PROJECT NEW ERA | GREEN PAPER

A New Era for Money

February 2022

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The mass adoption of any new form of money will shape the future of our global civilization. As innovators and disruptors, we must carefully examine societal impacts in the design of CBDCs and other digital currencies. We must recognise our responsibility to future generations who will ultimately be shaped by the execution of our ideas. paywith.glass is intelligent Digital Currency/Electronic Payments (iDC/EP) infrastructure which has been designed through careful academic research and industry collaboration at every step. Its development has considered the societal impact and the technical and economic risk factors that must be mitigated for it to be deemed fit for purpose. We are proud to lend our experience alongside input from the brightest minds of our generation, as we contribute to shaping the new era of money.

Daniel Holden
Group CEO

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Innovation creates change. As digital currencies expand their reach and become mainstream, there will be an explosion of use-cases and practical benefits to their adoption.

Trust Payments is very proud to support the thought-leadership in this area. As an innovative disruptor in the fintech space, we have been strong advocates of digital currencies, in responsibly regulated environments. Trust Payments is investing heavily to support this new era in retail payment experiences, which can be realised through digital currency adoption.

This paper sets out a way forward to leverage new regulation and technology to significantly enhance future payment utility and effectiveness. Change can now create great benefits.

Amit Sharma
Founder, CEO

FinClusive

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FinClusive is a hybrid fintech/regtech company that connects traditional banking with the blockchain-enabled payments and virtual asset networks and exchanges—with an embedded full-stack Compliance-as-a-Service (CaaS) platform. CaaS provides global-standard KYC/KYB coverage, client and transaction monitoring, watchlist/sanctions screening, and a full array of due diligence and analytics in one application. Built for both traditional (Tradfi) and decentralized financial services (Defi), FinClusive issues compliance backed digitally verifiable credentials--and legal entity identifiers (LEIs)--to clients enabling a secure KYC/KYB verification utility across providers globally.

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the payments association

The Payments Association is a community for all companies in payments where the connections, collaboration and learning shape an industry that works for all. Since 2008, The Payments Association has been stimulating innovation and building the bridges that join the ecosystem together. To join the Digital FMI Consortium contact the Director General, Tony Craddock (tony.craddock@thepaymentsassociation.org).

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Executive summary

Project New Era is a privately led initiative evaluating the path towards a retail Central Bank Digital Currency (CBDC) in the UK. The project proposes closer public-private collaboration in order to address key challenges and open questions relating to CBDC development.

The project commences with a Green Paper, co-developed by business leaders from across the financial ecosystem. The paper examines the case for retail CBDCs, details core design considerations, and proposes a roadmap for collective, public-private experimentation. The paper is a call to action for industry stakeholders including businesses, central banks, regulators, government officials and researchers.

Definitions of core concepts and financial instruments vary significantly across existing CBDC literature. This paper attempts to standardise terminology, but recognises the diversity of perspectives that exist. For avoidance of doubt, the paper solely considers the development of a CBDC ecosystem, and does not focus on cryptocurrencies. In this paper, a retail CBDC refers to a digitised form of M0[1] money, coexisting alongside cash and issued by a

1. M0: Comprised of banknotes and coin in circulation, plus central bank reserves; adapted from Bank of England

central bank as a direct liability for general purpose, domestic circulation. We also raise the potential for CBDC to form a new monetary category beyond M0 money, including as an on-balance sheet commercial bank[2] liability to mitigate any potential bank disintermediation.

The paper first analyses recent dynamics in the payments industry and the emergence of privately issued digital currencies, determining that market trends and existing payment inefficiencies are creating a platform for change. E-commerce and new digital payment methods, such as mobile wallets and UPI-based applications, continue to drive the displacement of cash payments (30% contraction globally in 2020 vs 2019), accelerated by COVID-19. Despite this, some segments in society will continue to prefer the use of cash, and circulation continues to grow across many economies[3]. In parallel with these changes, the next wave of disruption in payments has also begun, powered by Distributed Ledger Technology (DLT). DLT offers a new infrastructure for digital money, fulfilling traditional functions and providing new functionality like programmable payments. This could enable further innovation for all players in the market whilst enhancing customer experience.

In parallel, two types of private sector digital currencies have emerged, enabled by Distributed Ledger Technology: cryptocurrencies and stablecoins. Stablecoins are digital assets that aim to maintain a fixed value relative to a specified asset, and typically the U.S. Dollar. Stablecoins are beginning to offer some real-world utility, particularly in the Decentralised Finance (De-Fi) industry. Stablecoin growth exploded in 2021, though this is a small fraction when compared to total global non-cash payment volume[4]. Adoption as a means of payment for traditional goods, services, and assets remains limited.

With growth and early real-world utility, regulators are increasingly concerned by the potential risks posed by unregulated stablecoins on consumers and broader financial stability. These include issues around collateralisation with risky and/or illiquid assets, and the potential to trigger a 'run' where redeemability at par is thrown into doubt or 'breaks the buck[5]'. Risks also exist around consumer fraud and currency substitution by non-local currency stablecoins operating at a critical mass. Central banks and regulators across the globe are exploring two paths in response: regulating stablecoins and issuing a sovereign digital currency, CBDC.

A retail CBDC is a digital asset issued by a central bank for general purpose, domestic circulation. As a central bank liability, a CBDC could be free of credit and liquidity risks. Unlike a wholesale CBDC, it would be made available to the general population. A CBDC can generally take two forms:

1. **Conventional CBDC:** a digitised form of M0 money, co-existing alongside cash and issued by a central bank as a direct liability on their balance sheet; and
2. **Synthetic CBDC (sCBDC):** a digital settlement asset that is fully collateralised by central bank reserves but issued privately, similar to models used by some non-bank Electronic Money Institutions[6]

The distribution of CBDC in live implementations and pilots (including The Bahamas, Nigeria, and China, with an Indian pilot due later in 2022) is through a 'two-tier', indirect approach[7]. A two-tier model distributes CBDC to citizens through commercial banks and non-banks in an open market model. The central bank oversees management of the central ledger, including net settlement. Commercial banks and non-banks are responsible for wallet issuing and the provision of financial services.

Drivers for CBDC adoption vary by country, but the primary benefits are similar. These include near-instant settlement, potential for reduced transaction costs (both particularly material for merchants receiving consumer payments), fraud reduction, and programmable payments. Programmable payments - a new breed of automated payment - is distinctive in enabling new forms of self-executing payments based on programmed code and external triggers for complex, conditional payment propositions. Secondary benefits such as financial inclusion vary by country, while effectiveness for monetary policy implementation and countering the threat of stablecoins is yet to be established.

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2. Commercial banks are defined as deposit-taking, credit institutions
3. Bank of England, 'Notes in circulation' data table, January 2022 and US Federal Reserve, 'US Federal Reserve - Currency in Circulation: Volume', January 2022
4. BCG Global Payments Model, 2021
5. 'Breaking the Buck' typically refers to the net asset value of a money market fund, which uses amortisation to maintain a constant value of $1 USD, falling below $1 USD. We repurpose this concept for stablecoin collateralisation given the conceptual similarity.
6. Electronic Money Institutions Issue E-money (Electronic money), defined by the Financial Conduct Authority as monetary value used to make payments and is represented by a claim on the issuer; issued on receipt of funds; stored electronically (including magnetically); and accepted by persons other than the issuer
7. The alternative, 'direct' distribution model is understood as a central bank managing all aspects of a CBDC, without the involvement of banks and non-banks. This is a theoretical construct with limited real-world viability and does not appear in any advanced CBDC initiatives.

CBDCs are unlikely to displace stablecoins as a bridge for cryptocurrency traders in the short-term, given the need for direct integration with public blockchains like Ethereum. Due to compliance, cybersecurity and other regulatory concerns, this is an unrealistic outcome. However, CBDCs over the long-term could provide a regulated alternative in a future digital currency ecosystem. Superior end-user adoption over stablecoins, driven through enhanced value propositions like convenience and safety, may limit the materiality of stablecoin risks to financial stability.

Adoption of CBDCs is likely to take time, with significant hurdles to overcome. Current sentiment is that the first CBDCs in developed markets like Sweden will arrive between 2022 and 2023, with more to follow in subsequent years. A synthetic CBDC offers an alternative route to market, with functional equivalence to a conventional CBDC in terms of economic and societal benefits. However, many of the same risks exist with synthetic CBDCs, and new challenges are introduced.

Central bank CBDC research and broader topic interest is intensifying. ~90% of central banks surveyed by the Bank for International Settlements (BIS) are actively researching CBDCs, with a focus on retail applications. Developing economy progress is generally more advanced than developed economies, with three full implementations currently live in the Bahamas, Cambodia and Nigeria. The East Caribbean Currency Union's DCash pilot[8] and China's expanding e-CNY are in close pursuit[9]. The Reserve Bank of India has also announced the trialling of a Digital Rupee later in 2022. In the most prominent initiatives, central banks are typically supported by private sector players.

Early adopters are realising benefits by proactively shaping the role of digital money in their economies, guiding design and implementation choices to enable innovation in their markets. For example, most are supported by private sector technology[10] and provide a clear steer on the broader, open market ecosystem supported by the private sector through wallet issuing and service provision[11].

However, in many developed economies, considerable ambiguity remains regarding the direction of central bank plans for digital currencies. The current discourse is dominated by debates focused on issues rather than collaborative initiatives looking for constructive solutions.

A call to action

We encourage central banks to drive the process and provide clarity on the architecture of a future digital currency ecosystem. There is an opportunity to bring the industry together and define a clear framework for collaboration - with a roadmap to address open questions, risks and intended roles left to the private sector.

Key questions which continue to be raised in the market on CBDCs revolve around potential bank disintermediation and 'flight-to-safety' liquidity crunches during crises. There are also ongoing debates around how to protect high levels of privacy and ensuring strong standards of resiliency and cybersecurity.

However, options for effective mitigation are possible through collaborative, public-private design with a diverse range of inputs. For example, central banks can consider options for CBDCs as on-balance sheet liabilities for commercial banks, along with withdrawal limits and other disincentives to mitigate any future risks to the supply of credit in the market.

Additionally, to really prove the case for retail CBDCs, programmability needs to be enabled through an open, inclusive and well thought-through design that can enable tangible benefits for consumers and businesses.

In line with this, this Green Paper therefore proposes a roadmap for collaboration between the private sector, central banks, and regulators. The objective is to move the discussion forward by conducting a controlled, real-world pilot, tasked with addressing open design questions and mitigating risks, such as bank disintermediation. The pilot will help generate real-life data and feedback that central banks and policymakers can use to inform open design questions and drive policy decisions.

The first step on this roadmap is the testing of a 'pre-CBDC'. We define 'pre-CBDC' as a digital settlement asset that can be collateralised through commercial bank reserve account or commercial bank account. This is only intended to be used for the purposes of the pilot. The conceptual design will enable rigorous testing of a CBDC-like asset and simpler, cautious future transitions for central banks into synthetic or fully-fledged CBDCs.

8. Eastern Caribbean Currency Union website, January 2022
9. Reuters, '$9.5 billion spent using Chinese central bank's digital currency - official' November 2021
10. Reuters, 'Nigeria to partner with Bitt Inc to launch 'eNaira' digital currency | Reuters', August 2021 and Eastern Caribbean Currency Union website, 'Bitt Partners with ECCB to Develop World's First Central Bank Digital Currency in a Currency Union | Eastern Caribbean Central Bank', March 2021
11. See for example, Central Bank of Nigeria, 'Design paper for the eNaira', October 2021; and People's Bank of China, 'Progress of Research & Development of E-CNY in China', July 2021

To facilitate this, Project New Era will now aim to bring together a private consortium in the UK (Digital FMI Consortium), led by the private sector and in alignment with central banks, regulators, and government. The consortium will issue a pre-CBDC UK asset known as 'dSterling', with collateral held at a one-to-one ratio in a reserve account to reduce risk and validate use cases. The pilot will also consider options for the use of commercial bank liability to examine the role of banks in a CBDC environment, withdrawal limits and other disincentives to mitigate any future risks to the supply of credit in the market. The objectives of the pilot are as follows:

1. Resolving open questions and topics of debate in the market through intelligent, inclusive design (such as options for commercial bank liability);
2. Providing inputs to inform regulation and enable relevant authorities to drive policy decisions that incorporate multiple feedback loops from all industry stakeholders; and
3. Validating the four use cases highlighted in this paper, pressure-testing value potential, and providing data to central banks and regulators on how best to deploy a CBDC.

The paper examines four high potential use cases, summarised below:

- **Retail payments:** Delivering benefits of shortened payment settlement cycles and potential to reduce transaction costs for merchants when compared with card payments. Programmability enabling innovative use cases like conditional payments, and near real-time pay-per-use micropayments.
- **Cross-border transactions:** Enabling near-instant settlement, reduced transaction costs, and enhanced payment traceability compared with existing solutions. This use case requires collaboration with other CBDCs globally and the pilot will explore interoperability requirements to future-proof the digital financial market infrastructure (Digital FMI)
- **Tokenisation-as-a-Service:** Providing infrastructure for future use cases that enables private organisations on the Digital FMI to tokenise and transact assets for use in closed ecosystems with customers or suppliers. The assets can be financial, utility-based, or physical.
- **Servicing Payment Institutions (PIs) and Electronic Money Institutions (EMIs):** Enabling PIs and EMIs to use the dSterling as a secure, liquid asset with regulatory acceptance for safeguarding. The asset also enables access to an alternative payment rail, given challenges in the industry around non-bank access to banking.

We note these use cases represent just the 'tip of the iceberg,' existing to identify 'day one' value and provide a directional view on where the dSterling could deliver benefits as part of the broader exploration of a CBDC. Future innovation in the market will continually introduce new use cases and greatly enhance existing ones.

The outcome of these pilots will be shared openly with Central banks, regulators, and government to inform decision making and ongoing regulatory and CBDC research.

1 | Purpose of this Paper

This Green Paper seeks to stimulate a bold debate, defining a new era for digital money that coexists alongside other forms of money, including commercial bank deposits and central bank-issued banknotes.

The explosion of unregulated, privately issued crypto-currencies and stablecoins in 2021[12] has spurred regulators around the world into action. In parallel, the COVID-19 pandemic has intensified the decline of cash payments and the growth of e-commerce. This has created a perfect storm that is partly driving Central Bank Digital Currency (CBDC) research across the world. Although much has been written about CBDCs, there is widespread ambiguity regarding central bank plans for CBDC throughout the private sectors of leading developed economies.

12. TheBlockCrypto, 'Stablecoin Supply Charts', January 2022 (BCG analysis)

Polarised debates often dominate the CBDC discourse, with central banks attempting to preserve their neutrality. We see limited evidence of public-private collaboration that focuses on constructive exploration of retail CBDCs. This hinders the ability of central banks to assess value potential, address open design questions, and derive practical policy implications. When compared with early adopters such as The Bahamas, Nigeria, and China, developed economies can do more to proactively shape the role of digital money in their markets.

The Green Paper and the broader New Era project has been co-developed by a consortium of business leaders from across the financial ecosystem to fill this void. We lay out an ambitious roadmap for a multi-year journey split across three phases:

1. Publishing this Green Paper to define a framework for public-private partnership to explore a retail CBDC. The partnership exists to provide inputs for policy considerations and market use cases, in anticipation of a world where digital money begins to drive larger scale penetration throughout society.
2. Executing the Digital Financial Market Infrastructure (FMI) pilot in the UK, led by a private sector consortium. The pilot will provide sandbox environments to simulate a fully functional, commercial digital economy. A digital settlement asset, will be issued to test conceptual designs, define the ecosystem, and interrogate use cases for value potential. In the rest of this paper, we will refer to this asset as dSterling. Together, these components enable lower risk and real-world infrastructure design, identification of value for end-users, and the testing of policy frameworks for regulators.
3. Future collaboration with central banks and government, informed by the findings of the pilot, to support lower risk transitions from proof-of-concepts, and into synthetic and/or fully-fledged CBDC implementations.

To mark the end of phase one, we have summarised our extensive research in this initial paper. A series of follow-up engagements to debate the findings and the launch of the Digital FMI pilot will follow later in 2022.

The paper builds on existing international research[13], but is differentiated in prioritising non-academic, real-world considerations. We review the current digital currency landscape and the potential for a retail CBDC to address systemic inefficiencies experienced by retail participants. We also note the considerable challenges, risks and open questions that require navigation. A minimum viable design and high potential use cases are examined in detail. Finally, we lay out practical next steps for a pilot to test the findings of this paper, and to mobilise action towards the creation of a retail CBDC.

It is well understood that the path to a CBDC is a long and complex one. Domestic progress requires a framework for public-private partnership that is inclusive, leverages private sector strengths, and mitigates risks identified in this and other papers. International progress will require close co-operation and knowledge-sharing across jurisdictions to enable cross-border interoperability.

The Digital FMI pilot, powered by the dSterling settlement asset, provides a pragmatic first step to solve some key challenges, and to drive progress towards a retail CBDC. As detailed in *The Way Forward chapter* in this paper, this proposal uniquely brings together critical components to establish collective experimentation, including:

- Identification of high potential use cases and value enablement of a CBDC in a low-risk environment.
- Use of dSterling to bridge the benefits of private stablecoins with those of a CBDC for the purposes of testing.
- Involvement of banks and non-banks to explore options around commercial bank liability, ecosystem structure, and innovation through programmable payments.
- Coexistence and integration with existing forms of money, payment rails and digital currencies, along with multi-jurisdictional interoperability to enable cross-border transactions.
- Generation of real-world data to provide central banks and regulators with inputs for regulatory and legislative frameworks, as required to support a new era of digital money.

Successful execution of the pilot will pave the way for cautious progression towards a retail CBDC with clarity on use cases, commercial bank liability, conceptual designs, infrastructure, 'day one' value propositions, the role of the private sector, interoperability, and policy.

As private stablecoin adoption continues to demonstrate value-adding use cases, the risk of financial instability is likely to increase. Digital money is already extending its reach beyond the niche of speculative enthusiasts and into the wallets of retail investors. Governments, regulators, central banks, and corporations all have a timely opportunity to come together and pre-emptively shape the future of money, in a way that protects the public and unlocks benefits for all stakeholders across society.

13. Including the Bank for International Settlements (BIS), the International Monetary Fund (IMF), the World Bank, the Bank of England, the European Central Bank, the Bank of Canada, the G7 public policy principles for retail CBDCs, VISA and others.

2 | Background: A platform for change

Digital currencies emerged with the advent of Bitcoin in 2009. Since then, an array of competing cryptocurrencies and stablecoins (a form of cryptocurrency designed to maintain a stable price), have entered the market. In 2021, the combined market capitalisation of cryptocurrencies and stablecoins peaked at over~$3 trillion[14].

Because of these fast-moving trends, privately issued digital currencies are now firmly on the agenda of businesses, regulators, and central banks around the world, and yet, remain widely misunderstood. This chapter provides broad context and common terms for the rest of this paper. It will cover:

- An overview of recent market trends in global payments.
- A classification of digital currencies.
- The rise of stablecoins and potential risks to financial stability.

14. Coingecko, "Total cryptocurrency market cap", BCG Analysis

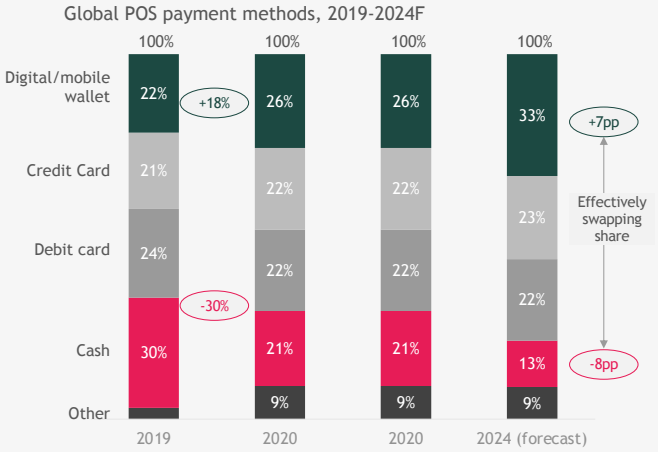
2.1 The decline of cash and the rise of digital payments

The decline of cash payments at the Point of Sale (POS) has long been in motion, driven by e-commerce growth and adoption of digital payment methods like contactless cards, digital wallets[15], and bank transfers. The COVID-19 pandemic has accelerated this trend.

By the end of 2020, for the first time, cash payments accounted for the lowest share of all major payment methods globally. Our analysis of Worldpay data points to a global ~30% year-on-year contraction in cash use in 2020 vs 2019[16]. Digital payment methods now account for most Point-of-Sale transactions in all geographies, except the Middle East and Africa (see exhibit one).

Exhibit 1 | Declining cash usage and increasing digital wallet adoption

COVID-19 drove ~30% YoY decline in cash use in 2020; eWallets to take further txn share from cash by 2024



Source: Worldpay from FIS, 'The Global Payments Report', 2020 and 2021; BCG analysis

Forecasts suggest digital payments are here to stay. With new consumer behaviours around convenience entrenched, digital wallets are likely to continue taking share from cash. By 2024, Worldpay data suggests global cash usage will shrink to ~13%, down from ~21% in 2020. In parallel, digital payment share is expected to expand to ~33%.

Despite these trends, the 'death' of cash is highly unlikely, with segments of society continuing to rely upon or prefer cash usage over digital forms of money. The value of total cash in circulation continues to grow in many economies, including the UK and the US. Bank of England data, for example, shows an average annual growth rate of ~7% between 2019-2021[17], with dollar banknotes growing at a similar pace[18]. Vulnerable groups like the unbanked and less digitally savvy will continue to exist, while the unique physical nature and anonymity of cash serves important use cases in society.

2.2 The growth of private sector digital currency

The next wave of disruption in payments is being powered by blockchain technology, as popularised by Bitcoin and the pseudonymous Satoshi Nakamoto. Blockchain is a type of distributed ledger technology (DLT), the foundational infrastructure for privately issued digital money. DLT is a combination of existing technologies, including Peer-to-Peer (P2P) networking, distributed timestamping, digital signatures, and hash functions[19].

Together, these technologies combine and form a record of transactions spread across a network of computers. Users can read, verify and add transactions by following the relevant protocol. The security of this record is provided through cryptography, a form of encryption. Most DLTs build on this by offering functionality to create smart contracts, pieces of self-executing code that govern the behaviour of digital assets on the network.

DLT could provide a compelling infrastructure for a digital currency because it theoretically enables:

- Near-instant transaction settlement;
- 24/7 availability;
- A new breed of automated payments known as programmable payments; and
- Potential for operational simplification and lower transaction costs.

The combination of these attributes in a single solution is novel, though developments have also occured in existing forms of payment too. For example, low value, domestic account-to-account transfers can occur in near real-time using the UK Faster Payments system. However, our analysis of Worldpay data suggests bank transfers formed ~6% of global retail e-commerce spend in 2020, and even less at the Points of Sale (POS)[20]. The

15. Digital wallets enable users to store bank cards or cash on digital applications to make payments (e.g., contactless mobile payments). They are independent from bank accounts.
16. Worldpay from FIS, 'The Global Payments Report', 2020 and 2019 (BCG analysis)
17. Bank of England, 'Notes in circulation' data table, January 2022 (BCG analysis)
18. US Federal Reserve, 'US Federal Reserve - Currency in Circulation: Volume', January 2022 (BCG analysis)
19. A hash function is any function that can be used to map data of arbitrary size to fixed-size values
20. Worldpay from FIS, 'The Global Payments Report', 2020 and 2019 (BCG analysis)

majority of payments are instead conducted via credit and debit cards, where merchants experience delays between payment and settlement, impacting cash flow. Although consumers do not directly bear the cost of card transactions, merchants can pay ~1-2% per transaction, which eats into margins or indirectly flows into consumer prices.

There is also no existing payment infrastructure that features programmability, demonstrated in the De-Fi industry through smart contracts. In the programmability deep-dive in section 3.5, this paper will demonstrate that the use of DLT has the potential to usher in radically new business models and customer value propositions.

Having said this, implementations of DLT for private digital currencies have not been without issue either. Congestion and slow processing speeds have plagued many cryptocurrencies, limiting real-world use cases. Financial crime has also been a significant challenge. A recent report found crypto-related fraud amounted to ~$14b USD in 2021, up 79% from 2020 though down to just ~0.2% as a percentage of trading volumes in 2021 as adoption grew[21]. Finally, Proof-of-Work[22] based blockchains, such as Bitcoin and Monero, have high energy consumption that has even led to electricity shortages in markets like Kazakhstan[23]. The high carbon footprint is a significant constraint with governments and companies prioritising sustainability as strategic priority. Alternative mechanisms like Proof-of-Stake[24] have been shown to have a significantly lower environmental impact[25].

De-Fi and related DLT payment tools have also attracted regulatory scrutiny for non-compliance with regulation, including AML and KYC. Cybersecurity risks also exist to consumers and the broader financial system. Some DLTs have been hacked at the wallet or exchange level, leading to large-scale losses given there is no insurance against such events[26]. Macroeconomic risks are particularly prevalent in the case of stablecoins, and we will examine them later in this chapter. Ultimately, DLT is not the only design option when building an infrastructure for digital currency. Design choices should be made in line with the use cases they are intended to fulfil.

Two categories of digital currency have emerged on public DLTs: cryptocurrencies and stablecoins (see exhibit two).

Private cryptocurrency and stablecoin volumes soar in 2021

Cryptocurrency and stablecoin adoption exploded in 2021 and there is now regulatory uncertainty around both as of February 2022. Although stablecoins are considered a type of cryptocurrency, their use cases are very different.

