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Central bank digital currencies: policy implications

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ABSTRACT

This paper lists fifteen key policy implications resulting from a decision to introduce retail and/or wholesale central bank digital currencies (CBDCs). It makes the distinction between ‘medium of exchange’ and the ‘exchange mechanism’. The former is one of the functions of money. The latter is a function of the technological approach in establishing the unit of account, store of value, and the payment protocol. Payments, transfers and settlement, are explored in respect of (i) wholesale CBDCs, (ii) retail CBDCs, (iii) digital payment platforms and, (iv) stablecoins. Each require distinct policy frameworks, and scholarly opinion on these are very diverse. Most academics agree on the privacy concerns related to account based digital money. The main areas of disagreement, however, are over which institutions/entities should be allowed to issue digital money, how such issuance should be supervised, and how decentralised digital tokens should be addressed from a policy perspective.

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A. Introduction

This paper reviews the policy implications related to the introduction of central bank digital currencies (CBDCs). These are a digital version of fiat currency.¹ They represent electronic liabilities of a central bank and can be used for payments, transfers, and as a store of value. They can be token or account based.

In order for CBDCs to be introduced as legal tender, or as a wholesale settlement unit, fundamental policy issues need to be addressed.² For example, how they should be structured and supervised. These issues have societal implications. For example, how regulatory authorities oversee the risk to users, firms, the financial system and the economy.³ These risks include credit, liquidity and market integrity, as well as technology and privacy issues. They also include the legal risks of counterfeiting, fraud, money laundering, terrorist financing, tax avoidance and evasion.⁴

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¹O Ward and S Rochemont, ‘Understanding Central Bank Digital Currencies’ (CBDC) (March 2019).

²S Williamson, ‘Central Bank Digital Currency: Welfare and Policy Implications’ (2022) 11 *Journal of Political Economy* 2289.

³C Viñuela, J Sapena and G Wandosell, ‘The Future of Money and the Central Bank Digital Currency Dilemma’ (2020) 12 *Sustainability* 9697.

⁴N Lockett, ‘Legal Perspectives on Digital Money in Europe’ (1999) 4 *European Business Review* 235.

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In any discussion on CBDCs, one has to be aware of a key friction amongst lawmakers. There is a belief by some that money issuance should not develop outside of a regulated environment, although others disagree with this. This friction is complicated by the fact that it is difficult to predict which way technology will evolve, and especially privacy protocols. That said, policy makers have to address this issue in order to be able to manage the decreasing role of cash, the increasing digitalisation of financial services, and the rise of alternative forms of payment such as cryptocurrencies.

The introduction of CBDCs requires a technical solution and the choice of technology has ultimate policy implications. The solutions themselves require development, although several beta versions are currently being tested. Such development requires funding in order to ensure a robust outcome, a prerequisite of a monetary system. In this respect, the technology choices come with associated risks, including the possible fragmentation of liquidity, the loss of central money control and the aforementioned privacy concerns. They also come at the expense of privately funded solutions, like digital payment platforms and stablecoins.

The way that CBDCs are introduced also matters. A fast transition from one form of payment to another, for example, could threaten the traditional way of banking mediation. That said, some argue that there is a case for improving speed and efficiency in payments.⁵ In order to accommodate such trade-offs, policy makers therefore have to make choices. For example, on how to ensure a fair and equitable embracing of entrepreneurial innovation. The legal and regulatory framework can help foster a supportive environment, but this is a policy choice that has to be made explicit.

Whichever CBDC technical solution is chosen, the relative novelty of digital transfers makes them vulnerable to fraud and/or misuse. As such, a degree of caution will inevitably be part of the roll out of CBDCs. This makes understanding the relative merits and implications of the introduction of CBDCs all the more important. Such merits also need to be understood at the testing stage, in order to allow for proper evaluation of the various technical solutions and their robustness.

B. Central bank digital currencies

Money has three functions, (i) a store of value, (ii) a unit of value, and (iii) a way to transfer that value. A CBDC has to fulfil all of these. Digital money is not new. Electronic transfer of value is already ubiquitous. That said, many of the proposed technical solutions for CBDC implementation go one technological step further and incorporate a hybrid form of blockchain. This innovation is key to the ability of both centralised and decentralised entities to issues digital money.

