for cash or bank deposits at higher prices above parity.

Additionally, quotas and limits could reduce the efficiency of a CBDC as a means of payment. It could introduce credit risks if a debtor relationship forms between agents (who have not met their quota) who sell or loan CBDC to others in excess of their quotas.

It should also be considered that, if limits are sufficiently large enough to reduce the risk of a bank run, then it is also probable that this would significantly weaken the functionality of a CBDC as a means of payment.

Response from financial institutions

Of central bank respondents, 83% felt their role would not change significantly; features such as the allocation of credit would remain a commercial bank task. Only one respondent from a small island economy suggested that 'it is conceivable that the ability to interact directly with the public enables central banks to allocate credit but also take on additional governmental value transfer functions in certain circumstances'. Another respondent posited a scenario where the extension of CBDC credit could become an experimental monetary policy tool.

Under a CBDC, central banks are unlikely to encroach on commercial banking services as the credit creation role remains firmly with the private sector. However, commercial bank deposits would probably fall. There would be even greater contestability if the CBDC is interest bearing.

Commercial banks may respond by offering a better spread above the policy rate offered on a CBDC. Furthermore, a wider range of banking services such as mortgage finance, consumer and business loans, wealth management and financial advice, among others, could compete against a CBDC.

Additional reactions from the private sector could include increased lending rates and fees for loans in response to rising funding costs. There would also be additional risk-taking by banks to compensate for reduced profitability. This would be probable, since banks are

heavily subsidised by deposit insurance, which would fuel greater moral hazard. Ultimately, the government could also offer a bail-out.

The distribution, scale of network and capacity to offer customer-facing services could mean commercial banks are relied on to distribute CBDC on the central bank's behalf. Since bank deposits and products would compete directly with CBDCs, commercial institutions may introduce frictions, such as fees, to discourage CBDC use.

Both commercial and central banks will have the ability to control CBDC demand. The former could use the above methods to compete with a CBDC, while the latter could impose volume limits. During normal times, it is probable that individuals would hold bank deposits to earn higher spreads and utilise the additional banking services with only a fraction held in CBDC. Wholesale funding would be relied on to make up the shortfall from deposits. In times of financial stress, a CBDC would enable a faster run from the banking system to state-guaranteed money. However, central banks have the tools to cope with such situations if they were to lead to financial instabilities.

Threat to monetary sovereignty

Some central banks said allowing privately-issued digital currencies to dominate the payments landscape would pose a far greater risk than implementing CBDCs, tipping the balance in favour of public digital money. More than half said they were very concerned about the possibility that private challengers would critically undermine monetary sovereignty. One respondent said, 'There is a concern that multiple private digital currencies could emerge in a competition to issue an alternative digital currency, gain adoption, and earn the resulting seigniorage... This is concerning because any adoption of an alternative unit of account will erode the central bank's ability to conduct monetary and financial stability policy.' Careful consideration should be given to all scenarios and implications of a CBDC for financial stability, and relevant regulation should be adopted to minimise funding instability and bank runs.

Once the ramifications of any possible CBDC issuance have been thought through, central banks will have to deal with the finer points of implementation: who bears the costs, who distributes the CBDC, and other similar issues. These will be explored in the next section. ■

Public-private endeavours for CBDC operations



The distribution of cash is a hybrid endeavour. While it is issued, designed, and backed by the authority of a sovereign government, it is distributed by private banks. This public-private structure determines the ‘moneyness’ of various forms of credit that exist in a contemporary economy. In most cases, a CBDC would seek to emulate cash in its moneyness, serving as an explicitly public, anonymous legal tender, countering the emergence of private digital currencies.

However, given that CBDCs are digital, authorities might face significant practical challenges in implementing this structure. Regulatory barriers might complicate the task of distributing a cash-like CBDC and ensuring cross-border interoperability. This section examines how central banks imagine a retail CBDC might be issued and distributed, who would bear the cost of this endeavour, and how regulation interacts with these choices.

Bearing the costs of a CBDC

In our 2018 report on wholesale CBDCs, the central banks we surveyed concluded on balance that ‘the central bank should own, manage and operate any wholesale CBDC system, as well as play the role of settlement agent,’ although individual participants and regulators could still maintain nodes on the system to some degree. Most said central banks would be responsible for determining who has access to the system.