Exhibit 2 | Two private sector digital currencies are emerging

	Cryptocurrencies	Stablecoins
Description	**Blockchain-based tokenised currency** with transactions recorded and verified on a digital ledger using cryptography	**A digital asset** that aims to maintain a stable value relative to a specified asset, such as fiat currency
Issuer	Issued by by anyone	Issued by private entities
Use case(s)	Investment, access to decentralized finance (De-Fi) and smart contracts	Cryptocurrency trading, De-Fi and payments (e.g., remittances)
Regulation	Depends on jurisdiction	Regulation expected

Source: 'Get Ready for the Future of Money', BCG publication, 2020

21. Chainalysis, '2022 Crypto Crime Report', February 2022
22. Proof-of-Work is a consensus model to verify transactions in a blockchain that involves intensive computer calculations typically leading to high energy usage
23. TheBlock, "Following energy shortage, Kazakhstan is reining in 2021's stampede of crypto miners", January 2022
24. Proof-of-Stake is an alternative consensus model to Proof-of-Work where instead of computer calculations, the value of a user's cryptocurrencies is used to verify transactions in a blockchain
25. Ethereum.org, "Ethereum's energy usage will soon decrease by ~99.95%", May 2022
26. Bitfinex, "Security breach", August 2016

Cryptocurrencies

Cryptocurrencies are designed as free-floating assets, with prices determined by market demand. Bitcoin, the first cryptocurrency, is optimised as a store of value. This is demonstrated by its prioritisation of security features over programmability or transaction throughput, which is typically ~5 transactions per second[27].

An array of cryptocurrencies has since entered the market, many operating on the Ethereum blockchain, which offers some upgrades on Bitcoin. This includes faster transaction processing (~30 transactions per second[28]) and programmability that has enabled the rise of De-Fi. Despite these relative improvements, cryptocurrencies are still characterised by slow transaction throughput. This has raised broader questions around the scalability of DLT when compared to non-DLT based infrastructure like card networks. Visa, for example, claims capacity to process 65K transactions per second[29].

Volatility is the other significant limiting factor. Though cryptocurrency growth has been explosive over the last eighteen months (the price of Bitcoin has nearly quadrupled from ~$10K in Q3 2020 to ~$36K in February 2022, after peaking at $69K in 2021), prices are typically very volatile on a day-to-day basis. Bitcoin experienced 10 percentage point swings in price more than ten times in the past year[30]. Other cryptocurrencies exhibit strong correlation with Bitcoin volatility.

These limitations have meant the primary use case remains as a speculative investment asset for traders and enthusiasts. Indeed, even though Bitcoin was recently recognised as legal tender in El Salvador, adoption of the asset for payment has reportedly been slow, with citizens even heavily protesting the move in October 202[31]. El-Salvador's sovereign spread has exploded since its adoption of Bitcoin as a legal tender from 5% to 35%, a high probability of insolvency[32]. The IMF has recommended that the country abandon its Bitcoin reserves and legal tender status as a condition for a major loan.

Stablecoins

The same cannot be said of stablecoins, which offer the functional benefits of cryptocurrencies, but with faster transaction speeds and no material price volatility. Major stablecoins experience higher transaction speeds and larger scale exchange. Stabilisation mechanisms such as collateralisation enable stablecoins to have predictable value. For example, over 95% of stablecoins claim one-to-one pegging with the US Dollar[33]. These attributes have led to their use as a safe haven for cryptocurrency traders locking in investment gains, offering the convenience of remaining 'on-chain'[34] to avoid the delays and fees of fiat off-ramping[35].

Stablecoins have also fuelled the growth of the De-Fi industry, used as collateral in services such as MakerDAO's DAI or Compound. As of December 2022, >40% of all USDC stablecoin are locked in smart contracts on Ethereum[36], showing the clear demand for Stablecoins in DeFi.

Corporations are also investing in stablecoins with the now sold Diem by Meta (formerly Libra by Facebook)[37] and Onyx by JP Morgan[38]. Visa has already enabled transaction settlement via the USDC stablecoin, and announced a project to enable interoperability between fiat and digital currencies[39]. More recently, PayPal is also exploring a stablecoin[40]. These moves reflect use cases for faster payments between organisations, avoiding high corporate fees and execution times, and for overseas remittances (e.g. DAI for Mexico-US). It should be noted, however, that settlement delays and costs incurred for cross-border account-to-account transfers is typically driven by AML/KYC requirements that banks are compelled to provide and that cryptocurrencies and stablecoins often skirt. This 'regulatory arbitrage' advantage may well be lost with the onset of impending regulation.

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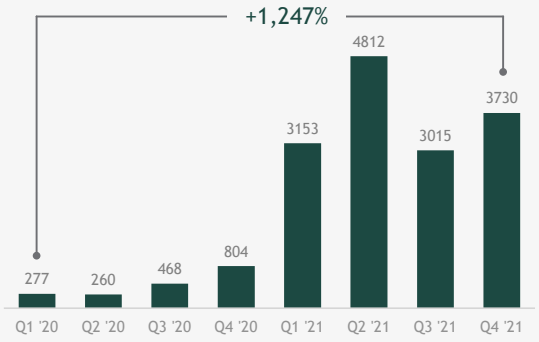
27. Blockchain.com 'Transactions per second'
28. Ethtps.info, 'Ethereum Transactions per second', January 2022
29. Visa website, 'Factsheet', accessed January 2022
30. Investing.com 'Bitcoin historical data' January 2022
31. BBC.com, 'Bitcoin protests in El Salvador against cryptocurrency as legal tender,' January 2022
32. Bloomberg, "Bitcoin bond plan sends El Salvador's dollar debt diving", November 2021
33. TheBlockCrypto, 'Stablecoin Supply Charts,' January 2022 (BCG analysis)
34. 'On-chain' refers to keeping assets and activities on a blockchain as opposed to more traditional infrastructure. I.e., USD Tether is on-chain while the normal USD is off-chain
35. Off-ramping: Stablecoin acts as a bridge between cryptocurrency and fiat currency, enabling traders to enter or exit a cryptocurrency investment by remaining on a blockchain through a stablecoin, avoiding the delays and fees that from entering or exiting directly into a fiat currency
36. Glassnode, 'USDC: Supply in Smart Contracts', BCG Analysis
37. Diem, 'The historical white paper', April 2020
38. Onyx by JPMorgan
39. Visa, 'Universal Payment Channels: An Interoperability Platform for Digital Currencies,' September 2021
40. Coindesk, 'PayPal Is Exploring Creating Its Own Stablecoin as Crypto Business Grows,' January 2022

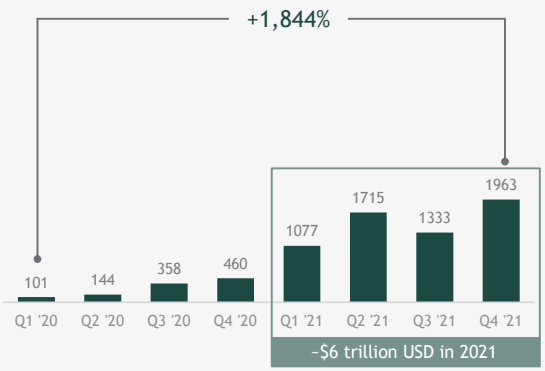
The strong correlation between cryptocurrency trading volumes and stablecoin usage can be seen in exhibit three, with a simple linear regression model returning an R-squared value of 91%[41].

Exhibit 3 | Cryptocurrency and stablecoin volumes exploded in 2021

Cryptocurrencies
Monthly exchange volumes on major exchanges, ($bn)



Stablecoins
Adjusted on-chain volume of major stablecoins[1], ($bn)



1. USDT, USDC, DAI, BUSD, USDP, GUSD, HUSD

Source: theblockcrypto.com, 'The Block Legitimate Index', January 2021; BCG analysis

Stablecoin on-chain volume grew 1844% when comparing Q4 2021 and Q1 2020 volumes, and total on-chain volume was a significant ~$6 trillion in 2021[42]. Although this would be equivalent to <1% of total global non-cash payment volume, the market capitalisation of major stablecoins stands at USD $150 billion in February 2022, up from ~$6 billion USD in January 2020[43]. This meteoric growth has finally caught the attention of regulators and central banks across the world.

The end is nigh for the unregulated stablecoin

Unlike cryptocurrencies, as we have shown, stablecoins are proving to have initial, real-world use cases. But this has not been without controversy, with the most prominent issue around collateralisation.

Tether is a prominent example, settling a $41m US Dollar lawsuit with the New York Attorney General (NYAG) in 2021[44]. The case centred around Tether's claims presented on their website over years, implying the USDT stablecoin was backed 100% by US dollars. Attestations covering this time showed Tether's reserve had limited cash backing with about 50% of commercial paper and certificates of deposit. Following the case, Tether adjusted its marketing to instead claim USDT was "backed 100% by Tether's reserves" instead. We note recent attestations that show Tether 's reserves are made up of highly liquid, low risk assets with heavy use of cash and cash equivalents[45].

Such issues were captured by a recent report on stablecoins, published in November 2021 in the U.S. by the President's Working Group on Financial Markets (PWG), the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC). The report recommended the introduction of new regulatory frameworks for stablecoins[46]. The Treasury department in the UK signalled similar intent via a call for evidence in January 2021[47]. Regulators argue that continued adoption could introduce new risks to financial stability.

Our research identifies five such risks:

1. **Consumer and investor fraud:** The absence of regulation and existing consumer protections like KYC, AML and CFT have given rise to fraud and other financial crime. Stablecoin transactions are also irreversible and near instantaneous, making it challenging to track transactions and recover losses
2. **Dollarization:** Market leading stablecoins claim to maintain one-to-one pegs to the US Dollar. For countries other than the US, this could enable flights away from domestic currencies and into stablecoins that offer redeemability with US dollars. Without regulation, this is challenging to control. At scale, it could compromise national monetary sovereignty by hindering the effectiveness of monetary policy implementation.

41. BCG analysis
42. Ibid. TheBlockCrypto, 'Stablecoin Supply Charts', January 2022 (BCG analysis)
43. Ibid
44. The Verge, "Tether will pay $41 million over 'misleading' claims it was fully backed by US dollars", October 2021
45. Coindesk, Tether Reveals More Details About Its Reserves - CoinDesk, 2021
46. President's Working Group on Financial Markets, the Federal Deposit Insurance Corporation, and the Office of the Comptroller of the Currency, 'Report on Stablecoins', November 2021
47. Her Majesty's Treasury, 'UK regulatory approach to cryptoassets and stablecoins: Consultation and call for evidence', January 2021

3. **'Digital runs'**: There are currently no legal requirements or auditing of stablecoin collateral. Regulators have flagged the risks of under-collateralised stablecoins that invest in risky assets. A fall in the market value of these assets can lead to the stablecoin 'breaking the buck' like a leading money market fund did in 2008[48]. This forced the Fed to bailout and backstop the dollar money market system. If doubts arise about the redeemability of the stablecoin this could trigger a 'digital run' and trigger flash sales of underlying assets, creating volatility in those respective markets.
4. **Concentration risk:** The stablecoin industry is highly concentrated, with the top 3 stablecoins making up 90% of the market capitalization[49]. Given the network effects of money, this could push the industry into an oligopoly as it matures. Having a singular, non-state entity control a sizeable portion of the monetary system also introduces a significant risk to monetary policy implementation.
5. **Disintermediation risk:** Stablecoins are typically backed by a limited share of cash, with leading issuers making heavy use of cash equivalents and other liquid assets. With larger adoption, this could lead to material net outflows from commercial bank deposits and reduce demand for cash in circulation. Additionally, central bank money plays an anchoring role as the monetary base. All other forms of money, including commercial bank money and e-money, can be converted back to, and redeemed for cash at par. If demand for cash declines continually, so too could this anchor.

The growth of private-sector digital currencies has spurred central banks and regulators around the world into action[50]. For example, Jerome Powell, the US Federal Reserve chair recently said: "We have a tradition [..] where the public's money is held in what is supposed to be a very safe asset. That doesn't exist for stablecoins [..] we need an appropriate framework[51]." China and Ecuador moved to ban all cryptocurrency transactions in 2021[52], while India has just proposed a 30% tax on income made in cryptocurrency investments[53]. Other governments are considering similar moves.

The differing approaches of the examples cited reflect some of the challenges in regulating DLT-based digital currencies. With the borderless nature of DLT, domestic regulation may be hard to enforce and alone may be an insufficient response. A coordinated, global effort by key jurisdictions and markets is necessary to make an effective impact but is not yet in place.

We therefore suggest that regulation alone, which can help to manage the risks identified and create safeguards, may still not sufficiently mitigate the risks from large-scale adoption. The interests of private issuers and policymakers will be challenging to align effectively. Accordingly, central banks are mulling over the potential for a general purpose or retail CBDCs as a strategic, long-term response to these risks.

By providing a regulated alternative, CBDCs may well offer some mitigation to the threat of stablecoins in a future digital currency ecosystem. Superior end-user adoption, driven through enhanced value like convenience and safety, could reduce the risks to financial stability. Having said this, the primary use cases for stablecoins remain related to cryptocurrency trading and De-Fi services. In the short-term, a CBDC will likely have limited capacity to take share of (digital) wallet from this market unless there is direct integration with public blockchains like Ethereum. Due to security and other regulatory concerns, this is an unrealistic outcome and others have made this observation too[54].

However, over the long term, there is clear potential for a CBDC - with the right design - to power a new financial services ecosystem that private alternatives are otherwise fulfilling. Although further fragmentation of payment methods in the market is likely, coexistence and seamless interoperability between all forms of money could increase consumer choice whilst maintaining financial stability. This is the focus of the chapter that follows.

48. The Balance, "Reserve", February 2021
49. TheBlock, "Stablecoin supply charts", January 2022 BCG Analysis
50. Bank of England, "CBDC Taskforce"
51. Senate Hearing committee, 'Stablecoins: How Do They Work, How Are They Used, and What Are Their Risks?', January 2022
52. Coindesk, 'Ecuador Bans Bitcoin, Plans Own Digital Money', July 2022
53. CoinDesk, "India edges toward crypto legalization with 30% tax", January 2022
54. Senate Hearing committee, 'Stablecoins: How Do They Work, How Are They Used, and What Are Their Risks?', January 2022

3 | Central Bank Digital Currencies

As stablecoin volumes continue to grow and regulators draw up policy frameworks with legislators, the first wave of Central Bank Digital Currencies are also appearing. As we will show, motivations for CBDCs vary significantly by country.

In developing economies, financial inclusion and payments efficiencies are at the forefront of publicly stated ambitions[55]. Full implementations are already live in countries like The Bahamas (Sand Dollar) and Nigeria (e-Naira).

In developed economies, where financial inclusion is higher and domestic payments are more efficient, these drivers can be less relevant. In such nations, CBDCs are considered by some to be, as a recent UK report quipped: "A solution in search of a problem[56]?" Larger economies appear to view CBDC more as a counter to the rise of unregulated, privately issued digital currency. For example, Fabio Panetta, a Member of the Executive Board of

55. Central Bank of The Bahamas, 'Project Sand Dollar: A Bahamas Payments System Modernisation Initiative', December 2019

56. Economic Affairs Committee, 'Central bank digital currencies: a solution in search of a problem?', January 2022

the ECB said: "... different forms of private money coexisting in the absence of sovereign money leads to crises. The primary policy objective of a digital euro would be to pre-empt such a situation[57]." Additionally, the People's Bank of China is supplementing the ban on the sector by rapidly scaling the e-CNY pilot, which has now been adopted by >140m users[58].

CBDCs occupy an emerging and dynamic niche in academic debate. As a new financial concept, there are fluid definitions and emerging concepts to consider. This section serves to provide common terms of reference, with a simplified taxonomy of CBDCs. The core of the chapter will outline the benefits, risks, and core considerations, including the coexistence of differing forms of money and the potential of programmable payments. The following areas are covered:

- CBDC taxonomy and distribution models
- Drivers and benefits of CBDC
- Deep-dive on CBDC-enabled programmable payments
- Macroeconomic CBDC risk assessment
- Prospects for coexistence between digital currencies and existing forms of money
- The likely progression of CBDCs
- Landscape review of international CBDC projects

3.1 CBDC taxonomy

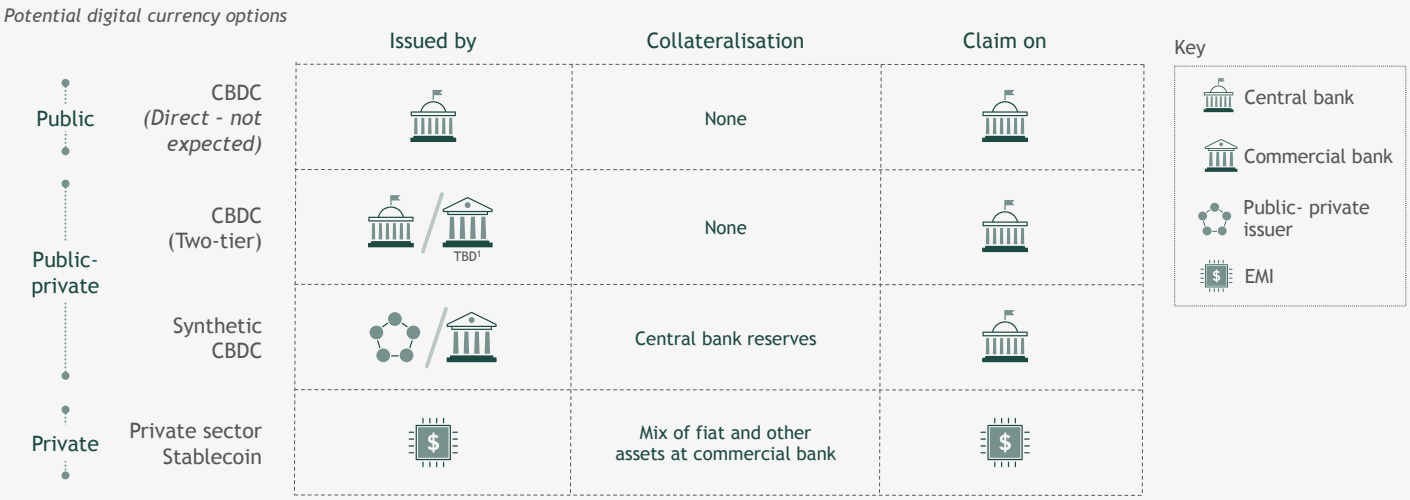
A CBDC can be described as a general-purpose digital asset issued by a central bank for circulation. As a central bank liability, a CBDC would be free of credit and liquidity risks. There are two primary forms of CBDCs which dominate academic discourse and central bank research today. We define them as follows:

1. **Conventional CBDC:** a digitised form of M0 money, coexisting alongside cash, issued by a central bank as a direct liability on their balance sheet. CBDCs share attributes with central bank reserves but are distinct in that reserves are only accessible to financial institutions[59]. The distribution of a CBDC, which will be covered in section 3.2, is summarised briefly here as either 'direct' or 'two-tier:'
   - **A direct model** involves a central bank issuing CBDC and managing all aspects of the currency, including holding accounts directly for citizens. This is a theoretical construct with little real-world viability.
   - **A two-tier model** distributes CBDC indirectly to citizens through commercial banks and non-banks in an open market model. The central bank issues CBDC and oversees management of the central ledger, including net settlement. Commercial banks and non-banks are responsible for wallet issuing and the provision of financial services. This includes KYC, AML[60], and account management. The potential for commercial banks to hold CBDC as a direct liability in this model is unclear but warrants further discussion and testing to avoid bank disintermediation that could have monetary policy impacts.
2. **Synthetic CBDC (sCBDC):** a digital settlement asset, that is fully collateralised by central bank reserves, but issued privately, similar to models used by some Electronic Money Institutions. This could ensure one-to-one redeemability and eliminate credit and liquidity risks by transacting in central bank money. Unlike a CBDC, issuance and management of an sCBDC is conducted by a private issuer (e.g., an Electronic Money Issuer or credit institution), with the central bank role limited to settlement services[61]. Although a different conceptual design to CBDC, it lands at the same outcome: a digital token that:
   - **a.** Represents a central bank liability, and therefore free of credit risk;
   - **b.** Redeemable at par with other forms of money;
   - **c.** Can act both as a medium of exchange and a store of value (depending on design); and
   - **d.** Is distributed to end-users via a private financial institution.

57. Fabio Panetta ECB 'The ECB's case for central bank digital currencies' November 2021
58. Reuters, '$9.5 billion spent using Chinese central bank's digital currency - official' November 2021
59. G7 (United Kingdom), 'Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs)', October 2021
60. Know Your Customer and Anti Money Laundering regulations
61. Tobias Adrian and Tommaso Mancini-Griffoli, 'The Rise of Digital Money', July 2019

Exhibit four illustrates the conceptual differences between a private stablecoin, an sCBDC and a CBDC. Both will be explored further in this chapter.

Exhibit 4 | Taxonomy of digital currencies

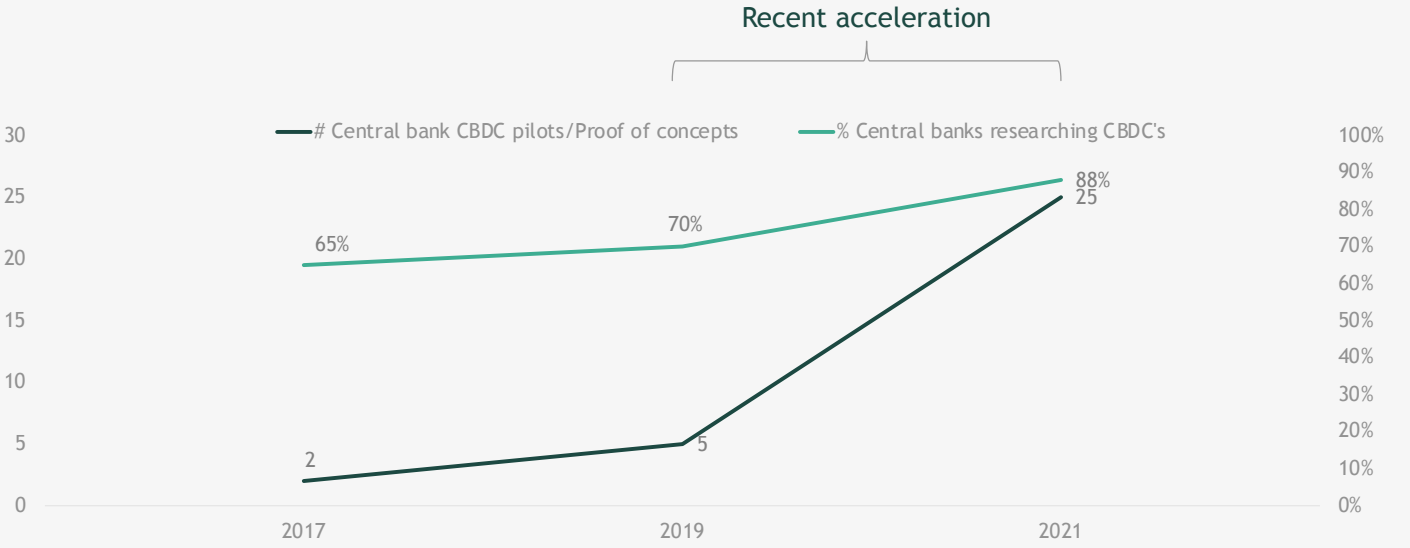


FMI: Financial Market Infrastructures

1. Options for commercial banks to hold CBDC as a liability on-balance sheet to be explored

Central bank CBDC research is intensifying. Exhibit five shows that ~90% of central banks surveyed by the BIS are either actively researching or conducting CBDC pilots[62]. This is up 18 percentage points in the last two years, with pilots increasing fourfold. There are only three fully launched implementations (The Bahamas, Cambodia, and Nigeria) to date, and all two-tier retail CBDCs. Many others are in close pursuit, including the East Caribbean Currency Union DCash pilot[63], and China's recently expanded e-CNY[64]. The distinction between retail and wholesale applications is outlined next.

Exhibit 5 | Central bank CBDC research is growing rapidly



Sources: Data from cbdctracker.org powered by BCG, December 2021 last updated January 15th 2022, BIS survey

62. Cbdctracker.org, January 2022; BIS, 'Ready, steady, go? – Results of the third BIS survey on central bank digital currency', January 2021
63. Eastern Caribbean Currency Union website, Eastern Caribbean Currency Union website, January 2022
64. Reuters, '$9.5 billion spent using Chinese central bank's digital currency - official' November 2021

There are two primary functions for CBDC, as detailed below. For the avoidance of doubt, Project New Era and the remainder of this paper is firmly focused on the exploration of Retail CBDCs only. The use of the term CBDC implies a retail CBDC, unless otherwise stated.

1. **Retail CBDC (rCBDC)** are designed for general purpose domestic circulation. This includes Business-to-Consumer payments, but also for Business-to-Business, Peer-to-Peer and Government-to-Consumer use cases. An rCBDC is therefore not constrained to retail purposes only, despite the name. Rather, the intended function here is for all of society.
2. **Wholesale CBDC (wCBDC)** are designed exclusively for the use of financial institutions to settle interbank payments and other financial market transactions. wCBDC is conceptually similar to the Real Time Gross Settlement Systems provided by central banks to financial institutions, enabling near real-time settlement of high value transactions in electronically stored central bank money. For this reason, and the fact that a wCBDC would in the first order bring benefits to banks, many countries have chosen instead to focus on retail CBDCs.

There is a third form of CBDC often discussed in literature, multijurisdictional CBDC (mCBDC). This refers to either a wCBDC or rCBDC that is interoperable between jurisdictions. We consider this to be a design capability that can be built into a retail or wholesale CBDC, rather than a separate category. For more information on how cross-border payments are done in a CBDC world, please refer to section 5.2.

3.2 Distribution of CBDC

A central debate in early CBDC discourse has been around the circulation of CBDCs in society. Our research suggests a consensus is now emerging around the 'two-tier' model.