A blockchain is essentially a digital record of a series of transactions. These are maintained over several computers linked together on the internet.⁶ It is tamper proof, time-stamped and considered secure, all attributes that are desirable for a state sponsored currency. The other major innovation facilitating CBDCs are distributed ledger technologies (DLT). These are the collective record of several blockchains.

⁵D Broby, 'Financial Technology and the Future of Banking' (2021) 1 Financial Innovation 1.

⁶M Nofer and others, 'Blockchain' (2017) 3 Business & Information Systems Engineering 183.

It is worth noting that although a blockchain is a key innovation, a digital payment can be as simple as an electronic instruction to transfer value. The use of blockchains and DLT in digital money eliminates the threat from double spending, whereby the same funds could be sent to two recipients simultaneously.⁷ A blockchain, however, is by no means a pre-requisite for a CBDC. As such, for the sake of clarity, a distinction should be made on the usage of blockchain in CBDCs, cryptocurrencies, stablecoins and digital payment platforms:

- (1) A CBDC may use a permissioned blockchain. The key differentiator is that the central bank retains control over currency issuance.
- (2) A cryptocurrency is built exclusively on a blockchain using decentralised cryptography. They typically co-exist outside of a central bank's remit. As blockchain technology is peer to peer, its use in crypto-currencies bypasses the traditional monetary transmission mechanism, and hence the way in which central bank induced monetary policy shocks impact the economy.⁸
- (3) A stablecoin is a hybrid cryptocurrency built on a blockchain. Unlike cryptocurrencies, they are tied to a fiat currency. That said, they are not explicitly backed by a central bank.
- (4) A digital payment platform can co-exist with all other forms of currency payments, be they fiat, stablecoin or crypto.

As such, the architecture of a CBDC is distinct from other digital money that uses blockchain as a solution and digital payment platforms. They are more correctly described as digitally native general-purpose forms of money. They are differentiated from cryptocurrencies and stablecoins by the principle that they can be redeemed in value from a central bank.

With no sovereign backing or physical form, there is some debate as to crypto-currencies appropriateness as a store of value, hence the increased focus on CBDCs.⁹ Stablecoins, however, offer a middle path for policy makers. That said, they will also require an enhanced framework of regulation if they become more important in retail transactions.

Further breaking down the technical architecture, one can say that the majority of CBDC solutions include a two tier approach based on central banks and financial institutions. In the second tier, the banks are the customer facing distributors, and typically where any usage of blockchain resides. There is (i) a *direct model*,¹⁰ in which users have accounts at the central banks; (ii) a *hybrid model*,¹¹ where the banks handle the retail payments; and (iii) an *intermediated model*,¹² where the central bank records the overall balance of banks. These all have different trade offs. The direct approach is more suitable

⁷S Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' [2008] Decentralized Business Review 21260.

⁸KN Kuttner and PC Mosser, 'The Monetary Transmission Mechanism: Some Answers and Further Questions' (2002) 1 Economic Policy Review 815.

⁹J Matkka, C Maier and L Reis, 'Is Cryptocurrency Money? Three Empirical Studies Analyzing Medium of Exchange, Store of Value and Unit of Account' in *Proceedings of the 2020 on Computers and People Research Conference* (2020).

¹⁰R Auerand and R Böhme, 'CBDC Architectures, the Financial System, and the Central Bank of the Future' (CEPR, 29 October 2020) <<https://cepr.org/voxeu/columns/cbdc-architectures-financial-system-and-central-bank-future>>.

¹¹J Zhang and others, 'A Hybrid Model for Central Bank Digital Currency Based on Blockchain' (2021) 9 IEEE Access 53589.

¹²R Adalid and others, 'Central Bank Digital Currency and Bank Intermediation' ECB Occasional Paper No. 2022/293.

for wholesale than retail CBDCs. The hybrid model is more suitable for retail. The intermediated model is more evolutionary, building on existing approaches to financial service provision.