Central banks expressed similarly uniform views in this year’s survey. The CBDC scheme should be ‘designed, owned, and governed’ by the central bank ‘almost by definition’, according to one developed economy policy-maker. Since the goal is to emulate cash, a CBDC should be a ‘claim on the central bank’, or in other words a truly public form of money. The central bank would thus retain primary responsibility for the operational costs, participants agreed, much in the same way that it bears the costs for cash management and distribution.

**‘The store of value should be accessible to intermediaries, such as wallet providers on internet platforms, that “buy” the CBDC from the central bank, similar to the way that banks distribute cash today.’
Advanced economy central bank**

Private-public prospects

Most participants said there would be significant scope for private sector involvement in a CBDC scheme, in the same way that cash is distributed and accessible through private sector intermediaries. Yet views diverged on what form this involvement would take. Some central banks noted that certain functions – such as ‘onboarding and overlay services’, or the actual distribution of the currency itself – could be ‘outsourced’ to private sector participants.

Among respondents, 64% suggested that such ‘intermediation’ functions would be important. In the words of one central bank, a ‘CBDC would be distributed by licensed internet platforms/wallet providers that can have access to central bank accounts to buy CBDC and distribute it to their customers’.

This is sometimes referred to as a ‘synthetic CBDC’, wherein e-money providers have access to central bank reserves and are responsible for customer management, know-your-customer and anti-money laundering processes, and other features. This design would minimise potential competition risks. As Philip Lowe, governor of the Reserve Bank of Australia, noted in 2017, a central bank opening exchange settlement accounts for its citizens would bring it into direct competition with the private banking sector with respect to deposits. In addition, one central bank surveyed said this kind of ‘hybrid’ model ‘would be appropriate in order to avoid a run on banks during hardships’. This framework would entail new regulatory and supervisory requirements of the relevant intermediaries.

Some respondents disagreed with the notion that private service providers should necessarily play a role. Small, dollarised island economies were among the most insistent that a CBDC should remain a central bank scheme, while some emerging market central banks said they had yet to reach a decision on whether private service providers would become involved. Advanced economy central banks were the most vocal on the integration of private intermediaries. This

rests ultimately on design choices, as touched on in section three. If central banks wish to maintain undivided control over all aspects of the CBDC, this would require the creation of central bank accounts to ensure that store of value and means of exchange functions can be adequately met. It is conceivable that in very small economies, especially those with underdeveloped credit markets, it would be more manageable for a central bank to take over customer service functions and other necessary tasks. This would be a more pronounced obstacle to central bank control in larger economies.

Nevertheless, given the preferences expressed by most advanced and developing economy central banks, it is probable that any potential CBDC would be structured as a joint private-public endeavour, with private sector intermediaries taking on various onboarding, customer-facing, and distribution functions.

Regulatory implications

Before delving into the specific regulatory implications of CBDC issuance, it should be noted that several central banks were concerned about whether their mandate even allowed them to issue a digital currency. As one survey respondent put it, ‘The practical relevance of new instruments would depend on a great variety of different factors, including, importantly, their solid legal footing on central banks’ mandates.’

This concern was widely shared by respondents, who all expressed disquiet about how CBDCs and developments in the digital payments landscape would affect their mandate. The Riksbank addressed this in its second report on the potential issuance of an e-krona, concluding that the project fit within their legal obligation to ‘promote a safe and efficient payment system’. This report also debated whether the e-krona should be granted legal tender status, which would prevent discrimination against a digital payment in e-krona, ensuring its widespread acceptance and potential use.

Regardless of the involvement of private

service providers and the legal possibility of issuance, all respondents agreed that regulators should be able to supervise the system stringently, especially in respect of larger payments. This matches the findings of our previous report on wholesale CBDCs, in which central banks stated almost unanimously that regulators should be the holders of a ‘node’ on any system backed potentially by DLT. As before, there was a clear sense that true anonymity would be largely impossible, as regulatory requirements would require authorities to be able to access payment information in certain cases, such as when there is suspicion of money laundering. Arguably, central banks already hold significant power to monitor public transactions. However, they are limited in using these powers, as they must first prove that doing so is in the public interest, as well as weigh up the high cost of their use.