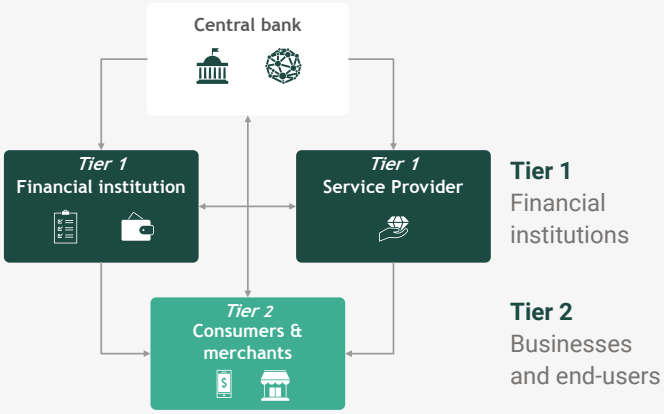
Existing discourse has focused on the two key options, 'Direct', central bank-led distribution to consumers, and the 'Two-tier', indirect distribution via commercial banks (like the distribution of banknotes today). Our view is that the direct distribution model, where a central bank manages all CBDC infrastructure, operations, and end-user services, is a theoretical exercise which is unviable. It takes central banks away from their core purpose, which is to manage monetary policy and financial stability. This view is supported by a recent publication from the UK House of Lords Economic Affairs Committee[65].

Two-tier model

This paper, therefore, only considers the two-tier model for indirect distribution. The two-tier model of a CBDC includes a core ledger that is owned and operated by the central bank as the enabling infrastructure for the broader ecosystem. The central bank issues the CBDC as a direct liability and distributes it to end-users via banks and non-banks. These organisations are responsible for onboarding end-users, performing KYC, AML, CFT, account management and the provision of financial services.

The merits of the two-tier model are plentiful. For central banks, it becomes another form of money and settlement to serve the needs of society and preserve financial stability. For banks and other financial institutions, it provides an ecosystem to acquire customers who are increasingly seeking digital methods of payments. This enables the realisation of benefits for all market participants across the ecosystem. We contend that, in addition to a two-tier distribution, central banks should also consider options for CBDCs to act as an on-balance sheet liability for commercial banks. We make an important distinction in our conceptualisation of this model, in contrast to normative discussion in this area. This is shown in exhibit six, along with the broader 'two-tier' structure. It is relevant here to cite the Bank of Japan's early concepts[66], which use a similar design. Our research also suggests China's e-CNY is divided in tiers between the PBoC and state-owned commercial banks, with the PBoC maintaining the core ledger and technology, and banks holding the e-CNY on their balance sheets[67].

Exhibit 6 | Two-tier CBDC structure



Source: BCG analysis

65. Economic Affairs Committee, 'Central bank digital currencies: a solution in search of a problem?', January 2022
66. DeCurret, 'Digital Currency DCJPY White paper', November 2021
67. Carnegie, 'What Will Be the Impact of China's State-Sponsored Digital Currency?', July 2021

3.3 Drivers for CBDC

Our research suggests drivers for CBDCs vary significantly across geographies. Different economies have challenges and strategic priorities which are unique. To account for this, we have segmented drivers into primary and secondary categories. We believe the primary drivers will be generally applicable across most countries, while secondary drivers will vary by country. Please refer to the referenced sections below for a deeper dive.

Primary drivers

1. The long-term threat of private sector issued digital currency on financial stability, including currency substitution and consumer safety. *Refer to the Stablecoin analysis in section 2.2 for a deeper exploration.*
2. The constraints of existing automated payment propositions like Direct Debit, recurring payments, and subscriptions. These require manual intervention, with limited functionality and scope. They also require complex solutions or value chains to work in real-time, and therefore make it time intensive to implement new business models like pay-per-use. *Refer to section 3.5 Programmability for a deeper exploration.*
3. Barriers such as settlement cycles and transaction costs for merchants accepting card payments, impacting cash flow and margins. *Refer to section 5.1, the Retail Payments use case for a deeper exploration.*
4. Slow payment execution speed, transaction costs and poor traceability for cross-border transactions (although improving with initiatives like SWIFT GPI). *Refer to Section 5.2, the Cross-Border Transactions use case for a deeper exploration.*
5. Inability for the unbanked to participate in the digital economy, with the global shift to electronic payments and e-commerce. *Refer to section 2.1 for a deeper exploration.*
6. The need to modernise existing account-to-account payment schemes built on legacy infrastructure.

Secondary drivers

1. Lack of operational resilience of existing monetary infrastructure, such as in the event of a natural disaster.
2. The reduction (but not elimination) in inefficient production and distribution of physical cash.
3. Tax evasion and social welfare fraud.
4. The need for central bank money as an anchor in society, ensuring confidence in the redeemability of other forms of money like commercial bank and e-money is on par with banknotes.
5. Inefficiencies in central bank use of discount rates to implement economic and monetary policy.

3.4 The benefits of CBDC

The benefits for CBDCs are largely derived from the enabling DLT infrastructure. Although there are design options besides DLT, our analysis has assumed a DLT implementation in this case. Because of this approach, we focus primarily on benefits relating to the drivers listed above:

1. Near-instant settlement and the elimination of delay between payment and settlement for merchants receiving domestic retail payments. Potential for reduced transaction costs, depending on the implementation. *Refer to the Retail Payments use case for a deeper exploration.*
2. Potential for programmable payments to integrate financial and payment processes into business logic, enabling new value propositions for payments and beyond. Diverse use cases, as discussed in the programmability deep-dive, will exist across all segments of society, such as payment on delivery of goods received, pay-per-use, tax collection and will execution. *Refer to the Programmability deep-dive in section 3.5 below for a deeper exploration.*
3. Near-instant settlement, lower transaction costs, the removal of counterparty complications, and clear traceability for cross-border transactions. *Refer to the Cross-Border Transactions use case for a deeper exploration.*
4. Potential for the unbanked to use a CBDC to join the financial system without a bank account, depending on CBDC design (discussed in Conceptual Design chapter). *Refer to section 2.1 for a deeper exploration.*
5. CBDC could be a more beneficial and affordable alternative to the expensive, capex intensive modernisation of payment systems. *Refer to the Cross-Border Transactions use case for a deeper exploration.*
6. Strategic counter to the growth of privately issued digital currencies. CBDC adoption could theoretically enable central banks and governments to manage macroeconomic and financial stability risks, assuming meaningful large-scale adoption relative to other digital currencies. This has not yet been achieved and therefore remains unestablished. *Refer to the Stablecoin analysis in section 2.2 for a deeper exploration.*

3.5 Programmability deep-dive: The novel potential of programmable money

A quick primer on programmability

Programmability refers to a new form of automation for digital assets residing on a DLT. This automation is typically offered in the form of so-called 'smart contracts'. Smart contracts are pieces of code that govern the behaviour of a digital asset or perform some other automated function. Terms and conditions are coded into a smart contract and are then self-executed without the need for any manual intervention or trigger[68].

A basic, illustrative example would be the use of 'if… then' logic to trigger a payment: 'if my bank balance is greater than £1000 on the first of the month, then send 20% of my salary to my savings account, otherwise send 10% of my salary to my savings account.' Far more complex logic can be used to automate and enable novel outcomes. Programmable assets have been a core component of the Ethereum blockchain, the first optimised for smart contracts. There are now multiple competing DLT and non-DLT technologies in the broader cryptocurrency industry, with smart contracts typically used for use cases such as launching tokens, tracking assets, or for various De-Fi services.

Programmability should not be confined to financial services either. Just as a software programmer can use code to create a vast array of outcomes, so too can a smart contract programmer. In this way, programmability has the potential to create genuine differentiation, both in financial services and beyond. The growth of programmable money on public blockchains also creates regulatory concerns, which have been covered in section 2.2.

Programmability in payments

Programmability has exciting new potential for payments based on the combination of two core components, which address limitations with existing forms of payment:

1. The synchronisation of payment and business processes, historically prevented by the lack of near-instant settlement and operationally complex processes.
2. The self-execution of pre-defined terms and conditions (including from external triggers), currently served by functionality like standing orders and Direct Debits which require manual intervention to change.

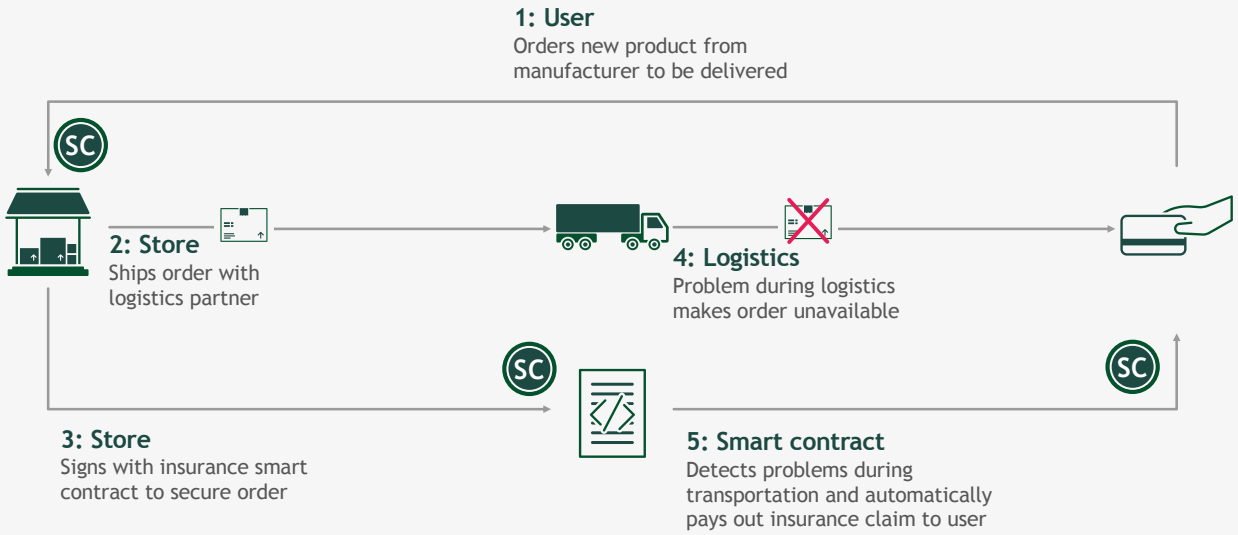
The lifting of these constraints will enable new use cases to emerge across industries benefiting from enhanced connectivity, full transparency, and DLT technologies. Potential use cases for smart contracts are numerous, and traverse segments including:

- Business-to-Consumer retail, such as pay-per-use insurance policies, or payment on receipt of e-commerce orders.
- Business-to-Business automated material procurement.
- Peer-to-Peer family inheritance and trust disbursements.
- Government-to-Consumer controls on social welfare spending.

68. Ethereum.org, 'Introduction to smart contracts'

The following exhibits (seven & eight) demonstrate two such Business-to-Consumer use cases:

Exhibit 7 | Insurance potential use case



Source: BCG analysis

Exhibit 8 | Delivery-on-Payment example use case

Source: BCG analysis

Programmable rules could also simplify and automate elements of monetary policy that are currently challenging to fine-tune. Hyper-personalised contracts, from mortgages to insurance policies, can be distributed with greater accuracy than is currently possible. Micro-financing and prediction markets could also be radically expanded by programmable money. Automated and transparently controlled escrow accounts for users or businesses and automating insurance and other financial applications can create massive efficiency gains. Further use cases by segment are articulated in the Retail Payments use case.

The development of programmability

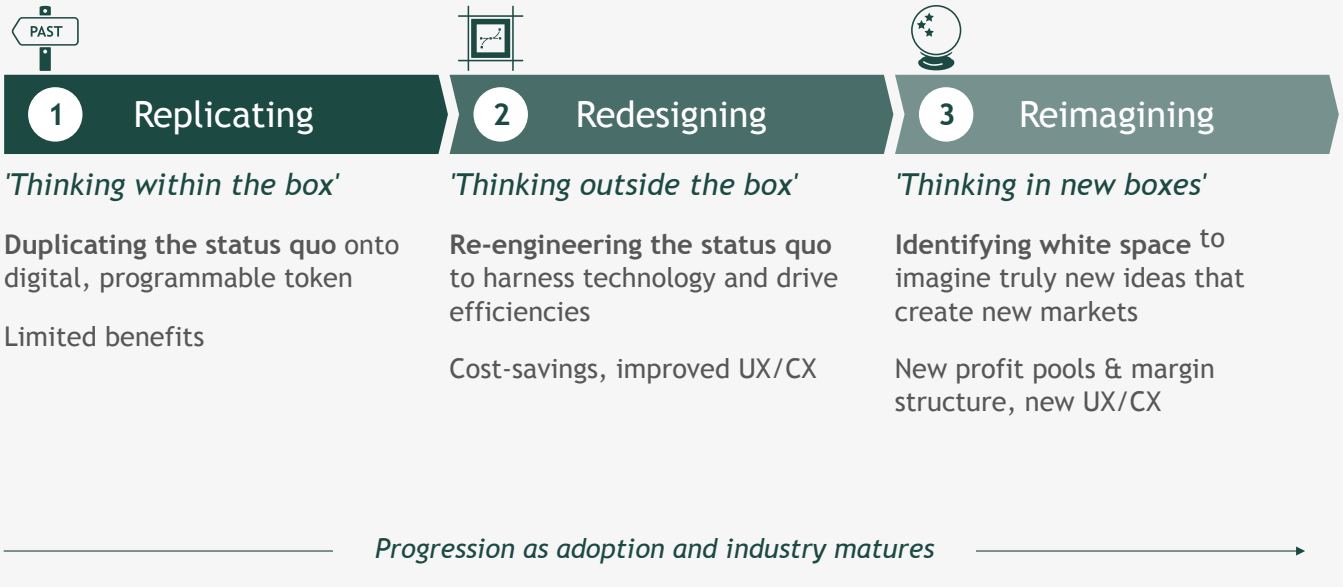
DLT and programmability will act together as a fundamental enabling technology, much like the development of the iPhone and App Store. The iPhone provided the infrastructure, while the App Store provided third–party app developers with a platform to harness the hardware and a sales channel to reach consumers through software solutions. Similarly, a CBDC DLT could provide the underpinning infrastructure for service providers to offer customers programmable value propositions.

Like the iPhone in 2007, the breadth and depth of innovation for such a new and paradigm-shifting invention is tough to predict. Instead, we broadly anticipate the waves of innovation through a three-stage maturity model, elaborated on in exhibit nine.

In the Replicating phase, value is limited in scope as service providers continue with existing operating and business models. In the Redesigning phase, innovators are rethinking how services, operating models, and benefits are achieved through efficiencies and improved user experiences. The final Reimagining phase delivers the greatest value by generating new business models and propositions. These are the most difficult to predict, with entirely new services that were impossible to deliver or even imagine in previous paradigms.

This maturity model is comparable to those seen across industries with the advent of the internet. In the newspaper industry, for example, newspapers were initially published as simple PDF copies of the print version online. As multichannel strategy emerged in the broader industry, this developed into dedicated articles for the website with appropriate user interfaces and direct data sharing. The reimagination is now currently in full flight, with market leading newspapers pivoting into digital media business models in response to the proliferation of alternative media forms, including YouTube, TikTok, and Twitch streams.

Exhibit 9 | Innovation through programmability likely to pass through 3 phases of maturity



Source: BCG analysis

3.6 Macroeconomic and systemic risks

Discussions on the topic of CBDC will rightfully come back to risk. Existing discourse calls out the potential for macroeconomic disruption and financial instability. Based on our literature review, we have distilled this down in the following section, isolating the core risks, the likelihood of impact, and potential mitigations. We present this analysis by using scenarios to bring these findings 'to life' for readers. In summary, our research suggests that with the right design, effective mitigations are available[69]. We also recognise the need for further analysis and real-world testing to reach any firm conclusions.

The adoption of CBDCs by countries would have implications for the conduct of monetary policy and could entail a series of risks that need mitigating.

CBDCs and Monetary policy

In the last 25 years, monetary policy has resorted to all possible instruments to counter the effects of the systemic crises that the global economy has suffered (Tequila crisis of 1995, Asian Financial Crisis of 1997; Russian default of 1998; Dot.Com bubble burst of 2000-01; Global Financial Crisis of 2008-09; and the global pandemic of 2020-22). Examples of these instruments can include summaries such as ZIRP (Zero Interest Rate Policy) or NIRP (negative interest rate policy), large scale asset purchases (QE), forward guidance, and during the pandemic, fiscal-monetary coordination. It will be hard to dismantle this apparatus while the pandemic is still raging, and for some time afterwards.

But in a world in which all these other main instruments have already been used, central banks are exploring whether CBDCs could offer a new potential tool to tackle the next systemic crisis. This is particularly relevant and timely with climate-related crises potentially looming.

CBDCs and Risks

To begin, the primary driver of retail CBDC risk is scale. The scope for large-scale adoption, with user bases in the tens of millions and gargantuan transaction volume, can drive structural changes across the economy. This can lead to a number of downstream impacts, five of which we have highlighted below. For these examples we have included initial, high-level analysis to be further expanded upon and developed:

1. Commercial bank disintermediation

2. Liquidity crunches during financial crises

3. Currency substitution and dollarization

4. Compliance and privacy

5. Cybersecurity

1) Commercial bank disintermediation

Bank profitability has been challenged by several drivers in recent years. First, a macroeconomic environment that has been weakened by a sequence of systemic crises occurring each decade (the dot.com burst in 2000, the Global Financial Crisis on 2008-09, and the pandemic of 2020-21), which have reduced the growth potential in most advanced economies. This weak macro environment has led to a steady reduction in market and policy rates, making it harder for banks to perform maturity transformation, a key driver of their profitability.

Secondly, the banking system has gone through a process of concentration, which has forced a reduction in operating expenditure to protect profit margins from the squeeze. A further strain on overall profitability has been from the increasing capital and liquidity buffers of the banking system. Finally, banks have been challenged by the emergence of fintechs, often competing on value and undercutting on price. In particular, the rise of fintech services in traditional banking sectors such as lending, payments, and investment management, has led to a progressive disintermediation process, which may be exacerbated by the emergence of CBDCs. We highlight one such scenario below.

Scenario

- CBDC is favoured by end-users due to risk-free deposits and/or programmable payment value propositions, leading to commercial bank deposit outflow into CBDC.
- There is less availability of cheap deposit funding, reducing commercial bank balance sheets and reducing lending capacity in the traditional banking system.
- The commercial bank deposit outflow happens at a pace that new lending in the CBDC environment cannot keep up with. Thereby causing a short-term shock to the system and potential credit crunch.
- Another risk is that if banks' lending activity is not coordinated with the issuance of CBDC by central banks, the funds deriving from extended loans are "parked" in CBDC accounts that are less "fungible" than bank deposits.

69. BIS, 'Central bank digital currencies: financial stability implications', September 2021

Potential Responses: deposit drainage can be mitigated by enabling commercial banks to hold CBDCs as liabilities on-balance sheet, along with proposed 'two-tier' design and competition for new revenue sources.

- Central banks can explore options for CBDCs to act as on-balance sheet liabilities for commercial banks to give them a stake in the digital currency world.
- The 'two-tier' distribution of CBDCs enables commercial banks to find new sources of revenue as wallet issuers and new lending products to offset the impact.
- CBDC adoption can be at a limited pace to reduce the scale of deposit outflow, while a phased implementation can allow for structural safeguards and legislation to catch-up.
- Commercial banks can compete for deposits against CBDCs through higher interest rates and innovative value-adding services in lending and payments.

Likely end state

- We note that the risk of disintermediation has higher likelihood if consumers begin to adopt CBDC in large numbers and CBDC cannot be placed on commercial bank balance sheets. Banks could be pushed to alternative wholesale funding and/or higher interest rates, impacting margins.
- Options for CBDCs as liabilities on commercial bank balance sheets should be explored as an innovative model to mitigate this potential risk. A public-private partnership and real-world piloting will be required to pressure-test what this could look like.
- A two-tier distribution to unlock new revenue streams, CBDC balance limits, and disincentives can also provide meaningful mitigations.

2) Run on commercial bank deposits during financial crises

Bank runs have been an intrinsic characteristic of the financial industry for centuries, especially when there were competing forms of privately issued 'money in circulation'. The monopoly over the issuance of "legal tender" given to central banks was a response to this phenomenon. The residual risk was mitigated with bank deposit insurance schemes, which had various structures (public, private, re-insurance scheme, etc).

With CBDCs entering the financial system, free of liquidity or credit risk, the possibility exists that in times of crisis, different forms of money could be converted into CBDC, exploiting the implicit protection derived from the central bank's balance sheet.

Scenario

- During crises, CBDCs could be used as a 'flight-to-safety' hedge against bank deposits or other forms of money due to its risk-free status.
- Near-instant settlement and low transaction costs act as enablers for a rapid drain on commercial bank deposits or other asset markets.
- Bank runs today are from one bank to another via account-to-account transfers, meaning systemwide deposit balances are not significantly reduced, with only a small outflow via cash withdrawals. However, deposit runs to CBDC, depending on the design, could remove higher sums of money from the commercial banking network.
- Digital wallets and other applications have added a new layer of convenience: people can "run" on their banks from the comfort of their sofa.

Potential responses: Central banks can regulate against on-demand CBDC withdrawals from banks to retain credibility.

- Introduce withdrawal limits and notices to prevent sudden outflows.
- Release wallet issuers from obligation to convert deposits on-demand into CBDCs (though this would greatly reduce CBDC liquidity). Carefully designed adoption limits, phased implementations, and other disincentives.

Likely end state

- There are sufficient levers for mitigation which should be incorporated into overall CBDC design. Withdrawal limits and restriction of on-demand convertibility to a (non-commercial bank liability) CBDC means systemwide deposit balances are not any more at risk than they are today.
- Limits on CBDC balances could, however, impact adoption, given their potential to distort optics of equality between CBDCs and other forms of money, even in normal times.

3) Currency substitution

There could soon be emerging geopolitical competition among countries to obtain a first mover advantage and push internationalisation of national currencies.

With interoperable, mCBDCs this could introduce new currency substitution risks seen broadly in the world today through dollarization phenomena in developing countries.

Scenario

- In a multi-CBDC, interoperable world, foreign CBDCs and private sector digital currencies (pegged to fiat currencies like the USD) could appear more attractive to consumers, particularly in jurisdictions with financial instability.
- There are several downstream impacts:
  - Intensification of currency substitution, particularly in jurisdictions with high domestic currency inflation.
  - Flights from domestic currencies have new potential to occur rapidly with near-instant settlements.
  - Central banks could lose oversight and monetary policy sovereignty.
  - Loss of oversight could also lead to issues such as tax avoidance and limited ability to combat domestic financial crime.
  - Over the long-term, this could lead to changes in the global reserve currency order.

Potential responses: unlike cash, CBDCs enable central banks to build restrictions that prevent currency substitution.

- Payment systems can be setup to ensure domestic transactions occur in local currency, while preserving foreigners' abilities to spend their money in the domestic market using their own wallets.
- Central banks can implement restrictions on non-resident cross-border transactions, e.g., to specific transaction types and/or values.
- International and domestic legislation can be introduced to support this.

Likely end state

- Currency substitution is already a material issue in countries with high inflation or instability, as seen in the dollarization phenomena. This issue has economic root-causes independent of CBDCs that need to be addressed.
- Assuming programmability and international interoperability, CBDCs could enhance a central bank's ability to introduce restrictions on transactions, unlike banknotes or cryptocurrencies.
- This would, however, also require complex international collaboration.

4) Compliance and privacy

Even if CBDCs are designed as a digital equivalent of M0 money, there is one substantial difference between these two liabilities: their information content. Banknotes guarantee maximum anonymity, while CBDC transactions could carry a wealth of data and meta-data. This could include the identity of the buyer and the seller, the product or service sold, and the place and time of the transaction. Because of this, it can be argued that CBDCs have a fourth dimension compared to the traditional three of money (unit of account, means of payment, and store of value): a store of information. In light of this, understanding the privacy implications of adopting CBDCs is of paramount importance for their actual implementation.

Scenario

- A balance must be struck between regulatory compliance and the right to anonymity.
- A single, national financial ledger, fully accessible and visible to a central bank, or a government, raises significant privacy concerns.
- Fully private shielded transactions on a central bank ledger open significant regulatory problems and are also untenable.
- End-user adoption may be compromised due to an unsatisfactory balance of anonymity and regulatory compliance.
- A permanent, immutable digital ledger does not comply with privacy regulation, e.g., the "right to be forgotten."

Potential responses: 'Two-tier' model keeps the privacy of compliance and account operations in private sector protected.

- The two-tier model could operate with Wallet Issuers owning onboarding, KYC, AML, and other regulatory activities with the private sector.
- Certified Wallet Issuers could authenticate identities of all users upon onboarding onto the system (but central bank ledger has pseudonymous data only).
- Confidentiality and privacy provided through permissioned DLT, with clear, provable limits to central bank or government oversight of CBDC transactions.
- Cryptographic transaction methods can provide third party access to selected data with user permission only.
- Store and allow for regulators and AML/KYC/CFT providers to parse anonymised data to flag behaviour or accounts.

Likely end state

- Permissioned access with central bank and regulator access on a need-to-know basis.
- Anonymity guaranteed up until a certain transaction threshold and only after a certain period.
- Built-in automated AML/CFT rules and checks to flag suspicious transactions or accounts and expose only the relevant information to central banks or regulators.
- Compared to cash, the digital records that CBDCs form could make them more adept at serving regulatory provisions such as record-keeping, suspicious transaction reporting, and sanction-related screening of transactions.
- Ability to delete information to comply with regulation or off-chain storage of actual de-anonymized data, with only proofs/hashes posted on-chain to provide validation of relevant regulatory compliance.
- 'Two-tier' model ensures compliance stays within the private sector

5) Cybersecurity and resilience

The issuance of a CBDC is effectively an entry into cyberspace. As such, CBDCs could become vulnerable to cyber-attacks, which have the potential to cause large-scale damage. A cyber-attack to the infrastructure that manages the entire CBDC operability could have significant ripple effects on an economic system.