With these various models in mind, another consideration for policy makers is who pays for the technology, the public or the private sector. The cost of developing the blockchain and/or the application interfaces (in the hybrid and intermediate model) will likely fall on the partner banks. The direct model costs will most likely fall on the central bank. The cost of point of sale technology, in contrast to the digital money itself, will likely fall on retailers. Meanwhile, the cost of developing digital settlement infrastructure will likely fall on a few large 'big tech' companies and the clearing banks. This is one of the reasons that the direct model is not the most popular choice. Central banks are more traditionally involved with payments clearing, and as such are not usually in the role of paying to develop infrastructure. To make this happen, policy makers will have to be more directive towards central banks, which is often frowned upon.

With all these considerations, the testing of CBDCs in both the retail (consumer) and wholesale (financial) markets is increasing. This has led several jurisdictions to explore their appropriateness and oversight.¹³ Before exploring this, the legal and regulatory framework is considered.

C. Legal and regulatory framework

The legal and regulatory framework for money is well established. Unless explicitly convertible into real assets backed by reserves, sovereign fiat money issued by a state authority has no intrinsic value. Such currency represents merely state backed tangible monetary instruments that can be used for payments and settlement. As part of contract law, its status as legal tender, however, allows it to be used to discharge financial obligations, when tendered in the appropriate amount and in the proper manner.

While regular property is considered a specific object, money is classified as a category-specific object in civil law. As a result, money follows the principle that possession equals ownership.¹⁴ This principle should be retained with respect to CBDC issuance. The role of the state is central to preserving this feature. Without legal certainty, the evolving nature of banking and big tech will potentially clash with the aims and objectives of CBDC issuance.

It has been argued that money is a public good.¹⁵ In this respect, it is non-excludable, in as much as citizens cannot be prevented from using it. The possibility that digital money could be cancelled gives rise to concerns about this important aspect of public ownership. Money is also considered non-rival, because a citizens use of money does not impede on another's citizens use, a key element of banknote and coin usage.

As mentioned, the increasing use of digital payments has prompted central banks to discuss and even test the implementation of CBDCs. The non-revocable right to issue sovereign backed legal tender essentially means that central banks are liquidity

¹³See Bank of Canada and others, 'Central Bank Digital Currencies: Foundational Principles and Core Features: Report No. 1' (2020).

¹⁴Y Yanchao, 'On the Legal Attributes of Digital Currency' (2021) 2 *Social Sciences in China* 123.

¹⁵G Camera, 'A Perspective on Electronic Alternatives to Traditional Currencies' (2017) 1 *Sveriges Riksbank Economic Review* 126.

unconstrained (unless they apply a fixed exchange rate regime).¹⁶ That said, such issuance needs to be within the existing framework of the state. This gives rise to:

Policy implication no. 1: whereby a CBDC should be recognised in law and its place in the sovereign regulatory structure clearly delineated.

This implication is all the more important for policy makers, as the legal and regulatory framework for digital assets and CBDCs, as opposed to physical cash, is ambiguous in most jurisdictions.¹⁷ Assets can be tangible or (in the case of digital currency) intangible. Fiat currency can be physical, in the form of a CBDC, or it can be both. Indeed it can potentially exist in different forms simultaneously (a digital currency receipt such as a stablecoin). In law, this should not change the substance of that asset, although ambiguity might exist in respect of new forms of money, such as a CBDC. This gives rise to:

Policy implication no. 2: whereby the classification of digital currency (CBDC and other forms) should focus on both nature and substance. Any rights and obligations conferred by ownership should be formally defined in law.

The above policy implication has particular relevance for payments infrastructure law and its regulation. Payment require a distinction between legal entities. CBDCs and instant *atomic* settlement could well change this paradigm.¹⁸ This is because the latter results in an instantaneous transfer of assets. The need for clarity is made all the more pertinent by the rapid pace of change, driven by the desire for greater efficiency. For example, in the United Kingdom, the Financial Services and Markets Bill extended the Banking Act of 2009 and Financial Services (Banking Reform) Act of 2013 to cover *digital settlement assets*. This in turn extended the FCA's regulatory reach, not just to CBDCs but also, to stablecoins for payments. It also extended policy reach to cover issuance and the storage of digital assets. However, the Bank of England retained its powers in respect of protecting against systemic risk.¹⁹

As digital assets are not tangible they have several features that differ from traditional physical assets and other intangible elements that typically have property rights. Within English law there is therefore a move to recognise digital assets as distinct third category of personal property.²⁰ This suggests that in future there may only be a transfer if there is some change state in the ledger. Control of such assets would have procession through that control, the same as intangible assets. This further suggests that there could be a possible separation between property and control, for example with derivative title of property. The thinking is that, it is haphazard to rely on case law to develop in order to determine what happens should CBDCs be introduced. For example, what happened to ownership when there is 'innocent acquisition' of a CBDC?