One alternative suggested by a respondent was to provide pseudo-anonymity, whereby users of CBDCs will generally be afforded anonymity in their transactions, but, when necessary, traceability is possible. There would also be a multistep legal process involved if a central bank or relevant authority requires access to personal transaction data.

This points to a broader theme that emerged from our survey. Central banks insisted that anti-money laundering laws and regulations to counter terrorism financing would have to be strictly enforced, a feature which would make a CBDC – to some extent – different from cash. Arguably, this could represent an improvement over cash for anti-money laundering purposes. As one respondent noted, ‘It would be easier to track down the transaction history, [though] it would not be a complete guarantee.’

Some respondents were optimistic that the technology behind a potential CBDC would make it easier to implement anti-money laundering regulations (although proper user authentication would be in place). Yet some expressed concern that there might be a clash between the implementation of this legislation

and the fundamental purpose of introducing a cash-like CBDC. One central bank summarised the problem as follows: 'It is necessary to balance the potential need for a private payment instrument with anti-money laundering requirements.' Cash is a public good, in that it is a truly anonymous, public means of payment. Yet this clashes with regulatory implementation. As such, central banks must carefully weigh these options, ensuring that the public-good aspects of a cash-like CBDC can be fully enjoyed by their respective constituents.

On a global scale, any CBDC would have to comply with the requisite BIS rules, in this case the Principles for Financial Market Infrastructures. These stipulate a defined set of rules that financial market infrastructures must meet to ensure their operational, legal and financial resilience. The ability of any individual public digital currency project to meet these criteria would generally depend on relevant design choices.

Cross-border interoperability

Despite the existence of global rules, they are not the decisive factor in determining whether a CBDC will be interoperable and able to service cross-border transactions. Rather, central banks were most concerned about the ability of national rules to apply across boundaries, and the potential incongruities that might arise between various CBDCs.

The stringency and properties of anti-money laundering and combating-the-financing-of-terrorism requirements may vary between countries, making it difficult for digital currencies to cross borders while also reducing the cumbersome frictions

'Ideally, if countries concerned could come together and agree upon a harmonised framework for retail CBDCs, then cross-border payments could be more easily facilitated.'

Advanced economy central bank

present in existing cross-border payments systems. This also applies to data protection standards, which vary across jurisdictions and may pose concerns around the anonymity and privacy of CBDC transactions. While some central banks noted they already had interoperability frameworks in place with various partner countries and/or through regional bodies, 60% expressed explicit concern that this issue would encumber progress on CBDC issuance.

One other main example concerns digital identity management and how this might work in cross-border transactions. In such a case, 'a single verifying mechanism not only confirms the identity at each end of the transaction but also does so for other processes that require verification, such as currency exchange,' as one survey respondent put it. This is especially necessary to fulfil know-your-customer rules in both countries.

Digital identity verification is essential to the operation of a CBDC, particularly in cross-border transactions. Tradeable digital assets must be tied to a digital identity system, which in turn might be tied to an automatic know-your-customer (and anti-money laundering) verification system. This is a foundational step to the potential use of CBDCs and must be addressed by central banks. Nascent developments in regulatory and compliance technology may benefit

central banks' experiments in the digital currency space.

This applies not only to questions around legal and regulatory harmonisation, but also to 'cross-country differences in technical and operational standards' that might be, in the words of one advanced economy central bank, the 'main obstacles to the regional or global interoperability of CBDC systems'. These standards might diverge across economies, preventing CBDCs from producing powerful efficiency gains in cross-border payments. This raises significant questions about liquidity management across borders. For instance, some CBDC systems might be transferring funds via Swift messages, while others may be using DLT-backed infrastructure reliant on tokens or stablecoins. Central banks in our sample did not specifically address the question of what liquidity might be needed in the event of such a cross-border transaction. Yet it is clear that some kind of unified corridor or harmonisation is required to achieve maximum efficiency gains. This requires further investigation, as many of the benefits of digital currencies hinge on addressing it correctly, to say nothing of the numerous other practical concerns described in this section. What is certain is that the private sector will be intimately involved in some capacity in the dissemination and management of any prospective CBDCs. ■