Scenario

- CBDC systems could introduce single points of failure for a nation's financial infrastructure. The recent DCash outage[70] evidences the need for highly resilient infrastructure, as well as fall-back mechanisms if these systems were to process a large percentage of a nation's transactions. These failures do not have to be natural or technical in nature but could be induced by hostile (state) actors and have significant economic consequences for national economies.
- Allows for near-instant transactions to potentially drain user accounts in seconds, providing no time for law enforcement to react.

Potential responses: centralised ledger systems with enhanced safeguards to offer strong resilience.

- Centralised ledger or permissioned DLT to enable central control over issuance, participation, and party rights.
- Allow for blacklisting of wallets, balances, and transaction privileges.
- Continuous deployment of new node and wallet software from multiple providers to spread risks and reduce single points of failure.
- Strong, reliable, and trusted backup systems able to return to a "restore" point precedent the cyber-attack.

Likely end state

- Permissioned access with central governance to drive cybersecurity standards.
- Open ecosystem of node and wallet software vendors for different parties to not have a single point of failure.
- Central bank/consortium power for blacklisting and reverting to block accounts, tokens, and transactions in the event of a software failure.
- Continuous automated observation of on-chain analytics and behaviours through law enforcement or regulatory bodies.
- Clear standard operating procedures and rules around failure modes, chargebacks, and arbitration.

70. Central Banking, 'ECCB Digital currency suffers outage' January 2022

3.7 Coexistence of digital currencies and existing forms of money: survival of the fittest?

This report has highlighted the fast-moving trends reshaping the global payments landscape. With innovation giving rise to digital payment methods, privately issued money, and CBDCs in some jurisdictions, end-users are increasingly transacting in new and diverse ways. We note the merits of increasing consumer choice but are wary that this fragmentation also has the potential to create consumer confusion. Purposeful, systemic guardrails and regulation will therefore be important to ensure that the benefits for both consumers and businesses are not diluted.

To this end, our research notes and aligns with the importance placed by central banks on coexistence between CBDCs and existing forms of money. The recently published G7 public policy principles mention that: "[CBDCs]... should coexist with, and complement existing forms of money, and promote innovation and efficiency in payments[71]." The following section dissects this statement and provides a view on a potential outlook for the future.

To begin, we consider the ambition for innovation and efficiency first. This chapter has demonstrated the potential for CBDC-led innovation to drive transformational efficiencies and new value propositions in payments. Prime examples include near-instant payments, financial inclusion, reduced transaction costs, and programmable payments to introduce new, automated propositions. The combination of these capabilities existing in a single solution, combined with strong regulatory oversight, provides a unique value proposition. The remaining discussion turns to coexistence with existing forms of money, a question long asked of CBDCs.

To begin, money can be broadly segmented into three categories:

1. **Central bank money:** created through banknotes and reserves. Central bank money provides a national unit of account for fiat currency and an anchor[72] to other forms of money by ensuring redeemability at par. In the UK, just ~5% of money is held in central bank money[73].
2. **Commercial bank money:** created in the form of bank deposits, through the issuing of new loans credited to customer accounts[74]. In the UK, ~95% of money is held in commercial banks[75].
3. **Non-bank money:** Electronic Money (defined in the *Payment Services for PIs and EMIs Use Case*) and stablecoins, defined in chapter 2[76].

Central bank money: CBDCs, as a new form of M0 money, would exist alongside banknotes and reserves. As mentioned earlier, we note that segments of society will always depend on or prefer the use of cash. As many central banks have stated[77], CBDCs are not intended to be a replacement for cash, which will continue to be issued in line with demand for it.

However, with the decline of cash payments and the rise of e-commerce, the role of central bank money in payments is diminishing. Central bank money serves as a crucial anchor for the financial system. CBDCs may help to bring central bank money into the digital age and protect this role. Central bank reserves, which are conceptually like CBDCs but only accessible to financial institutions to settle with a central bank, could remain independent of a CBDC.

It therefore seems possible that a retail CBDC could credibly coexist alongside existing forms of M0 money, while enhancing the utility of M0 in an era of digital payments.

71. G7 (United Kingdom), 'Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs)', October 2021; quoting 'Joint BIS report, 'Central bank digital currencies: foundational principles and core features', October 2020
72. Speech by Fabio Panetta (ECB), 'Central bank digital currencies: a monetary anchor for digital innovation',
73. Bank of England, 'New forms of digital money', June 2021
74. Ibid, Bank of England, 'Money creation in the modern economy', Q1 2014
75. Ibid.
76. Ibid.
77. Bank of England, 'Central bank digital currencies: foundational principles and core features', 2020

Commercial bank money: The impacts of CBDCs on commercial bank deposits have been discussed at length in the macroeconomic risk section. There we concluded that complete replacement of these is unlikely and careful design could enable a healthy coexistence. This could be possible through options for CBDCs as commercial bank liabilities, two-tier distribution, withdrawal limits and phased adoption.

Supporting this view, the G7 endorsed a recent BIS paper[78] which concludes that: "...the financial system is dynamic and evolving and has successfully navigated episodes of structural change over many years[79]." In line with this, we also note the oral evidence of Andrew Bailey, Governor of the Bank of England, to the Economic Affairs Committee: "Banks have adjusted to changing circumstances before. If they are healthy and competitive, one would expect them to adjust in the future, but it would be an adjustment[80]."

New digital money: This section primarily focuses on stablecoins. Some regulators have considered stablecoins a type of Electronic Money[81], given its comparable characteristics[82]. Consideration must be given to two central questions. First, is coexistence between CBDCs and private stablecoins a desired outcome at all? We have shown at length in section two how stablecoins can present risks, including currency substitution and dollarization, which could impact financial stability at scale. Indeed, this is a driver of CBDC research, particularly in larger economies. Stablecoins and similar digital currencies can however provide many benefits especially provided by the DLT on which they are issued. The answer to the first question therefore is: perhaps if the risks can be mitigated.

The second question is what response have stablecoins received around the world? This requires us to consider how different central banks are reacting to stablecoins. Our research suggests there are broadly two groups of nations. The first group is openly opposed to the adoption of digital currencies by its citizens, advocating blanket cryptocurrency bans that include stablecoins. We note nations in this group often have advanced CBDC initiatives and include the likes of China and Turkey[83].

The second group, while clearly expressing concerns, also accept a level of coexistence which enables innovation, but also introduces safeguards for financial stability risks[84]. Regulators in these states, which include the UK, EU, and US, are finalising stablecoin regulation and appear to be moving relatively slowly on CBDC implementation.

In our view, this divergence points to a future where privately issued digital currencies, including stablecoins and cryptocurrencies, can coexist with CBDCs to varying degrees around the world. There are three potential drivers:

- **Differences in local regulations have global impacts:** DLT-enabled digital currencies, available through the internet, cannot easily be controlled by states and are not bound by state borders due to decentralisation. Just as the banning of a social media company in specific states does not preclude a company from existing, similarly, domestic bans of private stablecoins will not 'kill' the industry. Even domestically, bans could create black markets. Unless there is a globally coordinated approach, digital currencies could be here to stay for as long as demand exists.

- **End-user value propositions will drive adoption:** Real-world utility and end-user benefits will ultimately drive the level of coexistence between CBDCs and private stablecoins. On the one hand, central banks have various comparative advantages that can be exercised to gain share from the private stablecoin industry. This includes the prospect of broader integration and interoperability with existing forms of money, the risk-free nature of central bank money, and the helping hand of legislation to support top-down adoption.

78. BIS, 'Central bank digital currencies: financial stability implications', September 2021
79. G7 (United Kingdom), 'Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs)', October 2021
80. Andrew Bailey, oral evidence to the UK Economic Affairs Committee, November 2021
81. Refer to Payment Services for PIs and EMIs Use Case for more details on Electronic Money
82. PYMNTS, 'UK Regulator Says Stablecoins Are EMoney', July 2019
83. Reuters, 'Turkey's crypto-payment ban looms', April 2021
84. ECV, 'The present and future of money in the digital age', December 2021

On the other hand, the private stablecoin industry has exploded in value and volume through 2021. Expanding use cases beyond cryptocurrency trading, in the De-Fi industry, are already starting to prove early value in the market among consumers. Existing infrastructure, such as Ethereum, has materially lowered barriers to entry, and private stablecoins are also benefiting from a first-mover advantage. Because of this, we expect competition with CBDC for adoption.

- **State of domestic financial infrastructure:** Finally, banking and payments infrastructure in developing economies could act as another catalyst, tipping the balance towards CBDCs in these states. As a viable alternative to lengthy, capex-intensive modernisation of payment schemes, CBDCs offer a greenfield opportunity to create tangible value for society. The Sand Dollar is one such example, reflecting the nation's need for financial inclusion and operational resilience given weak domestic financial infrastructure and the impact of tropical storms. We note that out of 13 pilots undertaken in developed economies, 9 are wholesale, while for 12 projects in developing economies only 2 are wholesale CBDC[85].

In summary, our analysis highlights the drivers that will dictate the extent of coexistence between CBDCs and existing forms of money, including digital currencies. In the next section, we provide an overview of the progress made to date in the global CBDC landscape.

3.8 Global CBDC landscape review

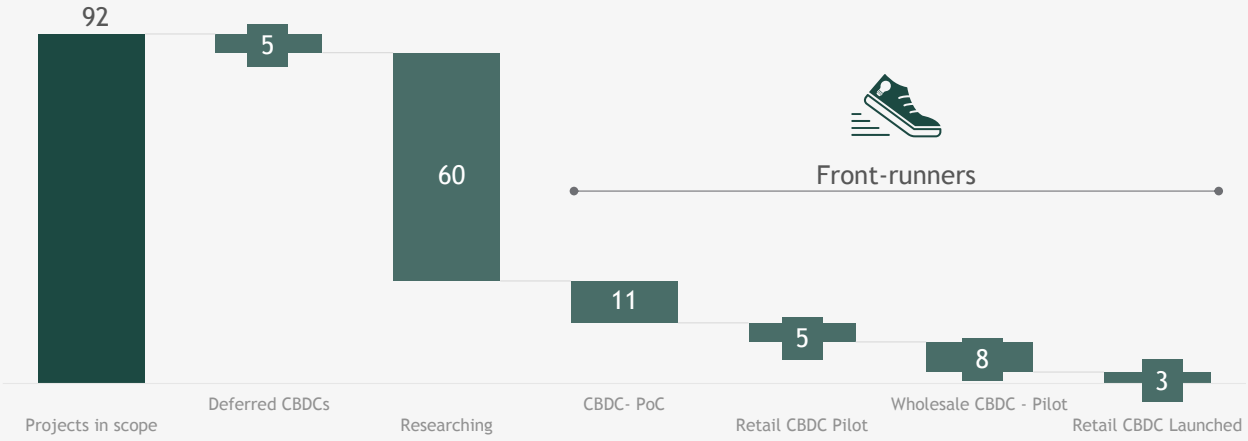
The benefits of CBDCs, together with the threat of privately issued currency, have concentrated the focus of central banks around the world on CBDC exploration. The volume and progress of CBDC projects have accelerated over 2020-21, with full implementations live in The Bahamas (Sand Dollar), Cambodia (Bakong) and now Nigeria (e-Naira). China's e-CNY pilot has been recently expanded and adopted by >140m users[86]. The Reserve Bank of India has also announced the trialling of a Digital Rupee later in 2022. This section provides an overview of the current CBDC landscape.

Our research is summarised in exhibit ten with the following headline findings:

- 92 central banks are publicly pursuing a CBDC project[87]. These are typically jurisdictions with high smartphone penetration.
- ~80% of projects are pursuing a retail CBDC, rather than a wholesale version. However, there are more Wholesale CBDC pilots, making up ~62% of the total.
- ~70% of total CBDC projects are in the research phase, with only three full implementations as mentioned above.
- Projects in the proof-of-concept, pilot or implementation phases are collaborating with private sector fintechs or financial services companies, including Stellar, ConsenSys, Bitt, and R3 Corda.
- Current sentiment is that the first CBDCs in developed markets will arrive in 2022-2023, with more to follow in subsequent years.
- Where details have been disclosed, it appears that most CBDC projects are using DLT in combination with at least one other specialist system.

85. Cbdctracker.org, January 2022 BCG Analysis
86. Reuters, '$9.5 billion spent using Chinese central bank's digital currency - official' November 2021
87. Cbdctracker.org, January 2022

Exhibit 10 | Breakdown of CBDC research by phase



Sources: Data from cbdctracker.org powered by BCG, December 2021 last updated January 2022

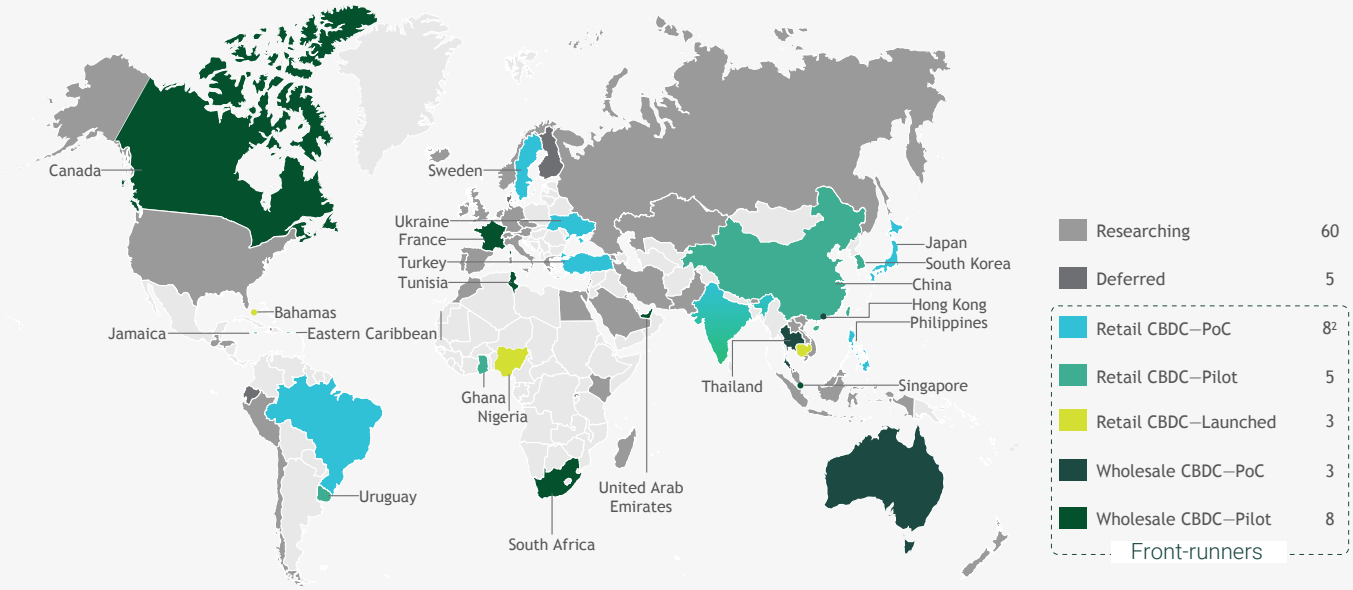
Who are the front-runners in CBDC development?

As discussed in section 3.3, our analysis shows drivers for CBDCs vary significantly by geography. Demonstrated in exhibit eleven, we see an even distribution of CBDC projects across developed and developing markets. Developing markets are overwhelmingly focused on retail CBDC applications (92%), developed markets have a far higher share of wholesale CBDC projects (38%). This reflects the impact of differing drivers on the two groups.

Developing markets are focused on financial inclusion in economies that have suffered from weak financial and payments infrastructure in the past. Access to digital payments and other financial services are clear levers to increase productivity in the economy and create a range of societal benefits. The picture is very different in developed economies, often with high levels of domestic payments efficiency and financial inclusion. We have covered drivers for these nations earlier in this paper.

It is therefore unsurprising that developing economies are the early adopters of CBDC, keen to seize the benefits of increased payments efficiency and economic participation. Developed markets, meanwhile, continue to question whether a material business case exists at all. In the final section of this chapter, we will discuss the next steps that are possible for central banks and introduce a new model for effective experimentation with this technology.

Exhibit 11 | Emerging markets are the front-runners in retail CBDC development



1. Data from cbdctracker.org powered by BCG, last updated January 2022; 2. India CBDC categorised as retail

Note: If countries have multiple CBDC projects running in different phases, then 1 is selected in following order: Launched > Pilot > PoC > Research

Source: Data from cbdctracker.org powered by BCG, last updated January 2022

3.9 Next steps for central banks

Through this chapter, we have outlined how central banks and regulators are weighing up three courses of action:

1. Banning stablecoins.

2. Regulating stablecoins.

3. Issuing a CBDC.

The following section focuses on key considerations that enable central banks to avoid a 'paralysis by analysis,' and pragmatically explore the use of CBDCs. To begin, central banks have attributes that privately issued digital currency issuers cannot replicate. These enhance the potential for a central bank to offer a currency that mitigates risk and drives end-user adoption:

- **Risk:** Money free of credit and liquidity risk, with broad potential for integration with existing forms of money
- **Safety:** Designed with regulatory compliance from the outset, ensuring safeguards for end-users
- **Reputation:** Unique, trusted brand value of central bank
- **Redeemability at par:** Value is guaranteed to be redeemable at a one-to-one ratio with fiat currency. Although many private stablecoins use currency pegs, a risk exists around 'breaking the buck' and private stablecoins also experience minor price fluctuations (~0.1-0.5%[88]), driven by supply and demand on exchanges.

CBDCs are a longer-term option

Adoption of CBDCs is likely to take time, with significant hurdles to overcome. Current sentiment is that the first CBDCs in developed markets like Sweden will arrive between 2022 and 2023, with more to follow in subsequent years. Any implementation will require highly considered and creative design to mitigate macroeconomic and systemic risks. Below, we summarise core open design questions that any successful CBDC must seek to answer as part of the development process:

Balancing macroeconomic risk with large-scale adoption

Concerns over the risk-free quality of CBDCs driving bank disintermediation have been covered extensively in this paper. Central banks could explore mitigations like withdrawal limits and disincentives, such as interest rates to promote coexistence with existing forms of money. Sequencing is also important, with phased rollouts helping to mitigate shocks to the system.

This is a delicate balance; if central banks create too many limitations, CBDCs could fail to drive adoption in the first place. Incentives may well be required for adoption, just as the e-CNY pilot has demonstrated through lotteries and other initiatives[89].

Developing a public-private ecosystem to enable two-tier distribution

The two-tier ecosystem will create new roles for commercial banks, non-banks, Payment Service Providers (PSP) and card schemes. These roles include wallet issuing, financial service provision, merchant acquiring and other payment services. The private sector will need time to shape propositions that add value in the market and are based on sustainable business models. As we have consistently highlighted, options for commercial bank CBDC liability will also need to be explored.

Establishing integration with existing forms of money and mCBDC interoperability

To unlock the full potential of CBDC and create valuable use cases, deep integration is required with existing and future banking infrastructure. This includes payments ecosystems, such as payment and card schemes. Interoperability with other domestic CBDCs is also a fundamental enabler to enable cross-border transactions. The infrastructure investment and international collaboration required to enable these components make this a challenging prospect, but the benefits case would likely be substantial.

Building new infrastructure and developing new capabilities

CBDC is new, 'greenfield' territory for central banks. Operationally, many central banks will consider developing the central ledger infrastructure in-house and from the ground up. The stakes are high, and it will take time to build, test and refine. This will likely differ from any other central bank infrastructure project, and new capabilities are required to ensure successful delivery. This includes leading-edge technology and talent to provide world-class cybersecurity and smooth operations.

In summary, CBDC is, rightly, a long-term endeavour. Our research suggests that given the scale of the challenge, some central banks may be a 'paralysis by analysis.' As section 3.8 has explored in more depth, most CBDCs projects are in the analysis phase, with just three full implementations. This viewpoint was reflected in a recent Bank of England statement: "If the results of this 'development' phase conclude that the case for CBDC is made, and that it is operationally and technologically robust, then the earliest date for launch of a UK CBDC would be in the second half of the decade[90]."

Given the inevitable delays in bringing a CBDC to market, we pivoted our research towards credible alternatives that would help unlock and advance progress towards a CBDC.

88. Grobys et al, 'On the stability of stablecoins', December 2021

89. People's Bank of China, 'Progress of Research & Development of E-CNY in China', July 2021

90. Bank of England, 'Statement on Central Bank Digital Currency next steps', November 2021

An sCBDC could offer a different route to market for central banks

IMF economists first shared the novel concept known as 'synthetic CBDC' (sCBDC) in a 2019 paper, exploring the rise of digital currencies like E-Money[91]. With the emergence of fintech PSPs, such as Electronic Money Institutions (EMIs) in the payments industry, central banks like the Bank of England are increasingly opening access to reserve accounts for non-banks.

Building on this, the writers argued that the ability for EMIs to issue E-Money, backed by central bank reserves, would be functionally equivalent to a CBDC. That is to say, an electronic form of central bank money that can be used as a means of exchange and a store for value, denominated in the national unit of account. Effectively, this would be a "public-private partnership" between an EMI and a central bank, with the EMI managing the issuance, distribution, and customer relationships. Central banks would only have to provide "settlement services", in a similar model to existing payment schemes[92]. We took this concept and developed it further.

We describe an sCBDC as a digital settlement asset that is fully collateralised by central bank reserves. Fiat currency in a central bank reserve account is held as collateral and tokenised into a digital asset at a one-to-one ratio. This provides end-users with access to central bank money, eliminating credit and liquidity risks, and ensures one-to-one redeemability.

The issuance and management of an sCBDC would be conducted by a private issuer (with the potential for non-banks as well as banks), with the central bank role limited to net transaction settlement. This arrangement could occur as an outsourcing by central banks to the private sector, as a joint public-private partnership or as a privately-led initiative (assuming there is reserve account access).

The use of a collateralisation mechanism clearly distinguishes an sCBDC from a conventional CBDC. Effectively, an sCBDC provides access to central bank reserves. This has led to comparisons with the conceptual model of wholesale CBDC: a digital form of central bank money provided to financial institutions. However, this E-money model means that the direct liability sits with the private issuer and not the central bank, presenting a default risk that would not be present in the case of a conventional CBDC. Additionally, an sCBDC could be made available for general purpose circulation, unlike wholesale CBDC.

Technicalities aside, our research suggests that an sCBDC could provide an alternative, faster route to market and deliver similar advantages to a CBDC. However, there are material disadvantages that should also be considered. We capture these below:

Advantages:

- Depending on the underlying infrastructure (i.e., the use of DLT), an sCBDC has the potential to deliver almost all the benefits of a CBDC, including near-instant settlement, potential for reduced transaction costs, and programmability.
- Partnership with a private issuer avoids significant overheads for central banks, and the complexities of a central bank in-house programme of development.
- Central bank reserves provide a risk-free store of value and trust in the digital settlement asset.
- The need for off-ramping[93] (assuming limited integration) could act as a disincentive that protects commercial bank deposits.

Disadvantages:

- Similar risks and open design questions for CBDC will also apply, such as those covered earlier in this section.
- Interoperability will be limited to the private issuer's platform in the absence of further integrations.
- Off-ramping creates inefficiencies and generates fees, reduces liquidity, and therefore may limit large-scale adoption.
- Default risk will exist because of the potential for a private issuer, unlike a central bank, to become insolvent.

An sCBDC offers a novel approach for central banks and the private sector to partner and establish a digital asset that carries viable potential, perhaps as a testing ground, to transition into a fully-fledged CBDC at a later stage. It is also a pre-cursor to a two-tier conventional CBDC model: a key takeaway, therefore, is the need for public-private partnership to test this ecosystem and enable real-world testing. We build further on the topic of public-private partnership in the next section.

91. Tobias Adrian and Tommaso Mancini-Griffoli, 'The Rise of Digital Money', July 2019

92. Ibid.

93. Converting from sCBDC into fiat currency

No central bank goes solo: existing public-private partnerships

Our research revealed that central banks typically engage private-sector companies in CBDC projects. Exhibit ten showcases recent case studies of such public-private partnerships. Nigeria and the Eastern Caribbean Currency Union are also both supported by private sector technology[94].

A wide range of benefits have been realised by these early adopters by proactively shaping the role of digital money in their economies. Central banks play a critical part in determining the overall design and implementation choices that enable innovation in the market. Nigeria and the Eastern Caribbean Currency Union have provided a clear steer on the broader open market ecosystem, supported by the private sector through wallet issuing and service provision[95].

However, in many developed economies, considerable ambiguity remains regarding the direction of central bank plans for digital currencies. The current discourse is dominated by debates focused on issues rather than collaborative initiatives looking for constructive solutions. Current sentiment is that the first CBDCs in developed markets like Sweden will arrive between 2022 and 2023, with more to follow in subsequent years[96]. Collective initiatives need to be defined now to avoid further delays and find solutions that unlock benefits for all market participants.