¹⁶VV Acharya, D Gromb and T Yorulmazer, 'Imperfect Competition in the Interbank Market for Liquidity as a Rationale for Central Banking' (2012) 2 American Economic Journal: Macroeconomics 184.

¹⁷MT Henderson and M Raskin, 'A Regulatory Classification of Digital Assets: Toward an Operational Howey Test for Cryptocurrencies, ICOs, and Other Digital Assets' (2019) 2 Columbia Business Law Review 443.

¹⁸D Zetzsche and others, 'DLT-Based Enhancement of Cross-Border Payment Efficiency – A Legal and Regulatory Perspective' (2022) BIS Working Paper No. 1015.

¹⁹The principle of same risk and same regulatory outcome was applied. To deliver this policy outcome, it was decided that stablecoin issuance should be fully backed. This mandates that backing assets are available if redemption is required, and that suitable governance is in place to ensure investor protection and market integrity.

²⁰UK Jurisdiction Taskforce of the LawTech Delivery Panel (UKJT), 'Legal Statement on the Status of Cryptoassets and Smart Contracts' (November 2019).

D. Payments framework

The payments framework, and hence policy related to it, is by nature complicated. It includes both the retail and wholesale money markets. In order to understand it, it is worth re-iterating that there are several alternative digital payment approaches which currently co-exist outside of the national regulatory structure. These include cryptocurrencies, tokenised bank deposits and stablecoins.²¹ These tokens and digital coins are depicted in [Figure 1](#) alongside the traditional central bank payment methods. Their existence complicates the policy landscape.

To set the scene for the way to mitigate payment risk through policy, one must understand the difference between wholesale and retail CBDCs. The former covers interbank settlement, and the latter covers CBDC use by the general public. In this respect, the structural mechanics of CBDCs should separate the concept of money as a 'medium of exchange' from the concept of money as an 'exchange mechanism'. In doing this, one can better understand the novelty of digital money. Namely, that it represents an electronic form of payment. From a central bank perspective, wholesale money markets are the easiest to monitor. This gives rise to:

Policy implication no. 3: whereby any law enabling a CBDC should differentiate between retail and wholesale use.

In order to understand the reason for this, one must be aware that much of the wholesale money ecosystem is account based. Retail money spans both account and token forms, and as such is harder to oversee. However, digital money such as stablecoins and cryptocurrencies are largely token based, and their pseudo anonymity presents greater oversight challenges. It has been suggested that combinations of both centralised and decentralised approaches can co-exist, although some jurisdictions prefer the advantages of greater oversight.²²

The debate on the future of digital money can be quite polarised, and therefore the policy outcomes can be quite diverse. Advocates of decentralised cryptocurrencies are often vocal in their opposition to CBDC adoption. This is based on the view that decentralisation can broaden financial inclusion, encourage innovation, and avoid macro-economic manipulation.²³ The policy case for regulation, however, is largely based on consumer protection. This is because the concepts of digital asset and digital financial asset are not well covered in most jurisdictions legislation.²⁴

In the context of these two world views, it is salient to note that tokenised bank deposits could fulfil the same function as a CBDC, as indeed could a stablecoin that is backed one for one with balances in a central bank.²⁵ As a result, money can exist outside of the central bank sphere of influence. For alternatives to the current system to be incorporated within the central banking framework, it is necessary to introduce a degree of

²¹D Bullmann, J Klemm and A Pinna, 'In Search for Stability in Crypto-Assets: Are Stablecoins the Solution?' ECB Occasional Paper No 2019/230.

²²G Danezis and S Meiklejohn, 'Centrally Banked Cryptocurrencies' (2015) arXiv:1505.06895.