64%

Among respondents, 64% said 'intermediation' functions, such as customer onboarding, which could be 'outsourced' to private sector participants, would be important in CBDC implementation

Advent of a retail CBDC expected within five years

IN THIS report we have set out – with help from the global policy-makers who participated in our survey, to whom we owe a debt of gratitude – current central bank perceptions of the advent of disruptive financial technologies and the possible introduction of central bank-issued digital currencies. Policy-makers' assessments are many and varied, and depend much on their economies' size and monetary policy objectives. But one thing is certain: regulators will not sit idly by as new systems pose potentially severe threats to existing structures. Policy-makers dare not risk being left behind as the technology continues to advance.

The principal conclusion is that we are likely to witness the introduction of a central bank – that is fiat – retail digital currency within the next five years, either as a complement to or as a substitute for notes and coins. It is improbable that the first such issuance will come from a G20 central bank; it is considerably more likely to be launched in a smaller and less complex economy in response to a specific policy objective and use case. This may relate to improving the overall effectiveness and resilience of a national payments system by reducing the prevalence of cash. Alternatively, it could be associated with extending financial inclusion; reducing the size of the dark economy; countering financial crime; or for a specific purpose, such as transforming the cross-border transmission of migrant worker remittances.

In most instances, the development is most likely to be nationally driven, but increasing co-operation and collaboration between monetary authorities are likely to become the norm. There will be no 'one size fits all' solution, and we expect to see the emergence of several different models, use cases and approaches, some perhaps even in direct intellectual competition with one another.

Although the primary drivers of these initiatives will be

central banks and associated national authorities, we anticipate extensive private-public sector partnerships wherein the private sector provides or indeed runs technology, infrastructure and operations on an outsourced or more deeply collaborative basis. We believe there will be a growing number of studies, use cases and pilot programmes as both sectors explore, design and test the art of the possible and desirable. We note, however, that these initiatives will be driven by policy and not technology. It remains unclear whether blockchain technology or its analogues are the best route forward for digital currency implementation, and central banks by and large are technology agnostic. Ideally, they will settle on their precise policy objectives and then find the most appropriate technological solution, rather than be wedded to a specific technology beforehand.

We do not envisage privately-issued digital currencies gaining significant traction or acceptance in a universal context, although there may be closed private networks in which they operate. The determination of national governments to protect the monopoly enjoyed by fiat currency, and the commitment of regulators to financial stability, will in our view raise insuperable hurdles to the establishment of a private digital currency as a significant means of exchange, however gilt-edged its asset backing. Pure, unbacked cryptocurrencies such as bitcoin will remain the minority pursuit of speculators and denizens of the dark web.

Our hope is that this report will serve policy-makers, industry specialists, economic commentators, scholars and the general reader as a useful companion to the impending and all-but-certain changes to retail payments systems. We at OMFIF and IBM welcome comments, affirming or otherwise, and look forward to charting the future of central bank digital currencies in further studies and through our continuing dialogue with policy-makers the world over. ■

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IBM Blockchain is recognised as the leading enterprise blockchain provider; working with hundreds of clients across financial services, supply chain, government, retail, media and healthcare to implement blockchain applications, and operate a number of networks running live and in production. The company's research, technical and business experts have broken barriers in transaction processing speeds, developed the most advanced cryptography to secure transactions, and are contributing millions of lines of open source code to advance blockchain for businesses.

Visit www.ibm.com/blockchain/industries/financial-services to learn more about our capabilities in the Financial Services industry.

About OMFIF

The Official Monetary and Financial Institutions Forum is an independent think tank for central banking, economic policy and public investment – a non-lobbying network for best practice in worldwide public-private sector exchanges. At its heart are Global Public Investors – central banks, sovereign funds and public pension funds – with investable assets of \$37.8tn, equivalent to 43% of world GDP. With offices in both London and Singapore, OMFIF focuses on global policy and investment themes – particularly in asset management, capital markets and financial supervision/regulation – relating to central banks, sovereign funds, pension funds, regulators and treasuries.

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This report is not solely for specialists in digital currencies and payments systems, but for a more general readership interested in financial and regulatory development. See page two for note on frequently used terms.



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