Exhibit 12 | Central banks typically supported by private-sector players

	Bahamas — Sand Dollar	Cambodia — Bakong	Singapore — Project Ubin
Purpose	• Increase financial inclusion • Reduce dependency on physical banking infrastructure	• Increase financial inclusion and banking efficiency	• Explore use cases of blockchain, improving cross-border transactions
Type of CBDC	• General purpose CBDC as fiat • CBDC to complement existing banking services • Funds stored in central bank; wallets will not bear interest	• Fiat does not appear to back CBDC issuance at present • Improved payments system with real-time settlements	• Tokenized currency backed by 'real' currency holdings; not fiat • Other use cases in insurance and advertising explored
Partners	NZIA as Fintech leading implementation on payment system, IBM providing blockchain knowledge	Core implementation partner Japanese FinTech, Soramitsu, developed application	>40 financial & non-financial firms included in project

94. Reuters, 'Nigeria to partner with Bitt Inc to launch 'eNaira' digital currency | Reuters', August 2021 and Eastern Caribbean Currency Union website, 'Bitt Partners with ECCB to Develop World's First Central Bank Digital Currency in a Currency Union | Eastern Caribbean Central Bank', March 2021

95. See for example, Central Bank of Nigeria, 'Design paper for the eNaira', October 2021; and People's Bank of China, 'Progress of Research & Development of E-CNY in China', July 2021

96. Cbdctracker.org, January 2022; BCG expert interviews

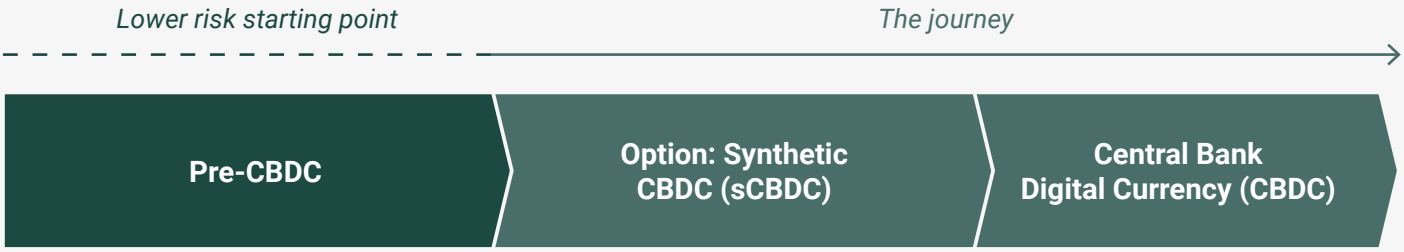
Call to action: a roadmap for public-private partnership

We encourage central banks to drive the process and provide clarity on the architecture of a future digital currency ecosystem. There is an opportunity to bring the industry together and define a clear framework for collaboration - with a roadmap to address open questions, risks and intended roles left to the private sector.

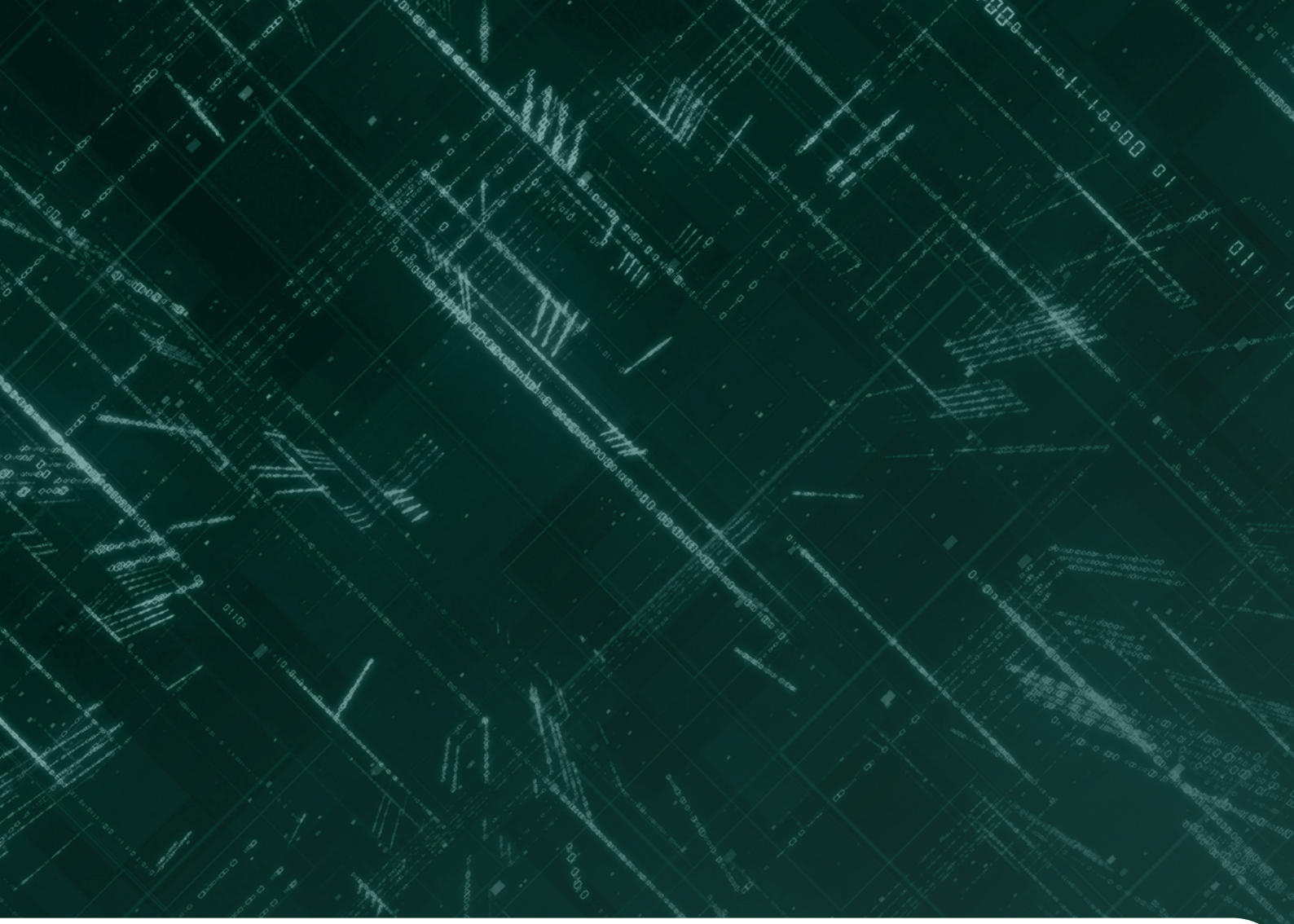
Bank disintermediation and 'flight-to-safety' liquidity crunches during crises are high priority risks to manage. Options for effective mitigation are possible through collaborative, public-private design with a diverse range of inputs. For example, central banks can consider options for CBDCs as on-balance sheet liabilities for commercial banks, along with withdrawal limits and other disincentives to mitigate any future risks to the supply of credit in the market.

This Green Paper therefore proposes a roadmap, summarised in exhibit thirteen, advocating for a real-world pilot to enable an exploratory journey towards CBDC. This is a simple, cautious and progressive framework that features the use of a 'pre-CBDC' asset as a first step for the purpose of testing, a 'synthetic' CBDC as an optional next step, and a conventional CBDC as an end state (all defined in exhibit thirteen).

Exhibit 13 | A roadmap for public-private partnership towards CBDC introduction



Pre-CBDC	Option: Synthetic CBDC (sCBDC)	Central Bank Digital Currency (CBDC)
A digital settlement asset that is **fully collateralised through commercial bank reserve account** or commercial bank account, and issued privately	A digital settlement asset that is **fully collateralised by central bank reserves but issued privately**, a similar model to Electronic Money Issuers	**A digitised form of M0 money, coexisting alongside cash** and issued by a central bank as a direct liability
Issued privately	Issued privately	Issued by central bank



4 | Conceptual Design

The path to a retail CBDC will undeniably be a long and complex one. But we believe the proposed roadmap provides a structured framework for public-private collaboration, ensures inclusive design, and reduces risk. This is achieved across three phases: the use of a 'pre-CBDC' asset for the purpose of testing, a 'synthetic' CBDC as an alternative route to market, and a conventional CBDC.

This chapter introduces the pre-CBDC and describes how this infrastructure can be mobilised:

- Pre-CBDC overview
- Account architecture and collateralisation
- Roles and responsibilities
- Macroeconomic risks
- Compliance, KYC, and encryption
- Data privacy
- Programmability concerns
- Interoperability with other systems
- Governance of the pre-CBDC

4.1 What is a pre-CBDC?

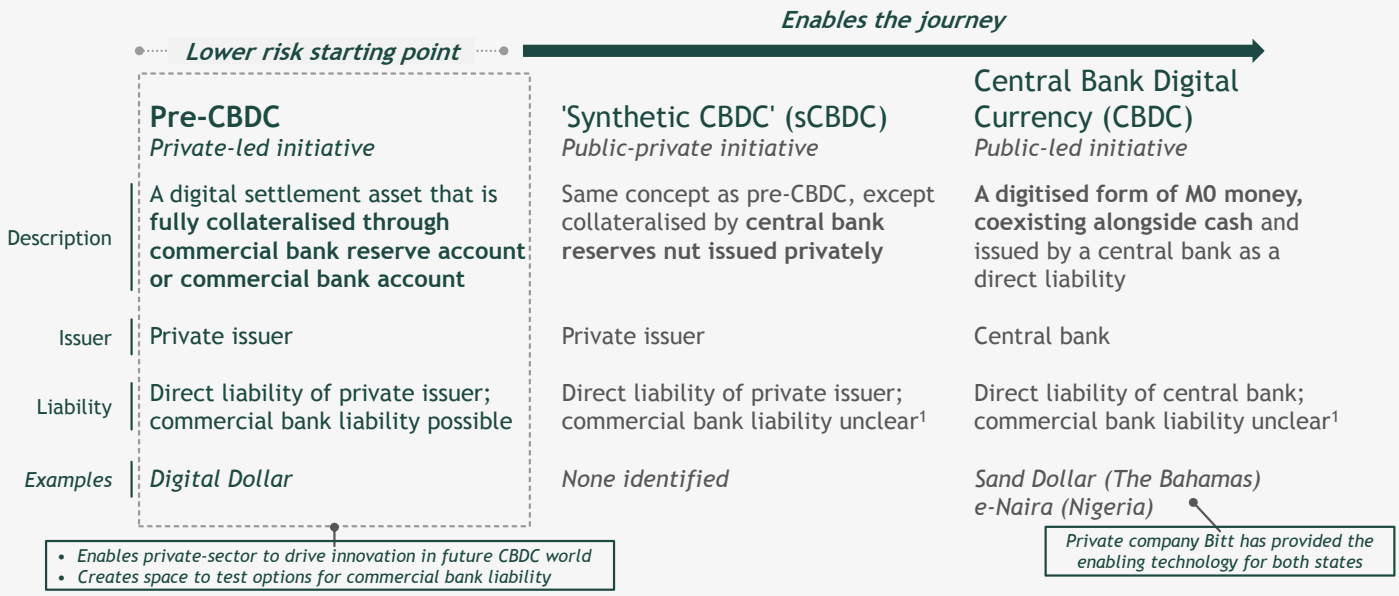
A 'pre-CBDC' is a digital settlement asset that can be backed through a commercial bank reserve account or a commercial bank account for the purposes of a pilot. Collateralisation is structured at a one-to-one ratio to ensure redeemability at par. The conceptual design enables rigorous testing of a CBDC-like asset, and simpler future transitions for central banks into synthetic or fully-fledged CBDC. This is laid out in exhibit fourteen. The project proposes to form a private consortium to issue the pre-CBDC asset and execute the pilot.

A pre-CBDC merges the benefits of open blockchains, such as instant settlement and cost efficiencies, with the necessary data privacy, regulatory compliance, cybersecurity framework and oversight required by a CBDC solution. The pre-CBDC also mimics the design of an sCBDC, but with a significantly lowered risk profile for a central bank, given that it will be led by the private sector. Additionally, this also enables faster speed-to-market.

Should central banks choose to provide reserve account access for the dSterling collateral, the asset would morph into an sCBDC. An sCBDC is functionally equivalent to a CBDC, but is issued privately, similar to an E-money model used by Electronic Money Institutions. This is an effective precursor to test the two-tier CBDC distribution defined earlier. Finally, when central banks are ready for broader involvement in the technical CBDC infrastructure and governance, the asset could be repurposed into a two-tier, conventional CBDC.

Exhibit 14 | CBDC development roadmap

A 'pre-CBDC' digital settlement asset provides the first step for central banks on the path to CBDC

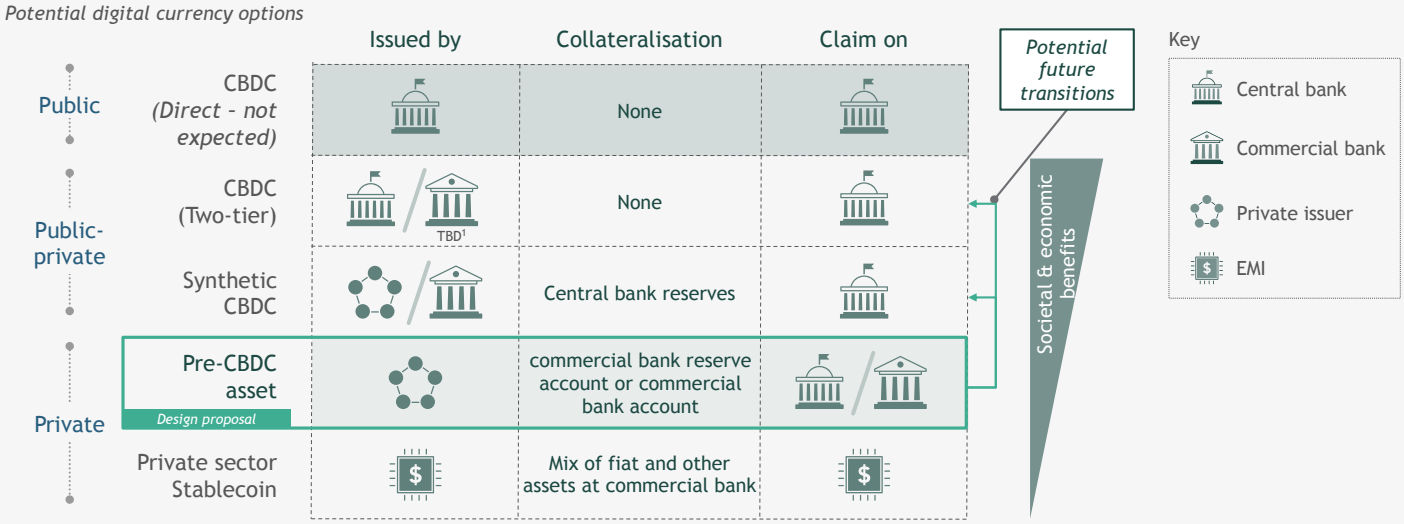


1. The issue of liability is a live area of discussion in the market, dependent on central bank objectives for a CBDC, and carrying significant policy implications

This evolutionary approach ensures any resulting CBDC is built to mitigate macroeconomic risk from the outset. The gradually increasing involvement of the central bank also allows central banks to focus on existing CBDC research and activities, whilst leveraging the private sector to drive progress and provide inputs.

In the following section we will detail how the pre-CBDC consortium, referred to as the Digital Financial Market Infrastructure (FMI) Consortium for the rest of this paper, can be mobilised and the design decisions required for a developed economy exploring this asset.

Exhibit 15 | Taxonomy of CBDC constructs with pre-CBDC



FMI: Financial Market Infrastructures

1. Options for commercial banks to hold CBDC as a liability on-balance sheet to be explored

4.2 Collateralisation

The architecture underpinning the consortium is based on collateralisation through a commercial bank reserve account or a commercial bank account. Consumer confidence in redeemability at par is an essential building block in the success of such a pilot. Pre-CBDCs are therefore backed with fiat currency at a one-to-one ratio. All digital currency is minted and tokenised via an engine which remains separated from the collateral account. Only wallet issuers will have direct interaction with the tokenisation engine.

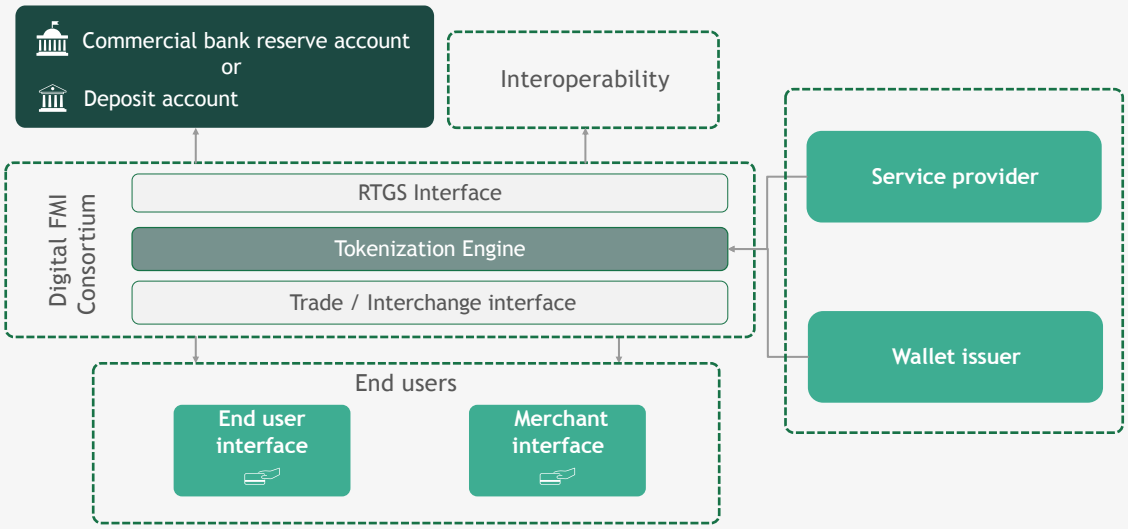
Tokenisation occurs in five steps:

- The end user requests pre-CBDC from a wallet issuer.
- The wallet issuer deposits the equivalent amount of fiat currency in the collateral account.
- The wallet issuer authorises the tokenisation of the fiat currency at a one-to-one ratio.
- Once the tokens are minted by the tokenisation engine, they are transferred to the wallet of the end user.
- The end-user can then access the pre-CBDC and access services from other providers on the platform, hold them, or redeem them back into fiat currency using the reverse process.

The Consortium manages the tokenisation engine, all the interfaces and connecting software, as well as the collateral account. A schematic of the proposed design is shown in exhibit sixteen.

Members of the consortium will also fulfil the service provider and wallet issuer roles in the pilot. The success of the system will rely on effective collaboration between these stakeholders. The roles and responsibilities are further explained in the following section.

Exhibit 16 | Conceptual design of Consortium

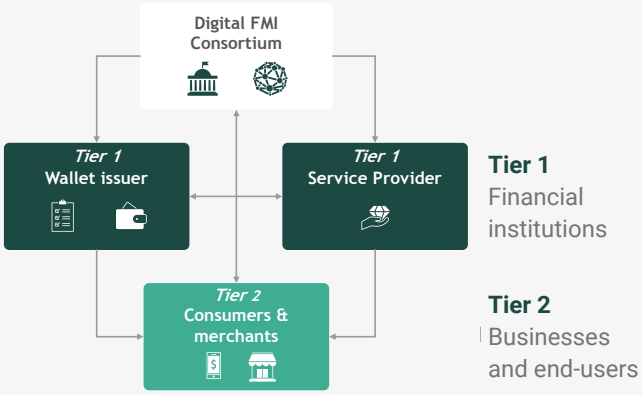


Source: BCG analysis

4.3 Solution architecture and roles

There are four core roles in the pre-CBDC ecosystem, as shown in exhibit seventeen.

Exhibit 17 | Participants in pre-CBDC structure



Source: BCG analysis

1. **Consortium:** Composed of the core pre-CBDC technology platform provider.
2. **Wallet issuers:** Responsible for onboarding end-users, running compliance checks, and establishing initial on/off ramps for consumers into pre-CBDC.
3. **Service providers**[97]**:** Parties offering financial services for end-users such as lending, payments and merchant acquiring.
4. **End-users:** Consumers, merchants and other businesses who access the pre-CBDC via wallets. When end users transact, they do so on the DLT on a peer-to-peer (P2P) basis.

Architecture poised to resolve design concerns from the outset

The architectural structure of the pre-CBDC can address the design concerns and considerations mentioned earlier. In the subsequent sections, we will explore how architectural features tackle concerns including:

1. Macroeconomic risk
2. Onboarding and compliance
3. Data privacy
4. Programmability
5. Interoperability
6. Governance

4.4 Macroeconomic risk

The Digital FMI Consortium exists as a vehicle to pilot the potential risk mitigations described in section 3.6. The use of a sandbox environment guarantees there is no macroeconomic risk potential, but this remains an important testing ground for a future solution operating at scale in the real economy.

Options for testing include:

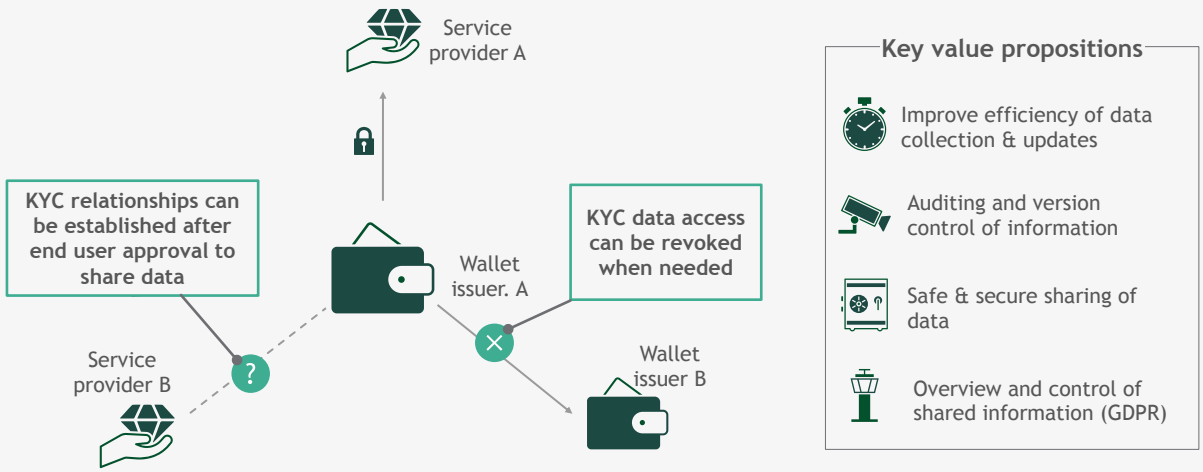
1. **Bank deposit disintermediation:** Two tier distribution models, use of commercial bank liability, disincentives including balance limits and interest rates to prevent usage as store of value.
2. **Bank runs during crises:** Withdrawal limits, non-convertibility on demand or time-gating convertibility.
3. **Global collaboration on financial stability:** Smart contracts that prevent use overseas, limiting currency options to targeted jurisdictions.
4. **Compliance and privacy:** Verifying identities during onboarding, anonymised ledgers, limited access to third parties, AI pattern recognition for AML/CFT compliance.
5. **Cybersecurity:** Decentralising the network, fail-over mechanisms, extensive stress testing, no single-points of failure.

97. *It is possible for a single party to fulfil both wallet issuer and service provider roles

4.5 Onboarding and KYC

Wallet issuers and service providers will be onboarded by the consortium and end-users will be onboarded by wallet issuers, who would perform KYC and AML compliance on all users. This initial onboarding ensures that all parties on the network have trust guarantees with each other. Trust guarantees ensure that end-users can move between different service providers and wallet issuers without having to go through the onboarding process again. KYC information will be shared in a safe and private manner, which can be done quickly and securely by establishing a platform that multiple stakeholders use. The proposed system provides each business entity with its own KYC node. These nodes verify the identity of users, see exhibit eighteen for a brief overview of the KYC node network and the value provided.

Exhibit 18 | KYC and compliance relationships



Source: BCG analysis

Compliance and encryption

All KYC data will be encrypted, with decryption keys provided on a case-by-case basis to relevant parties for checking the validity of transactions. The system is secure because communication between nodes is also encrypted, with mutual authentication required for peer-to-peer communication. Access to permission control information is stored in shared ledgers. Once the ledger is updated, syncing only takes place amongst the relevant parties.

The financial and regulatory benefits of shared KYC platforms

A shared KYC platform helps to reduce the need for inefficient document collection, freeing up time and resources for parties responsible for compliance checks. Platform participants can spend more time onboarding additional end users, boosting their earning potential by increasing the number of customers for their services.

In regulatory terms, data owners remain in full control of access to their data. The system is GDPR compliant by design, with opt-ins for information sharing included during the onboarding process. Shared updates improve the timeliness of data, ensuring all records are maintained effectively.

4.6 Data privacy

One of the most persistent design challenges is the trade-off between compliance and data privacy. Users require a safe, private ledger without external monitoring and data mining from untrustworthy sources. At the same time, responsible financial regulation requires auditability and traceability to prevent financial crime and keep the ecosystem safe.

Data privacy has become a sensitive issue in recent years, with some big tech companies targeted for lacking transparency around the monetisation of consumer data. If the consortium is committed to driving widespread adoption for pre-CBDCs, end users will need guarantees that their privacy will not be compromised by third parties. For this reason, identities will be separated from the core ledger, only verified upon onboarding, and used for verifying right to access.

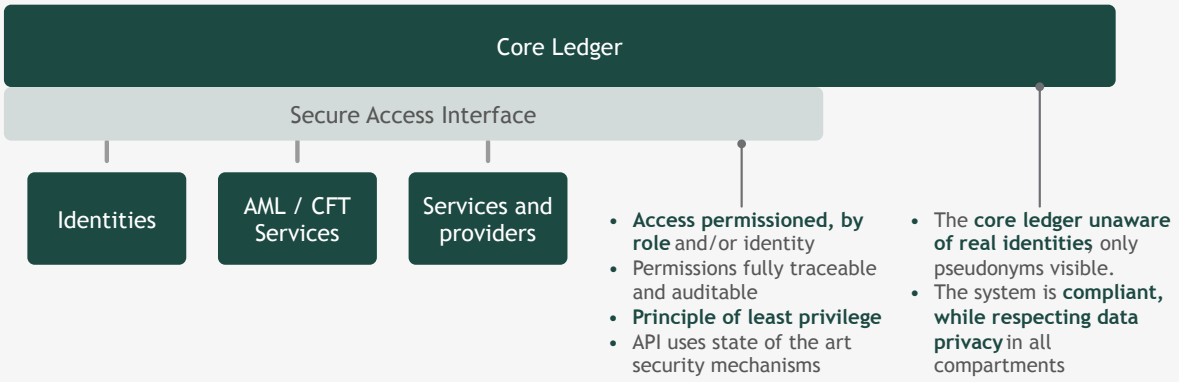
Third party access must also be limited to minimise the risk of data breaches. To ensure this, third parties must be screened thoroughly. Ledger access is contingent on service providers agreeing to a DPA (Data Protection Agreement) and regular auditing.