²³Y Chen and C Bellavitis, 'Blockchain Disruption and Decentralized Finance: The Rise of Decentralized Business Models' (2020) 13 Journal of Business Venturing Insights 151.

²⁴LJ Trautman, 'Bitcoin, Virtual Currencies, and the Struggle of Law and Regulation to Keep Peace' (2018) 102 Marquette Law Review 447.

²⁵A Lipton, 'Toward a Stable Tokenized Medium of Exchange' in C Brummer (ed), *Cryptoassets. Legal, Regulatory and Monetary Perspectives* (OUP 2019) 89.

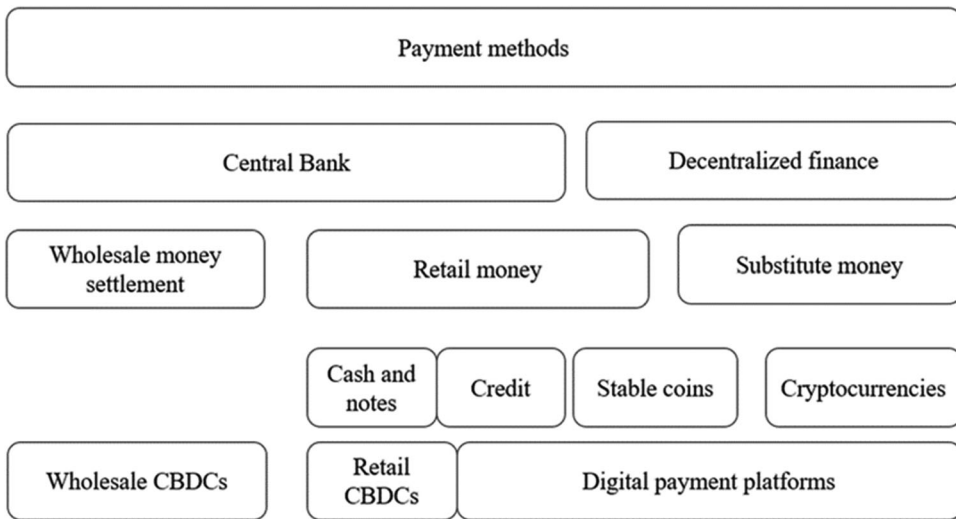


Figure 1. The digital payments landscape.

regulation; not least because a central bank deposit enjoys the benefit being risk free. This gives rise to:

Policy implication no. 4: whereby any law enabling a CBDC should differentiate between currency issued by a central bank and one issued by a decentralised entity. It should clearly state whether, and to what extent, alternative payments are regulated.

China, for example, has banned bitcoin and made its retail CBDC legal tender to maintain its status as a monopolistic sovereign issuer. As mentioned, most central bank laws, however, do not explicitly permit the issuance of CBDCs.²⁶ Such recognition is essential for the conduct of monetary policy and monetary conditions. This can be addressed by reform of the law for sovereign fiat money, but is slightly more complicated when it comes to recognising alternative and innovative forms of digital money.²⁷ Policy has to explicitly address the aforementioned difference between narrow and broader money. The former being related to retail usage and the latter largely to wholesale money markets.

It is in the retail market that the greatest ambiguity lies. Retail CBDCs are issued to the public for payment purposes. The policy design options are based on the type of technology, the architecture and the remuneration. To date there has been less enthusiasm for retail than wholesale CBDCs.²⁸ Indeed, it could be argued that stablecoins are a viable alternative for the retail market. The proponents of this line of thought argue that, CBDCs that incorporate smart programmability can potentially be abused by government.

²⁶The principle of the attribution of powers would suggest that a central bank may only conduct operations on which it has received a mandate.

²⁷W Bossu and others, 'Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations' IMF Working Paper No. 2020/254.

²⁸F Hayashi and YL Toh, 'Assessing the Case for Retail CBDCs: Central Banks' Considerations: Payments System Research Briefing' (May 2022).

Paper money, of course, does not have digital traceability and is harder to cancel or manipulate.