Law enforcement compliance

Law enforcement will require access to financial data to ensure that illegal activity is identified. For this reason, the solution must have the ability to provide access on a 'need to know' basis for law enforcement. Where financial impropriety is discovered, then assets, transactions and wallets could be frozen, blacklisted, or specific spending requirements instated.

Competitive AI solutions can be deployed to execute pattern-recognition at scale for AML/CFT purposes[98]. Identities are only revealed to the relevant parties once suspicious activity has been detected, and multiple authentication signatures should be required to access the revealed data.

Exhibit 19 | Core ledger privacy and permissions



Source: BCG analysis

98. Anti-Money Laundering and Countering the Financing of Terrorism

4.7 Programmability

Smart contracts have been a pioneering innovation by the private digital currency industry, enabling programmable money. This wave of innovation must be harnessed by keeping the design space open for service providers, while ensuring regulatory compliance and effective enforcement mechanisms. The consortium will intervene in the creation of programmable use cases only when regulatory requirements are compromised.

Setting agreed standards enhances compatibility and cooperation across the financial ecosystem. Communication, protocols, and interfaces will be standardised and open, allowing for maximum interoperability within the network, and with external networks.

Publishing core software under an open-source business licence allows external parties to build on the solution's functionality and applications, while still maintaining commercial control. To ensure ongoing compatibility and extendibility, the solution must build on and extend accepted and well-adopted open-source standards such as the Ethereum Virtual Machine and Ethereum Request for Comment. To build a viable ecosystem of applications, it is important to provide simple, standardised tooling to allow parties to port current applications and quickly build new ones.

4.8 Interoperability

The utility of money is directly driven by how widely it is accepted. Interoperability is therefore a critical success factor which must be designed into the pilot. This is primarily between the pre-CBDC asset and existing forms of money, payment rails including card and payment schemes, and other digital currencies. This requires:

Ecosystem standardisation

Setting rules that standardise behaviours and enable integration with third parties through communication and interaction standards. This open approach could also reduce the initial development costs and complexity for service providers.

Inter-ledger connectivity

Interlinking multiple digital currency systems enables cross-border transactions and builds a broader pilot user base for all systems. Regulatory bodies can still independently administer rules for the different systems to ensure local compliance.

Multiple currencies

To support cross border payments, it will be possible to issue different fiat-backed solutions on the network. This allows easy payments between different currency areas.

Existing payment solution integration

A pre-CBDC will coexist with existing payment rails. To ensure broader utility, integrations with existing payment solutions need to be built including card schemes, payment schemes and SWIFT.

4.9 Governance: A consortium of private companies

There are three dimensions that will determine the structure of the consortium:

1. **Regulation and jurisdiction:** Regulation varies across jurisdictions and changes over time. The legal structure will have to build in this global flexibility to ensure compliance.
2. **Liability and safeguards:** As a private issuer, insolvency risk needs to be managed with financial guarantees to ensure end-user trust in the system. Assets must remain protected during the onboarding and offboarding of consortium members and the one-to-one backing of assets must be always required.
3. **Oversight and control:** Governing mechanisms and operating models must meet local regulatory requirements. Conflicts of interest must also be clearly stated and understood so that mitigating actions can be taken early.

5 | Use cases

The adoption of digital money rests on its ability to offer value to end-users, which is in turn driven by the use cases it can fulfil. The utility of digital currencies has long been an area of debate, with a broad range of opinions on all sides.

On the one hand, enthusiasts point to payment efficiencies, programmability, financial inclusion, and security. On the other, sceptics question the incremental value this adds in developed economies, where payment systems have already made significant efficiency gains. The macroeconomic risks already discussed in section 3.6 are also frequently cited.

As we have shown, CBDC development will require time and investment, with cooperation between many disparate parties. To justify this level of investment, there must be compelling real-world applications from day one. In our research, we identified multiple use cases and have prioritised them down to four high potential areas. They cover a wide range of uses across different segments.

These use cases represent just the 'tip of the iceberg,' existing to identify 'day-one' value and provide a directional view on how a pre-CBDC could deliver benefits as part of the broader exploration of a CBDC. Future innovation in the market will continually introduce new use cases and greatly enhance existing ones. They include:

- Retail payments
- Cross-border transactions
- Tokenisation-as-a-Service
- Servicing Payment Institutions (PIs) and Electronic Money Institutions (EMIs)

Our analysis will primarily focus on the utility of a pre-CBDC asset in the UK market, though the findings are generally applicable to sCBDCs and CBDCs too.

5.1 Retail Payments

In chapter 2, our analysis highlighted the changes in global payment methods for retail spending at the Point of Sale.

In this use case, we take a deeper look at the existing payments landscape in the UK, including card and account-to-account payments. We also explore the impact of Open Banking legislation, recent infrastructure projects like the New Payments Architecture (NPA), and improvements to payment schemes including BACS and Faster Payments.

We argue that pre-CBDC assets could coexist alongside these payment methods and build on these advancements. A digital form of money offers new potential for faster settlements, increased efficiencies, reduced chargebacks, and friendly fraud, as well as the novel prospect of programmability.

Together, these attributes could form the basis for end-user adoption that enhances customer choice and experience. Harnessing this ecosystem could further the UK's leadership role in the global payments industry and benefit all market participants. The following section will cover:

- The UK payments market
- The ecosystem model for a retail CBDC
- Benefits compared to existing forms of payment
- Programmable payments
- Potential for adoption

The UK payments industry

The UK payments industry follows global payment trends identified in section 2. These include the decline of cash payments at the Point of Sale (POS), which has halved in share from ~27% in 2019 to ~13% in 2020, and the rise of digital payment methods like e-wallets, which have doubled from ~4% in 2019, to ~8% in 2020[99]. Adoption of e-commerce is high, accounting for a ~20% share of retail spend and an average growth forecast of ~10% over 2019-2024[100]. These trends reflect a clear shift towards digital options and away from cash payments.

The UK has one of the most advanced payments industries in the world. Superfast broadband access is ubiquitous (96%), and smartphone penetration is high (85%)[101]. Payment schemes such as BACs and Faster Payments offer efficient solutions for lower value, domestic settlement, and open banking legislation has given rise to new entrants. The UK is one of few markets globally that enable non-bank PSPs to settle directly with the central bank, rather than through a banking intermediary (see use case 5.4 'Servicing PIs and EMIs' for more details). Together with private sector advancements in E-Wallets and Buy Now Pay Later, consumer convenience and choice are well established.

Looking ahead, further improvements in payments infrastructure can also be expected. In account-to-account payments, the Faster Payments transaction limit will be increased this year to £1 million, up from £250K. The NPA will merge BACS and Faster Payments by 2024 to enable near real-time payments that are available 24/7, with no cut-off time. Further developments like data standardisation and 'Request to Pay' will arrive even sooner[102]. Elsewhere, the Bank of England is renewing the Real-Time Gross Settlement service which uses the CHAPS system, expected to go-live in 2024[103].

99. Worldpay from FIS, 'The Global Payments Report', 2020 and 2019 (BCG analysis)

100. Ibid.

101. Ofcom, 'Connected Nations 2021 - UK Report', December 2021

102. Pay.UK website, 'New Payments Architecture programme', accessed January 2022

103. The Bank of England website, 'RTGS Renewal Programme', accessed January 2022

The ecosystem model for a retail pre-CBDC

The pre-CBDC would provide end-users with access to a new payment rail that coexists alongside existing rails for card payments and account-to-account transfers. As outlined in the Conceptual Design chapter, the end-to-end transaction flow offers simplification, new benefits and value propositions that build on the advancements already made through open banking and NPA.

The transaction flow, outlined in exhibit twenty, involves a Business-to-Consumer (B2C) payment with funds travelling from a consumer to a retail merchant.

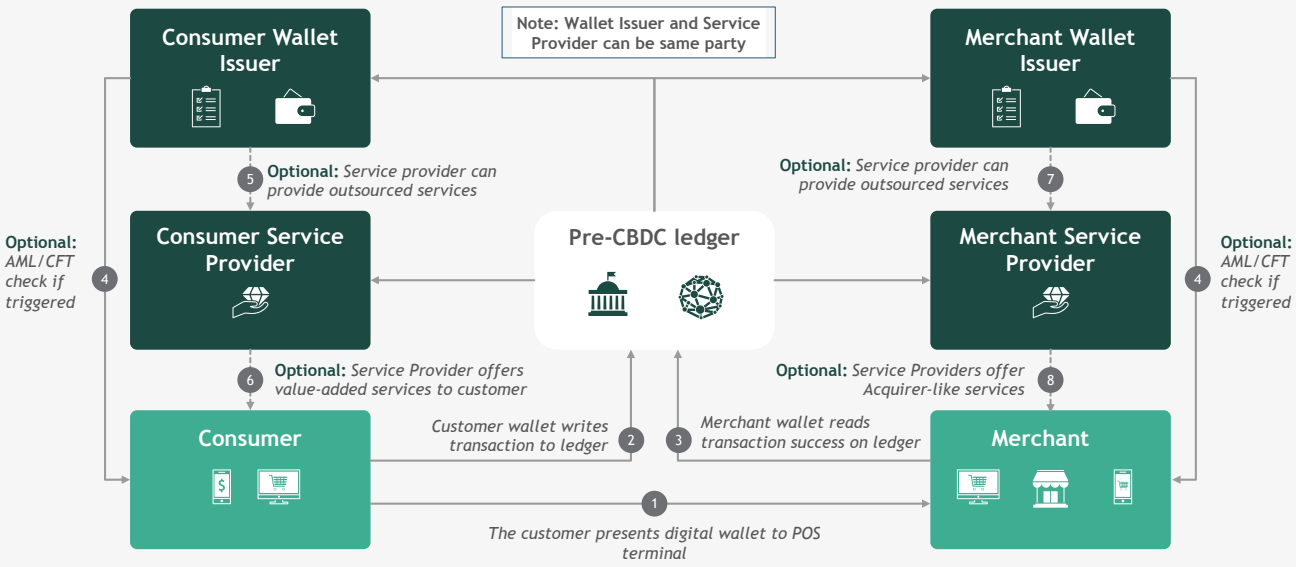
Using a peer-to-peer (P2P) style model, a basic payment only involves three parties: the payer, the central ledger, and the payee. Settlement is near real-time and the potential for cost efficiencies is material, with lower variable costs possible through a DLT implementation. Wallet issuers will provide access to pre-CBDC through a digital wallet, and service providers can provide additional, value-adding consumer or merchant-focused services such as programmable payments (see Programmability deep-dive) and merchant-acquiring. Meanwhile, the transaction processing is handled by the central ledger.

This model has scope for applications across B2C, Business-to-Business (B2B), P2P and Government-to-Consumer (G2C) segments. We foresee the following general benefits:

- Near-instant payments, including micropayments and disbursements
- Lower transaction costs
- Reduced chargebacks
- Programmable payments, including deferral (e.g., payments made after an event-based trigger), conditional (e.g., limiting use to time or location), and pay-per-use (e.g., utility bills)

In the following section, we substantiate these benefits in comparison to existing forms of payments, such as card and account-to-account transfers.

Exhibit 20 | Transaction flow diagram in pre-CBDC payments



Source: BCG analysis

Card payments

The current card payment value chain is operationally complex, with an array of parties enabling the processes of authorisation, clearing, and settlement. A typical transaction has three or four intermediary parties in addition to the payer and the receiving merchant. These include a card scheme, an issuing bank, and an acquirer (which will also undertake or outsource transaction processing). Authorisation of a card transaction takes seconds, and typically no cost is borne by the payer.

From a merchant perspective, it can take up to three days to receive the payment, which is batched through the day and paid in bulk. We recognise the increasing prevalence of next-day settlements, but this is not uniformly the case for card payments. Transaction costs can vary from ~0.5% to ~2% depending on card type, location, and channel[104]. A premium is typically charged for 'Card-Not-Present' transactions, which are often e-commerce sales. As e-commerce penetration grows, the trend represents a growing share of overall merchant transactions.

Overall, it appears possible for a pre-CBDC to offer benefits for merchants when compared with card payments. Near-instant settlements speed up cash cycles and improve intraday liquidity. Transaction costs could be lower; this could aid small and medium sized businesses that benefit less from volume discounting of fees offered by payment service providers. From a consumer perspective, these benefits are of limited materiality and are unlikely to drive adoption alone.

Account-to-account payments

The UK has an advanced and efficient network of domestic payment systems. BACS and Faster Payments serve high volume, low value payments, while CHAPS is used for higher value, same-day payments. These systems provide effective payment solutions, though limitations also exist.

For example, BACS uses a three-day settlement cycle and is therefore limited to non-urgent payments[105]. Faster Payments was subsequently introduced in 2008 to offer settlement within two hours (often near-instant), and available 24/7. Transaction costs are relatively low, though they are higher than BACS and payments cannot be reversed[106].

CHAPS is the UK's high value, wholesale system that offers near instant or same day settlement. Operating hours, however, are limited to weekdays, with a 14:00 payment cut-off. Transaction costs are also typically high, and use cases are therefore limited to wholesale or critical payments (like a house purchase).

As mentioned earlier, Pay.UK's NPA initiative and the Bank of England's RTGS Renewal Programme will drive considerable improvements in these payment schemes, including faster settlement, reduced transaction costs, and greater functionality. It should be noted, however, that the impact on retail payments at the POS may be limited. Our analysis suggests bank transfers were not materially used by consumers at the POS and accounted for just 6% of e-commerce spend in both 2019 and 2020[107]. Given the limitations discussed, it is reasonable to expect a pre-CBDC to also offer incremental benefits when compared to existing account-to-account payments too.

Benefits

A pre-CBDC could provide benefits compared to existing payment methods in four areas discussed here:

1. **Near-instant settlement:** Eliminates card transaction batching and delayed cash cycles for merchants. Faster Payments and CHAPS are reasonable alternatives for rapid settlement but are not typically used in retail transactions at the POS. Consumer benefits here are likely to be limited.
2. **Transaction cost reduction:** The extent of transaction cost savings will ultimately depend on design decisions around the implementation of digital currency and the supporting ecosystem. There could be different approaches to payment transaction costs and fees, such as subscription models. In any case, it is reasonable to expect that merchants will continue facing costs when accepting pre-CBDC payments, and cost savings may not be a core adoption driver. As with near-instant settlement, transaction cost reduction also offers limited benefits for consumers, who do not incur these costs.

104. BCG expert interviews

105. LiNK, 'An Introduction to the UK's Interbank Payment Schemes, 2017

106. Ibid

107. Worldpay, 'The Global Payments Report 2020', January 2021 (BCG analysis)

3. **Chargeback reduction:** Chargebacks[108] resulting from criminal or 'friendly fraud[109]' are a growing issue for merchants. With pandemic-led e-commerce intensification, a recent report suggested merchants surveyed experienced a 25% increase in chargebacks post COVID-19[110] on average. The growth is driven partly by the increase in Card-not-Present transactions, where the payment is made without the physical presence of the card or customer. For merchants, this leads to lost revenue, increased costs and wasted effort[111]. The pre-CBDC asset could make a material difference in addressing some of the underlying causes. Programmable payments could, for example, allow funds to only be released if goods are physically received by consumers. The use of cryptography and avoidance of card details also reduce the risk of fraud. We therefore deduce that there are clear benefits for merchants and consumers.
4. **Programmable payments:** Further to the Programmability deep dive in section 3.5, there are two core components that enable exciting new potential for programmable payments:
   a. The synchronisation of payment and business processes, enabled by near instant settlement; and
   b. The self-execution of pre-defined terms and conditions, enabled by automated smart contracts.

This creates broad potential for pre-defined, automated payments including but not limited to time, location, value, frequency, and external triggers. This enables a host of new payments which can drive efficiencies and spur novel innovation. The true potential of this will take time to be fully harnessed.

Benefits are likely to arise from the enhancement of current services and provision of entirely new ones, such as near real-time, guaranteed payment on delivery of goods, pay-per-use utilities and instant insurance provision and disbursement. There is potential for programmability across all retail segments. To illustrate early potential, we have mapped some possible applications.

We have divided these across B2C, B2B, P2P and G2C transactions.

- **Business-to-Consumer:**
  - Payments triggered when e-commerce orders are received.
  - Limiting use to a product category, store, brand, location, or time
  - Combination of fractional and/or micropayments with pay-per-use (pay per energy unit used), and streaming (pay per minute viewed)[112].

- **Business-to-Business:**
  - Supplier payments triggered when supplies received.
  - Customer refunds triggered when an order is returned to a distribution centre.
  - Automated machine-to-machine procurement of raw materials.
  - Sale of spare capacity on marketplaces (e.g., all sorts of assets, from marketing properties to heavy machinery and vehicles)[113].

- **Peer-to-Peer:**
  - Deferred payments (e.g., payments to family or friends once certain time-based milestones are reached).
  - Conditions (e.g., inheritance (will execution, trusts), limiting use of funds (preventing alcohol, tobacco spend, gambling)).

- **Government-to-Consumer:**
  - Social welfare (e.g., event-based payment triggers).
  - Conditional use (e.g., limiting use of social welfare funds).

In summary, pre-CBDC and future CBDC assets appear unique when compared to existing forms of payments, given the unique combination of benefits they will offer. This is especially true of near-instant settlement and smart contract-enabled programmability, which are not found together in any other form of non-digital money. This could be the basis for future adoption, over and above the incremental benefits to settlement times and costs mentioned earlier. In the final section of this use case, we turn to the question of adoption.

108. Chargebacks: A cardholder attempts to reverse a card transaction, typically without going through a merchant's refund process
109. Friendly fraud: Cardholder disputes a transaction they don't recognise, or intentionally attempts to abuse system
110. Chargebacks911.com, 2021 Chargeback Field Report (Merchant Survey Results), 2021
111. Ibid
112. Ibid Finanzplatz München Initiative (fpmi), 'The Programmable Euro: Review and Outlook', December 2021
113. Ibid

Pre-CBDC adoption

In our research, we have developed a framework for the adoption of a pre-CBDC and future CBDC for retail payments, based on five core drivers. In this paper, we have spoken at length about the first four, as shown in the exhibit below. The rest of this chapter will focus on targeted adoption initiatives.

Exhibit 21 | Drivers of CBDC adoption in retail payments

Source: BCG analysis

Targeted initiatives to drive adoption

Driving initial consumer and merchant adoption will require targeted initiatives bespoke to both parties. We summarise some of these from our landscape review.

Consumers:

Programmable payments could drive long-term consumer adoption at scale. However, several other measures can be taken to instigate the network effects required to build a critical mass. Enabling infrastructure, including interoperability and integration with existing forms of payments like card and payment schemes, will be fundamental.

China's e-CNY pilot has grown consumer adoption through lotteries with pre-funded wallets, retail partnerships, and roll out on public transport. Some state employees have also been paid in e-CNY.

Merchants:

As with consumer adoption, programmable payments can also play a role on the merchant side. Merchants, acquirers and other PSPs could offer value-added, programmable payment propositions to consumers. Through partnerships with other service providers in the value chain, bespoke customer offerings can be developed. Free merchant wallets could also increase uptake amongst B2C businesses.

5.2 Cross-border transactions

Cross-border transaction volume reached ~$130 trillion in 2019[114], driven by the globalisation of trade and increased digitisation of financial services. Despite ongoing improvement and modernisation of the SWIFT system, cross-border transactions remain slow and expensive. Using a pre-CBDC could address these inefficiencies by increasing speed and reducing costs. This chapter explains how a pre-CBDC achieves these outcomes by covering:

- Drivers of cross-border transaction growth
- Potential paths forward for cross-border transactions
- An overview of mCBDC solutions
- Benefits that a pre-CBDC solution could provide

114. BCG analysis, 'BCG Global Payments model'

The value of a pre-CBDC for cross-border transactions

International payments are an important feature of a digitally connected economy. With ever-improving internet speeds and broader smartphone penetration, consumers and businesses alike are gravitating towards new payment methods. Both groups are seeking options that enable them to conduct international transactions with minimal charges and inconvenience.

However, cross-border transactions present a complex landscape for central banks to navigate when developing CBDCs. CBDCs could present a fresh opportunity to facilitate greater cross-border transactional functionality than is currently available.

Three converging drivers accelerating cross-border urgency

Cross-border payment services are becoming increasingly competitive due to the convergence of three drivers:

1) The rise of digital payments

Digital payments are growing strongly, increasing the need for seamless and low-friction payment systems to ensure business ecosystems run smoothly. Following the pandemic, e-commerce growth has intensified, establishing a migration to digital payments that is here to stay.

2) Globalisation of trade and financial flows

International business is no longer the sole purview of large commercial brands. E-commerce has enabled small businesses to operate globally, with customers and suppliers located across continents. With cross-border transactions a day-to-day reality for more businesses than ever, round-the-clock access to international payment methods is a critical enabler.

3) Growing uncertainties and complexities of doing business

The balance of risks to the financial system has changed considerably in recent years. New standards such as KYC and AML compliance requirements have increased the complexity of operating in the modern economy while traditional risks remain. There is a need for increased transparency, settlement speed and operational efficiency to power productivity in the economy.

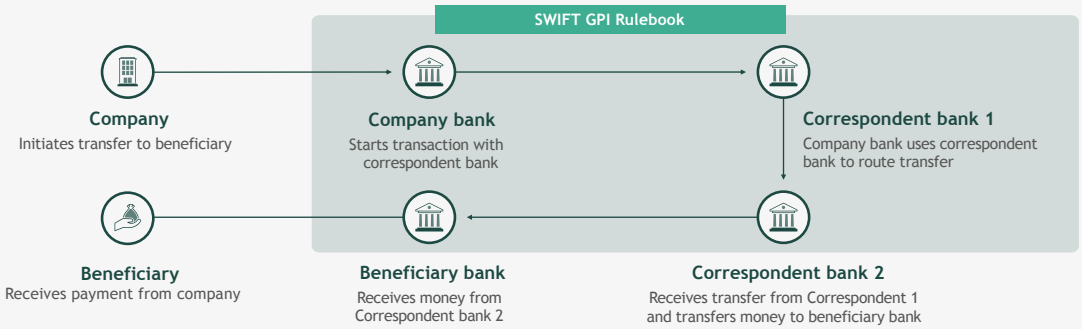
Current state of cross-border transactions

In 2019, total cross-border payments revenue reached $57bn (USD) with the top ten payment corridors accounting for over 15% of the value. These payments are supported by many different solutions, but 70% of cross-border transactions occurred through the SWIFT network[115].

The SWIFT network recently shared progress in reducing settlement times down from three days to one via their GPI (Global Payments Innovation) program, with 50% of transactions settling within thirty minutes. SWIFT uses a system of correspondent banks to route payments, shown in the illustrative exhibit twenty-two. Charges range from approximately £25 to £40[116]. Banks also typically charge intermediary or foreign exchange fees.

Card networks and fintechs such as Currencies Direct and Wise also offer cross-border payment services. These services use different models for international payments, including P2P transfers via digital wallets[117], or directly with banks and without corresponding banks[118]. This can reduce some inefficiencies, but carries constraints such as broader interoperability.

Exhibit 22 | SWIFT payment flow example



Source: BCG analysis

115. BCG analysis, 'BCG Global Payments model'
116. Ibid.
117. Revolut, 'international payments'
118. Visa Direct, 'Visa Direct'

Two architectural options to drive progress

While improvements to existing payment infrastructure and networks like SWIFT are ongoing, a second stream of research has appeared, multijurisdictional CBDCs (mCBDC)[119]. An mCBDC can take different forms but the most commonly explored is the linking together of domestic CBDC systems in different jurisdictions to facilitate cross-border trade and payments. This method of facilitating cross-border payments has the potential to radically simplify payment streams and can lead to faster settlement, reduced transaction costs and less liquidity trapped in the correspondent banking system[120].

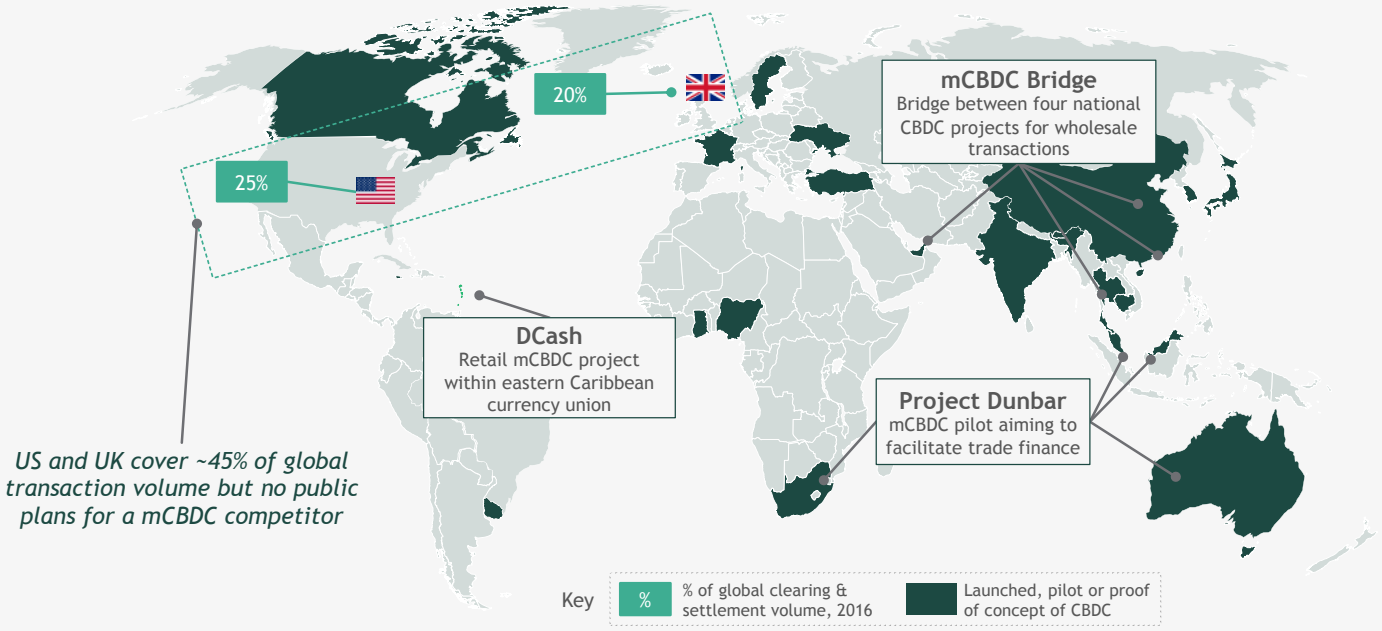
Building an mCBDC infrastructure in tandem with emerging technologies provides governments and central banks with options for functionality they would not otherwise enjoy. In many ongoing pilots, P2P payments are either available or possible to deploy in the future. The mCBDC networks often rely on DLT technology and provide parties on the network with the ability to use programmability, settle transparently in near real-time and at low cost[121].

Although potentially more costly than renewing existing systems and networks, an mCBDC provides a clean slate to ensure development goals can be aligned from the outset to deliver central bank objectives.

An overview of mCBDC research worldwide

Developed economies are less incentivised to develop mCBDC architecture from scratch given existing efficiencies. However, developing nations with lower financial inclusion and in search of payment efficiencies, may be more willing to adopt an mCBDC approach. This split can be seen in the development of multijurisdictional mCBDCs across the world in exhibit twenty-three[122]. The major mCBDC projects currently live, mCBDC Bridge[123], project Dunbar[124] and the DCash currency union[125] largely involve developing economies. The US and the UK, which together clear 45% of international trade, have no such initiatives.

Exhibit 23 | Greenfield approach more popular in developing economies



Sources: Data from cbdctracker.org powered by BCG, December 2021 last updated January 2022

119. CBDCTracker.org, BCG analysis last updated January 2022
120. Oliver Wyman and JP Morgan, 'Unlocking $120 billion value in cross-border payments', November 2021
121. BIS, 'Inthanon-LionRock to mBridge' September 2021
122. Cbdctracker.org, January 2022
123. BIS, 'Inthanon-LionRock to mBridge' September 2021
124. BIS, 'Project Dunbar', 2021
125. DCash, 'DCash Currency Union', 2021

The Digital FMI Consortium instant settlement solution

The potential benefits of an mCBDC could be significant enough to warrant exploration and piloting in developed economies. The pre-CBDC can power these initiatives, serving as a testbed and reducing risk.

Multiple digital assets on the same ledger for P2P transactions and settled in fiat

In the proposed Digital FMI Consortium solution, UK banks could store several fiat-backed digital currencies. By retaining the currencies in the bank, P2P transactions could take place seamlessly on the ledger until customers require fiat payments, then they can redeem their assets via off-ramping. There would be four steps to this process.

1. A UK commercial bank stores GBP in the consortium reserve accounts, with the Consortium minting pre-CBDC at a one-to-one ratio with fiat.
2. The **UK buyer** receives the GBP backed asset.
3. The **UK buyer** exchanges GBP assets with an **FX provider**, which transfers the converted EUR assets to the **EU-based** seller.
4. The **EU-based** seller can use EUR assets on the network or off-ramp the digital currency with the relevant bank in their jurisdiction.

How it works

Pre-CBDCs are issued in relevant jurisdiction, backed by fiat in the target central banks. Issuance and redemption are handled by commercial financial institutions, which are hosted in each jurisdiction. Foreign exchange trading is taken on by liquidity providers that set rates, including outside market prices, and charging mechanisms. This is shown in exhibit twenty-four.

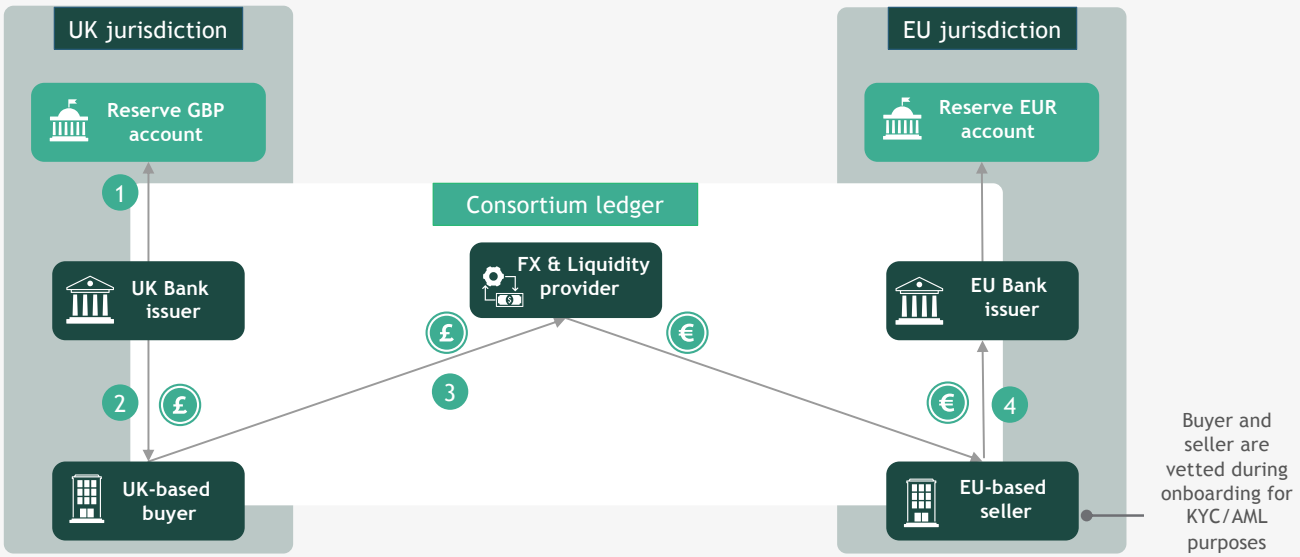
Various pre-CBDC currencies can be issued on the same ledger, with access granted on a user-by-user basis. For example, a company might be vetted for usage of USD on the central bank ledger, but not GBP pre-CBDC. Third party monitoring ensures compliance and AML/CFT checks take place.

Future evolution of the Consortium ledger's infrastructure

The proposed architecture of the Consortium is flexible enough to evolve in future years to support fully interoperable mCBDCs. With developments and adaptations to the Consortium's design, the system could support multiple ledgers at once.

The high level of interoperability in the consortium design allows simple bridging mechanisms to other CBDC projects and expands the international reach of the payment infrastructure.

Exhibit 24 | Payment flow of pre-CBDC cross-border payment



Source: BCG analysis

5.3 Tokenisation-as-a-Service

The tokenisation and payment infrastructure built for a pre-CBDC could also be used for with other assets. With this architecture, the consortium could allow other organisations to exchange value through white-label versions of the settlement asset, or alternatively backed assets such as commodity or security-backed tokens. Since this technology is new and being actively explored, the potential of this use case is only just emerging.

What is Tokenisation-as-a-Service?

Tokenisation-as-a-Service (TaaS) is the provision of infrastructure for future use cases that enables private organisations on the Digital FMI to tokenise and transact assets for use in closed ecosystems with customers or suppliers. The assets can be financial, utility-based, or physical.

Tokenisation-as-a-service models could democratise access to new and diverse digital asset classes, allowing entrepreneurs and businesses to develop new value propositions. This way, central banks and governments can choose their preferred level of involvement and allow space for innovation where desired. The benefits of Tokenisation-as-a-Service will depend on whether the assets are fiat or non-fiat backed. Generally, a potential solution based on the pre-CBDC architecture could provide the benefits of full one-to-one backing, having an easy plug and play architecture, supporting all types of assets, and providing complete regulatory compliance and certainty.

Plug and play payment infrastructure

The Consortium is responsible for minimising operational complexity for client companies and end users. Clients use the Consortium's API to plug in their infrastructure and connect to the Tokenisation-as-a-Service solution. The consortium's TaaS solution can support a range of technical services, including the operation of IT infrastructure, the creation of user wallets, on-off ramp systems for fiat exchange, and ensuring regulatory compliance.

Types of assets and value

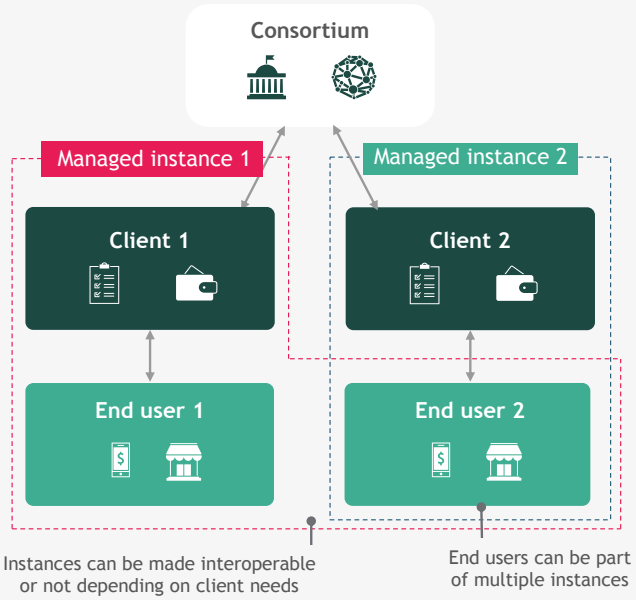
Not all assets supported by Tokenisation-as-a-Service models require fiat backing. An example of a useful non-fiat backed asset could be loyalty points, which client companies can administer more effectively with Tokenisation-as-a-Service models than current systems. Once the Digital FMI Consortium is up and running, other assets, such as commodities, equities, and other fiat currencies, can be rapidly onboarded for clients where necessary.

The broad range of assets can allow client companies to set programmatic rules. The rules can be based on specified roles, individuals, or unique use-cases. Clients can set levels of access based on flexible privacy criteria. Client stablecoins can be both interoperable across the consortium's platform, or cordoned off, based on individual client's needs.

The role of the Consortium

For TaaS to work, the Consortium provides the underlying infrastructure and architecture. The Consortium is also expected to manage issuance and redemption of tokens in line with client demand. The client is responsible for branding, marketing, and business development, whilst the consortium maintains the accounts, sets the core technology standards, and outlines future technological objectives.

Exhibit 25 | Setup of Tokenisation-as-a-Service construct



Source: BCG analysis

Types of clients and uses

Modern payment infrastructure is useful beyond fiat and digital currency exchanges. Non-fiat assets can enable more direct control for client companies by using the TaaS system. Non-fiat assets could include loyalty schemes, events, and attractions. The following subsection will provide an example for each segment, first covering fiat assets before discussing non-fiat assets.

Fiat-backed assets: Gig economy disbursements

For fiat backed assets under a TaaS scheme, there are uses in large ecosystem coordinators like Apple, SAP, and Google. Another possibility is the disbursement of funds throughout the gig-economy, an existing pain point for many digital companies. Currently, payment processing delays create persistent instability for gig-economy workers[126], reducing the appeal of jobs in the sector. Closed systems, powered by consortium led TaaS infrastructure, could offer a solution to the problem and give greater financial control to client companies. This solution would architecturally look like exhibit twenty-six included below.

Benefits for platform coordinators:

Platform coordinators could benefit from integration with the Consortium's Tokenisation-as-a-Service infrastructure, including:

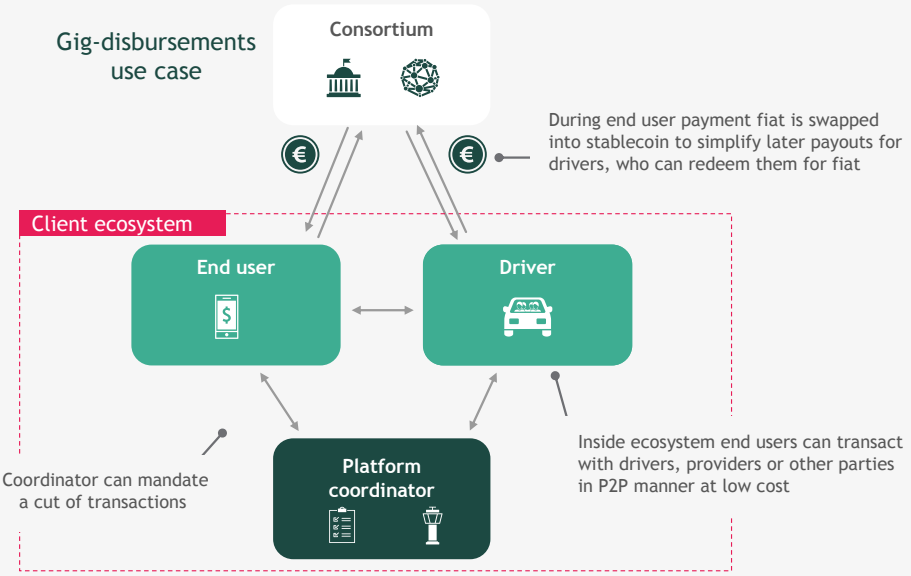
- A high level of analytical insight and data capture.
- Dynamic control over payment systems at low friction.
- External data sources (e.g., smart contracts executed based on delivery of goods triggers).
- Low fee and real-time pay-outs for workers

Potential concerns of platform providers

Accessing the full benefits of gig-economy disbursement presents logistical challenges for platform providers. Platforms will need to be willing to relinquish some of their control if they hope to maximise commercial advantages. Practical questions remain around how to best deliver efficient integration. External and internal challenges could hamper platform providers in making the most of the Tokenisation-as-a-Service opportunity.

Platforms have built their business presence on internal system controls, with connectivity for end users and gig-workers provided exclusively through apps each company owns outright. However, if they choose not to work with consortiums, platforms will suddenly become liable for building everything themselves.

Exhibit 26 | Gig-disbursements use case diagram



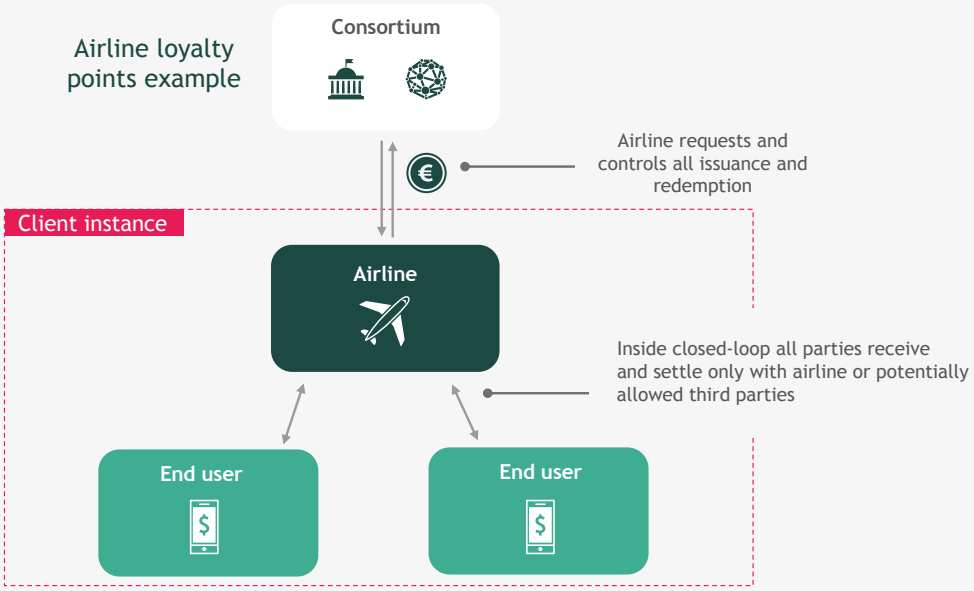
Source: BCG analysis

126. FinExtra, 'The rise of the gig economy: How Electronic Payments can help'

Non-fiat backed assets: Transforming loyalty points

Through the architecture provided by the consortium, almost any asset that can be safeguarded can be tokenised. This includes commodities, physical assets or loyalty points, for example. The underlying technology behind loyalty points has not changed dramatically in recent years. For this example, we have chosen to focus on airline loyalty points schemes to map out how the system could work.

Exhibit 27 | Airline loyalty use case diagram



Source: BCG analysis

Redesigning airline loyalty points: Increasing data analytics focus

For airlines, loyalty programmes can account for up to 10% of revenue[127], making them an important component of the overall business. A TaaS based loyalty program solution could provide an enhanced loyalty proposition, driven by offering a range of benefits. Examples of these benefits include easily interchanging loyalty points for fiat or other digital assets, utilising loyalty points for programmable use cases and receiving or spending points in multiple locations.

Potential concerns for a loyalty point offering

Loyalty systems carry a significantly differentiated set of requirements from a pre-CBDC and therefore require large development and design costs. The costs involved with developing a full solution with Consortium APIs could be prohibitive, as the use case is not very close to the core capabilities of the Consortium.

The value of Tokenisation-as-a-Service

In summary, the most valuable use case for Tokenisation-as-a-Service appears to be for fiat-backed assets. High-friction ecosystems are an ideal target for a solution that offers simplification and scalability. By contrast, non-fiat backed assets may be more difficult to justify targeting client companies, especially as capital expenditure remains high due to more bespoke design requirements.

Like Tokenisation-as-a-Service, digitised currencies could help to support the nascent fintech industry.

127. BCG Analysis, BCG Expert interviews

5.4 Servicing Payment Institutions (PIs) & Electronic Money Institutions (EMIs)

After the 2007-2008 Great Recession, regulators in the payments industry introduced legislation that allowed non-banks to enter the market for the first time. However, non-bank payment service providers have often struggled to obtain banking access, which is required to provide services and fulfil safeguarding requirements.

This section covers:

- Context that gave rise to the growth PIs and EMIs
- The requirements of safeguarding regulation
- Challenges in obtaining Indirect Access (such as de-risking) and Direct Access to payment schemes
- How a pre-CBDC solution can be used to address pain points in the market

Servicing PIs and EMIs

PIs and EMIs are non-bank PSPs, offering payment services to consumers and merchants. EMIs have the distinction of issuing electronic money (e-money) as a store of value, like the holding of deposits (but exempt from banking regulation), for end users. These entities have emerged over the past two decades.

In the aftermath of the 2007-2008 Great Recession, the European Commission introduced the First Payment Services Directive (PSD1)[128] in 2009. This was a response to market concentration and poor consumer experience in the payments industry. PSD1 enabled non-bank entities, including PIs and EMIs, to operate as Payment Service Providers (PSPs) alongside commercial banks. The legislation drove competition and improved customer experience.

PSD1 was followed by the Second Electronic Money Directive (PSD2) in 2018 (which also brought in the concept of Open Banking in the EU), further enhancing competition between commercial banks and PSPs[129]. Today, there are hundreds of PI and EMIs operating in the UK and EU markets.

As non-bank entities, PIs and EMIs require a banking partner to hold their funds which have been accepted in return for payments or e-money issued (safeguarding rules). There are two specific bank account required, and in the UK, Tier 1 commercial banks are the leading providers of these accounts:

1. **Operating accounts:** to hold funds and make payments including settlement to the schemes if they are issuing payment cards through say Visa or Mastercard; and
2. **Segregated client accounts:** to hold client funds at rest as required by safeguarding rules.

Indirect and Direct access to payment schemes

In addition to the two accounts above, to provide account-to-account payment services, PSPs also require access to payment schemes (CHAPS, BACS, Faster Payments in the UK). Access to payment schemes is typically via a commercial bank. This is known as 'Indirect Access' (or 'agency banking'). In some jurisdictions (e.g., EU), this remains the only option.

In the UK, however, 'Direct Access' was made possible for non-banks in 2018 and involves direct settlement with the Bank of England (BoE). A BoE settlement account is granted through the Direct Access application process to enable this. This BoE account replaces the need for access through a commercial bank. For reasons we will show later, most PIs and EMIs have not pursued Direct Access.

Safeguarding regulation for customer funds

PIs and EMIs offering payment services receive client funds to hold if they are issuing e-money, or if providing a payment service to execute payments. A customer, for example, will transfer funds to a PI to make a payment. Safeguarding regulation exists to protect customer funds from the impact of insolvency by avoiding co-mingling with company funds[130]. This is important because funds custodied by PIs and EMIs are not classified as bank deposits, and therefore do not qualify for the £85K FSCS deposit insurance scheme[131].

There are multiple methods of safeguarding, including segregated bank accounts, insurance policies and the use of High-Quality Liquid Assets. Segregation is the most widely used and preferred by regulators, requiring client funds to be held in a separate 'Safeguarding' bank account with a commercial bank[132]. This further underscores the dependence of PIs and EMIs on commercial bank partners.

128. European Commission, 'PSD 1', 2007

129. The first Electronic Money Directive was adopted in 2000 and defined 'Electronic Money Institutes' in regulation for the first time

130. Clifford Chance, 'Do UK e-money and payment services firms hold safeguarded funds on trust?', August 2021

131. Non-bank entities are not able to receive customer deposits

132. Or other authorised credit institution

Indirect access challenges

De-risking, the refusal or withdrawal of banking services by commercial banks[133], has been a longstanding issue in the industry. This has been driven by three post-recession regulatory changes:

1. **Structural changes post 2007-2008 recession**, preventing commercial banks from lending against safeguarded funds. PI and EMI funds therefore offer a lower return potential than other sources of capital.
2. **Intensification of AML and CFT regulations**, increasing compliance overheads as digitally enabled financial crime emerges, impacting commercial bank risk appetite.
3. **Unclear regulation of new business models**, making it challenging for banks to accurately risk-assess PIs and EMIs, many of whom are scored as high-risk new entrants by the banks.

While all three changes brought undeniable benefits to consumers, including enhanced protection of safeguarded funds from insolvency and the combating of financial crime, they have also driven significant de-risking of PIs and EMIs by the banks. Paradoxically, this is in direct contradiction with the original intent of regulators, which was to enhance competition. In response, the UK government has attempted to intervene via the formation of the Payment Systems Regulator (PSR) in 2015; the Payment Service Regulations in 2017 (PSR 2017); market reviews by the FCA and PSR in 2016, and by HMT (ongoing).

The failure of regulatory intervention

The 2017 Payments Services Regulations were partly designed to enforce better Indirect access for PIs/EMIs. In 2016, reports commissioned by the FCA and PSR surfaced some of the issues surrounding this.

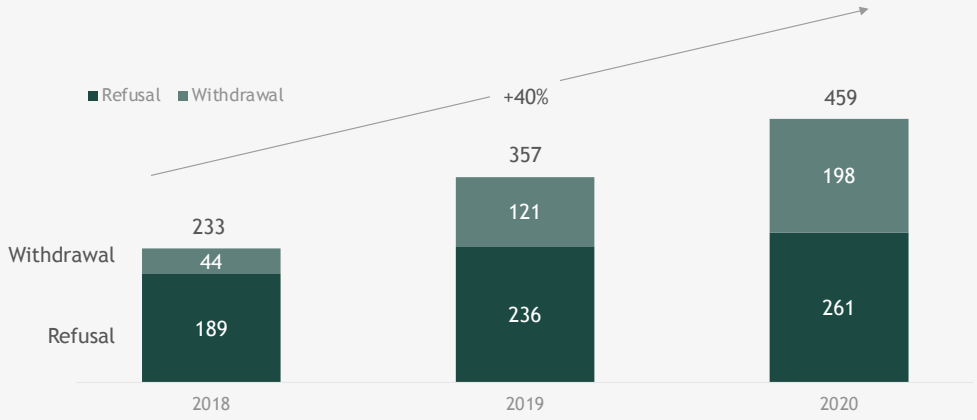
In response, the PSR 2017 introduced the POND construct to commercial banks: "Accounts are provided on a POND (proportionate, objective and non-discriminatory) basis." Regulation 105 also includes a requirement for banks to notify the FCA when access is refused or withdrawn[134]. The FCA has also added that "Commercial banks should not have policies based on restricting access to those services for certain categories or types of PSPs[135]."

Despite these efforts, our research suggests this regulatory intervention has failed to have a significant impact. We share three such examples below.

1. Our analysis of notifications for refusal or withdrawal of access shows significant growth since the PSR 2017 regulation. Notifications have grown at a Compound Annual Growth Rate of 40% over the period 2018-2020 (see exhibit 28). The PSR has also stated that this data, which is self-reported, is not always shared by banks with the FCA on occasions where it should be[136].

Exhibit 28 | Notification of refusal has increased by 40% CAGR 2018-2020

Notifications self-reported to FCA by credit institutions on refusal or withdrawal of access, #



Source: 'Access and governance report on payment systems: update on progress', Payment Systems Regulator, January 2022 and June 2019

133. 'Drivers & Impacts of Derisking', John Howell & Co. Ltd. for the Financial Conduct Authority, February 2016
134. The Payment Services Regulations 2017', Her Majesty's Treasury, July 2017
135. Payment Services and Electronic Money - Our Approach', Financial Conduct Authority, November 2021
136. Payment Systems Regulator; 'Access and governance report on payment systems: update on progress', Payment Systems Regulator, January 2022, and June 2019

2. We found evidence that PIs and EMIs can still be completely barred from making Indirect access applications to commercial banks, in contravention of FCA guidance quoted above. A tier 1 UK bank, for example, refused applications from PIs and EMIs on its website. We note the PSR's view[137] that this may be driven by the impact of the pandemic on the bank in question.
3. To corroborate the findings above, we conducted interviews with UK EMIs. All interviewees mentioned issues with de-risking and the constant search for commercial bank partners to offset this risk. One interviewee also shared the impact of safeguarding balance limits, which were insufficient to cover their client base.