China has led the way in retail CBDCs with its e-CNY testing and launch. This has the status of legal tender. The Chinese government has also adapted their legal framework, introducing a cryptography law and revising the Law of the Peoples Bank of China. It is worth noting that China has a structural advantage in as much as it has an existing retail digital payments infrastructure consisting of barcodes at point of sales. These are linked to the widely used WeChat Pay and Ali Pay platforms.²⁹

In order to avoid breaching anti money laundering laws (AML) and aid the black economy, retail CBDCs require a policy on know your customer (KYC) rules. These are regulations that require financial institutions to verify the identity of their clients and assess their potential risks for money laundering (or financing terrorism).³⁰ These rules are important for preventing criminal activities, and they apply to CBDCs just as they do to other forms of money. Central banks, or the entities that issue CBDCs on their behalf, will need to verify the identity of their clients and assess their potential risks before allowing them to use CBDCs. This will help to prevent the use of CBDCs for illegal activities and ensure the integrity of the digital currency. Within the technical framework of CBDCs, KYC issues can be automated.³¹ In order to do this, policy makers need to be more descriptive if what information is required and how best to identify identity. Questions need to be asked. Should the UK, for example, introduce biometric digital identity cards? Also, should CBDCs have their provenance recorded.

Any retail CBDC also has to take into account existing retail exchange mechanisms. Retail payment providers charge process fees which are opaque and act as a cost on economic activity.³² Cash does not charge a fee to cover the cost of the infrastructure required to support it. In order to make payments, an individual currently had to prove his or her identity, but this is not the case for cash.

It is salient to note that there has also been scholarly discussion on what would happen in the event that there is a run-on deposits' in an environment where depositors can switch holdings to a risk free central bank CBDC.³³ Clearly, a central bank would be preferable to a retail bank in times of uncertainty. Some suggest, banking run risk could be reduced by caps on withdrawals and transfers, and/or the imposition of penalty fees and rates. From a policy perspective, lawmakers should consider whether imposing such constraints is a healthy usage of the CBDC and focus instead on trust in the CBDC. This gives rise to:

Policy implication no. 5: whereby a retail CBDCs should be supported by privacy legislation to support trust in its use. This should put in place checks and balances to foster such trust.

²⁹T Aveni and J Roest, 'China's Alipay and WeChat Pay' (December 2017).

³⁰M Gill and G Taylor, 'Preventing Money Laundering or Obstructing Business? Financial Companies' Perspectives on "Know Your Customer" procedures"' (2004) 4 British Journal of Criminology 582.

³¹D Broby, A Daly and D Legg, 'Towards Secure and Intelligent Regulatory Technology (Regtech): A Research Agenda' [2022] Technology and Regulation 88.

³²W Bolt and S Chakravorti, 'Pricing in Retail Payment Systems: A Public Policy Perspective on Pricing of Payment Cards' (2011) De Nederlandsche Bank Working Paper No. 331.

³³M Kumhof and C Noone, 'Central Bank Digital Currencies – Design Principles and Balance Sheet Implications' (2018) Bank of England Staff Working Paper No. 275.

There are social inclusion policy issues to consider in respect of CBDC retail payments. For example, what about the poor and unbanked, or those without access to technology. This is particularly relevant to small remittances from individuals in developed to developing countries.

Wholesale CBDCs, meanwhile, are central to the payments landscape. The current policies and system for international payments works well in advanced economies, but is convoluted when extended to developing markets.³⁴ Cross border payments need to be flexible and have the ability to adapt. There is a need to (i) maintain high regulatory standards, (ii) promote openness, (iii) promote competitiveness, (iv) deliver fair and proportionate regulations and (v) support economic growth through innovation.³⁵ Technically speaking, a form of wholesale CBDCs already exist, as payments in fiat money are digital in nature.

The scholarly discussion on CBDCs is focused on tokenised forms, the next generation of Real Time Gross Settlement (RTGS).³⁶ This technology facilitates atomic payments and smart contracts.³⁷

Payment policy for wholesale CBDCs will not be formed in a vacuum. The Society for Worldwide Interbank Financial Telecommunication (SWIFT) is already the established protocol for payments used by the majority, but not all countries.³⁸ It is a robust approach that delivers the majority of payments within 24 hours, and a substantial number of payments within five minutes. That said, it is not instantaneous and without frictions. It is also not ubiquitous, nor end to end. Payments are subject to delay, the majority of which occur as a result of the receiving party. In order to address this, wholesale CBDCs need to combine the sending and receiving parties with one single act.

It is also salient to note that the use of CBDCs for cross-border transactions will require international cooperation, which may be complicated by the varying approaches to digital assets by different countries.³⁹ This gives rise to:

Policy implication no. 6: whereby wholesale CBDC innovation and testing should be supported by removing any unnecessary regulatory burdens.

E. Systemic risk

As the issuance and use of money is central to any economy, the potential of systemic risk of a CBDC has to be considered. In this respect, policy makers need to understand whether CBDCs facilitate contagion and/or financial market failure.⁴⁰

³⁴D Zetzsche and others, 'DLT-Based Enhancement of Cross-Border Payment Efficiency – A Legal and Regulatory Perspective' (2021) 1–2 Law and Financial Markets Review 70.

³⁵HM Treasury, 'The Wholesale Markets Review: Consultation Response' (March 2022).

³⁶EA Opore and K Kim, 'Design Practices for Wholesale Central Bank Digital Currencies from the World' in *Symposium on Cryptography and Information Security (Kochi, Japan, 28–31 January)* (2020).

³⁷There are also applications in the way that compliance and data can be addressed.

³⁸T Qiu, R Zhang and Y Gao, 'Ripple vs. SWIFT: Transforming Cross Border Remittance using Blockchain Technology' (2019) 147 *Procedia Computer Science* 428.

³⁹The US Federal Reserve is considering issuing a CBDC and has established the Digital Dollar Project to outline the next steps. In addition, the Financial Conduct Authority (FCA) is working on developing digital identity to support a future CBDC.

⁴⁰S Martínez-Jaramillo and others, 'Systemic Risk, Financial Contagion and Financial Fragility' (2010) 11 *Journal of Economic Dynamics and Control* 2358.

In the case of CBDCs, the main systemic risk is the potential for a technology failure of the central bank server system, its associated financial institutions and/or the internet.⁴¹ This could be caused by a variety of factors, such as a cyber-attack, a technical malfunction, or other technological issues. If the system supporting the CBDC were to fail, it could potentially disrupt the entire financial system and have serious consequences for the economy. To mitigate this risk, central banks would need to put in place robust security measures and ensure that the system supporting the CBDC is highly resilient. For these reasons, policy makers should be cautious when prescribing the design of a CBDC. For example, a retail CBDC that has a date expiry in built to encourage consumption. This gives rise to:

Policy implication no. 7: whereby the introduction of a CBDC requires a robust national digital infrastructure and disaster recovery plan.

Any issuance by a central bank, be it CBDC or otherwise, has balance sheet implications and hence systemic concerns. This issuance of a new form of money could impact the transmission mechanism.⁴² It is suggested that this could be managed by limiting CBDC issuance and dissemination.⁴³ To do this, a CBDC should be on par with all other forms of central bank currency. That said, whether a CBDC would be considered as such is a moot point. As mentioned, there is a concern that in the event of a banking run, a CBDC could be a preferred form of money and displace bank deposits. This might in turn alter a banks susceptibility to distress.⁴⁴ This gives rise to:

Policy implication no. 8: whereby a central bank has to decide whether the CBDC is to be interest bearing, as well as how that interest rate is determined relative to the reserve rate.

In summary, the key systemic observations in the literature are that design matters,⁴⁵ disintermediation risk will be limited, and the risk of bank runs might be manageable. The factors that drive the method of payment include the transaction cost, the ease of use and affordability. Likewise, the public is concerned about security. The amount a consumer might put into a CBDC would depend on the interest rate associated with deposits.⁴⁶

F. Monetary policy

The monetary policy implications of CBDCs are mostly theoretical but have real world economic consequences.⁴⁷ In addition to running monetary policy, central banks also oversee operations, maintain currency reserves and issue currency. The latter is typically in the form of 'narrow money', such as banknotes or short-term time deposits; as well as

⁴¹C Labovitz, A Ahuja and F Jahanian, 'Experimental Study of Internet Stability and Backbone Failures' in *Digest of Papers. Twenty-Ninth Annual International Symposium on Fault-Tolerant Computing* (IEEE 1999) 278.

⁴²J Meaning and others, 'Broadening Narrow Money: Monetary Policy with a Central Bank Digital Currency' (2018) *International Journal of Central Banking* 1.