Direct access challenges

Although the availability of Direct access is a positive development for the industry, our research suggests this will not resolve the issues experienced with Indirect access:

- Firstly, onerous Direct access application requirements effectively shut out smaller players and new entrants who make up the bulk of the market. These requirements include multi-million average turnover or e-money balances, regulatory assessments, in addition to technical requirements.
- Secondly, slots to obtain Direct access are limited, and current lead times sit at around 18 months due the current BoE RTGS renewal.
- Finally, while Direct access and subsequent provision of a BoE settlement replaces a Transactional account with a commercial bank, Operational & Safeguarding accounts are still required. This is because the BoE accounts can only be used for payment scheme settlement with no excess overnight balances allowed. Furthermore, transactional accounts will also be needed where the PI or EMI does not have Direct access, or where the scheme does not settle via the BoE (e.g., foreign currencies).

For these reasons, Direct access is challenging to obtain for PIs and EMIs, and it does not replace the need for commercial bank access.

Research conclusion

Based on the evidence, this paper recognises that regulators and commercial banks have sound rationale for the drivers that underpin de-risking activity and the impacts on Indirect Access, even if the execution has been imperfect. We also acknowledge the positive developments brought about by the impact of broadening Direct access and the growth of Indirect Access Providers.

To continue and build on these positive developments, we propose further regulatory review to protect innovation and enhance consumer choice. This is particularly important given ongoing Pay.UK investments in open banking, NPA and the BoE RTGS renewal programme.

There is little doubt that many PIs and EMIs in the UK are effectively stuck: commercial banks continue to restrict Indirect access, whilst direct access via the BoE remains out of reach for most. A solution is needed if the fintech industry, particularly the PSPs, are to survive and keep competition alive.

The solution: overview, benefits, and risks

Access to banking for fiat payments cannot be resolved directly through the Consortium solution. However, the Consortium (as detailed in the Conceptual Design chapter) can make the new pre-CBDC asset available to PIs and EMIs as a secure, liquid asset with regulatory acceptance[138].

For an EMI, typically a small portion of e-money held is transacted daily, and as such, it is unlikely to be an issue for the EMI to off-ramp such amounts to settle card payment schemes and facilitate those transactions. However, it will not alleviate the need for access to payment schemes such as SWIFT and BACS to enable money transfers, until the pre-CBDC is able to facilitate such transfers directly, which of course is its aim.

In the spirit of PSD2 and Open Banking, the solution can help to drive innovation and broaden the market by enabling new entrants with access to instant, programmable payments. The closed-loop nature of the Consortium also effectively cordons off risk to the wider financial system.

137. Payment Systems Regulator; 'Access and governance report on payment systems: update on progress', Payment Systems Regulator, January 2022, and June 2019

138. Regulations 23(6)b and 21(6)(b), The Electronic Money Regulations, Her Majesty's Treasury, 2011

Naturally, the primary use case for PIs and EMIs will be the use of the pre-CBDC to provide end-user payment services, achieved via the tokenisation of client funds. Operationally, the model is like the issuance of e-money. End-user fiat currency is received as collateral and safeguarded by the Consortium in the treasury account. The tokenisation engine will mint pre-CBDC at a 1:1 collateral ratio, ensuring full redeemability. If done in this way the EMI/PI could issue the pre-CBDC and, rather than it being the safeguarding device, the FMI's account at the Bank of England would facilitate compliance.

In a full implementation, we expect PI and EMI adoption of the pre-CBDC to include the ability to offer programmable payments. This would enable novel end-user value propositions, such as deferred, conditional and rule-based payments. Such payments would be self-executing, removing the need for manual intervention or triggers (see Programmability deep-dive in section 3.5).

Other adoption levers could include the need for instant settlement. An example of this could be where cut-off times for current payment schemes are missed, or where a transaction exceeds the limits enforced on current payment schemes. Further analysis of the potential for transaction cost savings and added benefits to end users is required.

Beyond payments, there is potential for PIs and EMIs to integrate into the Consortium infrastructure and provide B2B and B2C financial services for end-clients, including wallet issuing, compliance, account management, on-boarding and other ancillary services. This could act as a blueprint for broader third-party services provided via API access to the ledger.

Expected benefits:

- **Pre-CBDC assets for Safeguarding:** pre-CBDCs being accepted as secure, liquid assets by the FCA for PIs and EMIs
- **Pre-CBDC assets being issued by EMIs:** when the newly formed FMI takes on EMIs as its agents to issue pre-CBDC backed with funds held at the Bank of England, this automatically fulfils the PSR safeguarding requirements and opens a wealth of new benefits:
  - **Programmable payments:** new and bespoke automated payments based on deferral and other rule-based conditions, enabling new business models that could command a premium.
  - **Near-instant settlement:** direct transactions that settle in near real-time.
  - **Always online:** digital FMI available 24/7, with no cut-off time or loss of service.
  - **Unlimited transaction value:** theoretically possible to have unlimited transaction value, although this will be manually constrained in the pilot.
  - **Richer transparency:** transactions on ledger will be visible and traceable to relevant parties only to protect privacy. These records have the potential for a multitude of use cases, from tax compliance to the proof of capital adequacy for credit institutions.
- **Risk-free:** as funds are stored 1:1 in a treasury account at the Bank of England, they are effectively risk free, unconstrained by the FSCS insurance limit on bank deposits.
- **Coexistence with payment schemes:** the solution is complementary to payment services offered by schemes, and interoperability will be developed in the medium to long-term

Open questions and risks

- **FCA acceptance:** FCA needs to approve pre-CBDC assets as secure, liquid assets for safeguarding.
- **Initially limited market size:** pre-CBDC transactions can only be made between participants integrated in the Consortium platform, so there is limited real-world viability without broader network effects or integration with traditional fiat payment schemes.
- **Access to banking:** during the transition to full CBDCs, PIs and EMIs will still require day to day operational and scheme settlement banking services from commercial banks, so issues will remain in fiat payments.

Interviews and a survey with PIs and EMIs were conducted to gauge market interest. Interviewees cited benefits including the safeguarding solution, the potential for 24x7 liquidity, the potential reduction of collateral tied up with card payment schemes, the opportunities for programmable payment solutions and the transparency benefits of being on-chain. However, it was also clear that the primary value driver would be solutions to resolve the current access to banking issues.

In line with this, the project retains an adjacent interest in understanding the potential of non-bank institutions, like the proposed Consortium, to provide these safeguarding propositions for PIs and EMIs. Looking ahead to a real-world pilot, the design of the service proposition, business model, and benefits case will need further research and development.

6 | The way forward

This paper has shown both the transformative benefits offered by a retail CBDC, and the open questions, risks, and other challenges for CBDCs that require solutions. As we define the path forward, we have prioritised the gaps in the current discourse to ensure the New Era project is complementary and drives progress.

In summary, our research has highlighted the following opportunities for the pilot that will be prioritised:

1. **Private sector ambiguity:** In many developed economies, considerable ambiguity remains regarding the direction of central bank plans for throughout the private sector regarding central bank plans for CBDC. This hinders the ability to define constructive solutions for the significant open questions that remain. Through alignment with central banks, regulators, and government, we propose to bridge the gap and mobilise action.

2. **Value identification:** Papers exploring retail CBDCs have often taken broad, theoretical views on what could be possible. To advance this discussion, use cases which offer the highest potential to add genuine value in the market and drive adoption must be validated.
3. **Real-world testing:** There is a significant body of academic discourse focused on macroeconomic and technical analysis, including topics like bank disintermediation and conceptual design. This paper builds on these findings, but real-world commercial testing is the best way to validate these hypotheses and understand the implications for current regulatory and policy frameworks.
4. **Retail-focus:** Where proof-of-concepts or pilots are underway, they have often focused on wholesale applications such as permissioned or public organisation initiatives. This project, in contrast, must focus on general-purpose retail applications to avoid duplication, and deliver the benefits of digitised money to all of society.

The project will therefore pursue a public-private initiative to define the role of the private sector, with a focus on use case validation, conducting real-world testing, and identifying societal benefits. To capture this opportunity, we have defined a roadmap split across three phases:

1. Publishing this Green Paper to stimulate debate and define the way forward
2. Executing the Digital FMI pilot, led by a private sector consortium to enable lower risk and real-world infrastructure design, identification of value for end-users, and testing of policy frameworks for regulators.
3. Collaborating with central banks and government, informed by the findings of the pilot, to support lower risk, strategic transitions from proof-of-concepts into synthetic and/or CBDC implementations.

6.1 Phase 2: Towards a series of UK pilots

The project proposes to form a private consortium, called 'Digital FMI Consortium', to issue the pre-CBDC asset and execute the pilot, transferring the risk and overheads to the private sector. The 'pre-CBDC' asset will be referred to as 'dSterling', with backing at a one-to-one collateral ratio in a commercial bank reserve account, or commercial bank account, to reduce risk. The pilot will also consider options for the use of commercial bank liability.

Principles and objectives for the formation of the Digital FMI Consortium

Further to the opportunities above, there are two underpinning principles for the Digital FMI pilot.

Real-world assessment of value: The potential of use cases to drive market adoption must be identified. In this paper, we have considered conceptual questions around benefits, risks, design, and other key considerations. A theoretical assessment alone is insufficient for a project of this magnitude. In the pilot, we plan to interrogate these findings further, sizing the investment in enabling infrastructure and better understand what a day-one solution looks like. This will also help to answer questions around end user adoption.

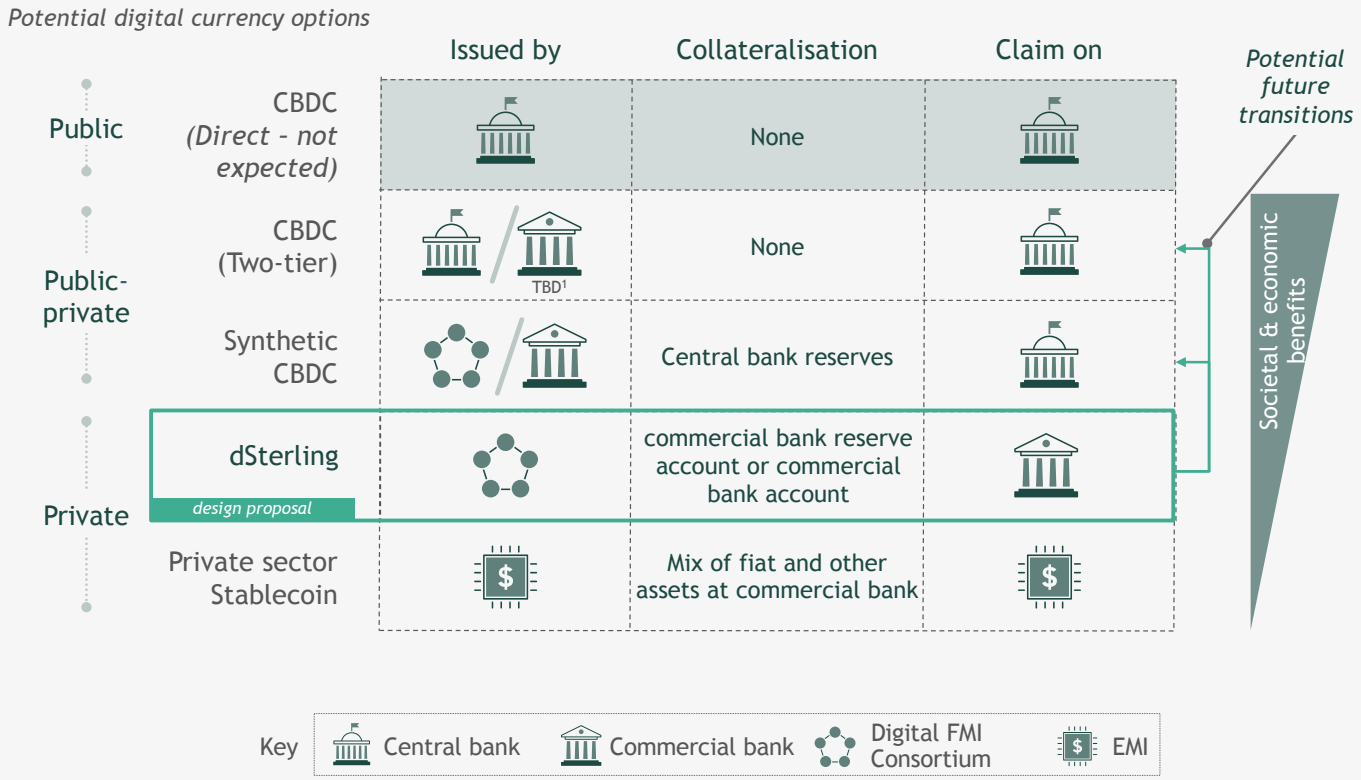
Public-private collaboration: We have highlighted how central banks continue to grapple with the role of commercial banks, macroeconomic risks, and questions around financial instability. These challenges are driving the slow, careful deliberation observed in developed economies over a retail CBDC. Commercial bank disintermediation and bank runs are at the heart of these concerns. Existing academic discourse has produced insightful technical analysis and modelling of hypotheses. The pilot can help to better test and understand these hypotheses and the implications of risks on existing legislation and policies.

In line with these principles, we see three core objectives for the pilot:

1. Resolving open questions and topics of debate in the market through intelligent, inclusive design;
2. Providing inputs to help inform regulation and enable relevant authorities to take policy decisions that incorporate multiple feedback loops from all industry stakeholders; and
3. Validating the four use cases highlighted in this paper, pressure-testing value potential and providing data to central banks and regulators on how best to deploy a CBDC.

If successfully executed, the pilot could subsequently facilitate future transitions into a synthetic or conventional CBDC (see exhibit 29), informed by clarity on use cases, conceptual designs, infrastructure, initial value propositions, the role of the private sector, interoperability, and policy frameworks.

Exhibit 29 | Taxonomy of CBDC constructs including Digital FMI Consortium



FMI: Financial Market Infrastructures

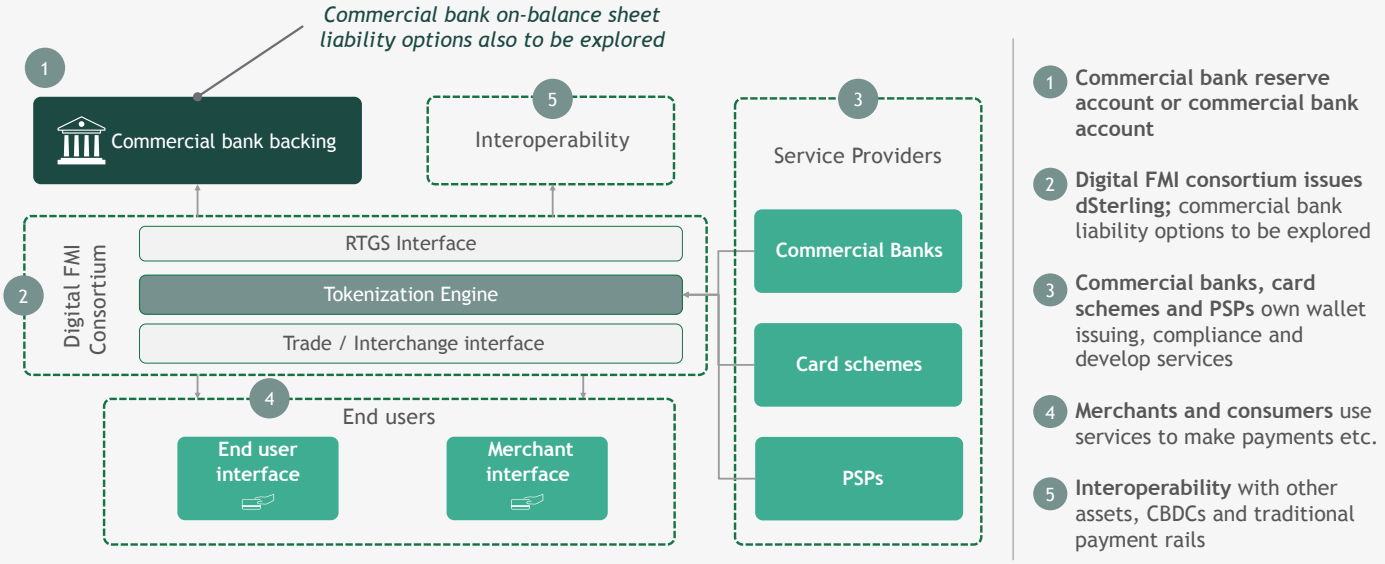
6.2 The Digital FMI Consortium

As described in the Conceptual Design chapter, the Digital FMI Consortium architecture is a two-tier model (see exhibit 30). At the core of this construct is a commercial bank reserve account or a commercial bank account, serving as collateral for tokenisation. Service providers and wallet issuers provide wallets and financial services to end users.

The use of a consortium structure distributes liability and reduces the counterparty risk experienced by other private initiatives. Multiple technology options will also be explored (e.g., DLT vs. non-DLT).

The initial pilot will occur in the UK. Service providers will be entities approved to provide financial services in the UK and are being recruited to join the Consortium to help shape and deliver the pilot.

Exhibit 30 | Conceptual design of Digital FMI Consortium



Source: BCG analysis

The legal structure for the Digital FMI Consortium

Initial structures for the proposed legal structure of the Digital FMI Consortium have been discussed with legal experts but will be jointly designed and agreed by Consortium members. Over time, we expect the legal structure to evolve.

Building trust and managing insolvency

Like any financial asset, we recognise the central role of end-user confidence in the issuing entity. We have therefore considered options to manage the unlikely event of an insolvency through liability distribution, to ensure the security of assets and minimise risk in the unlikely event of a Consortium member's collapse.

Most private stablecoins today use a simple, single-party liability distribution. This creates substantial liability risk for consumers in the absence of any financial backstop. In contrast, a pre-CBDC must hold its assets in a reserve account with no liability risk. We propose a consortium liability distribution. The proposed model uses a mutual valuation of digital assets to ensure complete fungibility and the spread of risk. The Consortium's treasury will guarantee all fiat collateral, so that no assets are lost in the event of insolvency.

A new era for digital payments

This paper exists to stimulate debate and bring about a structured, public-private framework to advance exploration of a general-purpose retail CBDC. We believe that the successful execution of the dSterling pilot will provide the necessary proof points and objective inputs to support central banks, regulators, and private sector companies to make this step.

We encourage central banks to drive the process and provide a clear steer on the future digital currency ecosystem in their respective economies. This Green Paper provides a roadmap and framework for closer public-private collaboration to address open issues, design mitigations for risks, and proactively shape the ecosystem.

Digital money is no longer a niche topic for speculative enthusiasts. This paper has shown that the forces determining future global financial structures are already at play. Governments, central banks, regulators, and private businesses can come together and seize this opportunity to shape the evolution of money for the benefit of all. Doing so could usher in a new era of efficiency, enhanced competition, financial stability, security, and public trust, all backed by the reputation and liquidity that only a central bank can provide.

To gain a deeper understanding of the points covered in this document, please download the Green Paper here, which summarises months of dedicated research. You can express your interest in the Digital FMI Consortium by signing up online.

Acknowledgements

We thank the many stakeholders across the payments and banking industry for their open and supportive contributions. We acknowledge the efforts of all Syndicate Leaders and Syndicate Members whose insights have enabled this report to reflect the latest developments on the front line of payments and fintech innovation. We are also grateful for Brunello Rosa and Nouriel Roubini's independent evaluation of the proposals made for the Consortium in their capacity as economic advisors to this initiative.

Without these contributions, this report would not have been possible.

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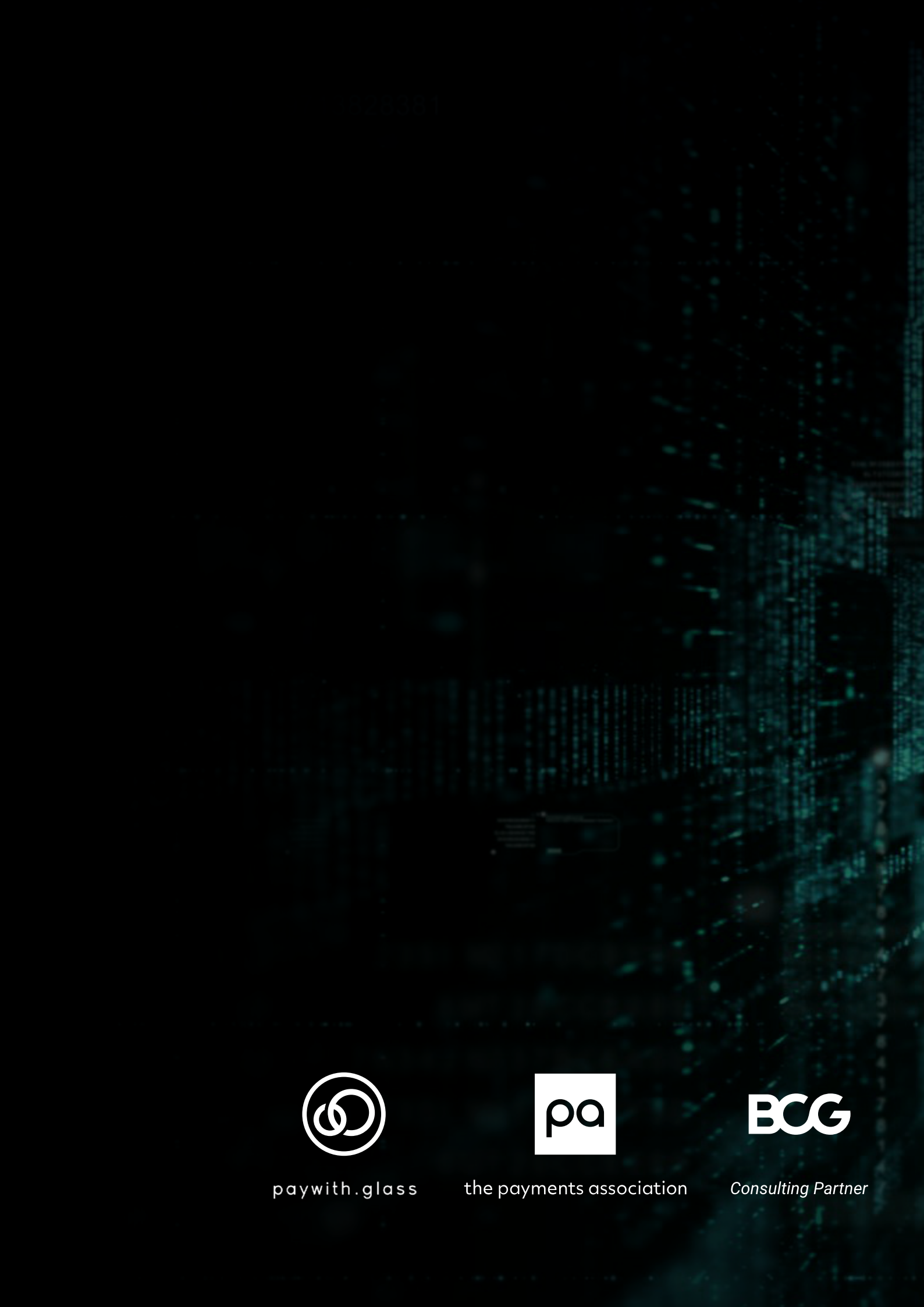
Syndicate Member Directory

algbra	Algbra is a next generation fintech platform, leveraging state-of the-art technology, working with tier one partners and operating within the UK regulatory framework. The Algbra platform is built to create a values-based ecosystem that fits with the everyday financing needs of ethically-minded consumers. DeFi is an important part of this mission, pioneering movements across finance, communities and wider society.	**algbra.com**
Baker McKenzie.	Baker McKenzie is the original global law firm - with 77 offices across 46 countries, we partner with our clients to deliver solutions in the world's largest economies, financial centres and emerging markets. Our leading global FinTech practice provides the full range of legal services that FIs and fintech innovators need to develop and adopt products and services such as crowdfunding, payment technology, cryptocurrencies, blockchain, NFTs, digital banking and peer-to-peer lending.	**bakermckenzie.com**
CoinPayments	CoinPayments is the easiest, fastest and most secure way for merchants worldwide to receive a payment in cryptocurrencies. It is the first and largest cryptocurrency payments processor with more than US $10 billion in total payments to date, while supporting more than 2,000 coins. Founded in 2013, It is the preferred cryptocurrency payment solution for merchants and eCommerce platform providers worldwide.	**coinpayments.net**
Currencies Direct	Currencies Direct stands out in the foreign exchange industry for its unique combination of payments technology and personalised human support. Established in 1996, Currencies Direct was the first non-bank foreign exchange provider in Europe	**currenciesdirect.com**
Ibanera	Ibanera is a digital banking platform and fintech services provider, tailored for financial institutions and businesses worldwide. Ibanera offers cross-border payments, mobile banking, merchant services, digital asset and blockchain services, and compliance initiatives in North America, Europe and Singapore.	**ibanera.com**
ICEBERG MARKETS	Iceberg markets was founded with the mission to globalize regulated cryptocurrency derivative instruments. Engaging as a broker of exchange traded and over-the-counter Crypto derivative instruments and products. Easily and securely trade cryptocurrency derivatives, for the first time, with a regulated counterparty!	**chompbtc.io**
Ince	The Ince Group provides accounting, consulting, financial services and pensions and legal advice to clients across a broad spectrum of sectors. We have offices in the UK, Europe, the Middle East and Asia.	**incegd.com**
LHV	Progress is the centerpiece of LHV agenda since we are offering the full payments vertical to digital assets and payments service providers, and we are looking forward to helping fin techs build on the grand ideas of this green paper.	**lhv.ee**
Modulr	Modulr is the payments platform providing digital businesses across the accountancy, financial services, crypto and travel industries with a fast, reliable and flexible way to move and manage money. We help businesses embed payments technology and launch entirely new propositions.	**modulrfinance.com**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