⁴³U Bindseil, 'Central Bank Digital Currency: Financial System Implications And Control' (2019) 4 *International Journal of Political Economy* 303.

⁴⁴P Callesen, 'Can Banking be Sustainable in the Future? A Perspective from Danmarks Nationalbank' Speech at the Copenhagen Business School (30 October 2017) <<https://www.bis.org/review/r171031c.htm>>.

⁴⁵K Huynh and others, 'Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency' Bank of Canada Staff Working Paper 2020-7.

⁴⁶J Li, 'Predicting the Demand for Central Bank Digital Currency: A Structural Analysis with Survey Data' (2023) 134 *Journal of Monetary Economics* 73.

⁴⁷This is the result of the actions taken by a central bank to manage the money supply and achieve macroeconomic goals. Any issuance of CBDC would be just one aspect of this.

'broad money' in the form of longer-term deposits.⁴⁸ Retail CBDCs are essentially 'narrow money'. Wholesale CBDCs, meanwhile, refer to interbank transactions and their settlement by central bank reserves. In this respect, they are part of the national payment infrastructure and restricted to a limited group of users.⁴⁹

A central bank has a mandate to manage inflation through the setting of interest rates.⁵⁰ In order to do this, it has the ability to set interest rates, buy or sell government bonds, and change the reserve requirements for commercial banks. The question therefore arises as to what level of interest should be applied to CBDC deposits. The goal of monetary policy is to maintain systemic stability, price stability, full employment, and economic growth. The untried nature of CBDCs could see monetary mistakes potentially threaten systemic stability, without appropriate policy considerations. Consider, for example, a world where sovereign retail CBDCs yielded a rate of return the same as a deposit account. The logical preference would be to hold CBDCs in digital wallets rather than banks.

Consider also the competitive nature of CBDCs with cryptocurrencies. Traditionally, as part of the monetary transmission mechanism, a central bank issues currency, supports the payment system and acts as a bank of last resort to ensure financial stability.⁵¹ As cryptocurrencies represent an innovation in both the medium of exchange and the exchange mechanism, they do not fulfil these functions. They were developed in order to be transferred without a trusted third party. As a result, unlike fiat money, they are largely unbacked by assets. As such, policy makers need to consider what the implications of CBDC issuance will be on the cryptocurrency markets.

Similarly, CBDC issuance will compete with other forms of digital money. Digital payment platforms like Alipay and WeChat Pay, also mediums of exchange, are similarly based on fiat money.⁵² These are both within or without the reach of a central bank. The policy challenge is therefore not simply a choice between paper versus digital (medium of exchange), but a decision on which forms of digital to endorse (exchange mechanism). This gives rise to:

Policy implication no. 9: Whereby any law giving legal recognition to a CBDC should refer to both the medium of exchange and the exchange mechanism, as well as being worded in technology agnostic way.

As a CBDC is an exchange mechanism, the focus on technology is an important part of CBDC policy formulation. There is an element of 'fear of missing out' by central banks and lawmakers as a result of the pace of change. According to the Atlantic Council, as at November 2022, 10 countries have launched a CBDC and 105 countries are exploring the concept.⁵³

⁴⁸Measures of money supply differ between jurisdictions. There are several measures, that capture narrow and broad monetary aggregates. Narrow money supply measure typically cover the most liquid assets. Broader money supply measures include the less liquid types of assets.

⁴⁹A Carstens, 'The Future of Money and Payments' Speech held at the Central Bank of Ireland, Dublin (22 March 2019) <<https://www.bis.org/speeches/sp190322.htm>>.

⁵⁰RE Lucas, 'Two Illustrations of the Quantity Theory of Money' (1980) 5 *The American Economic Review* 1005.

⁵¹F Giavazzi and A Giovannini, 'Central Banks and the Financial System' in S Eijffinger and D Masciandaro (eds), *Handbook of Central Banking, Financial Regulation and Supervision* (Elgar 2011) 3.

⁵²YM Kow, G Xinning Gui and W Cheng, 'Special Digital Monies: The Design of Alipay and WeChat Wallet for Mobile Payment Practices in China' in *IFIP Conference on Human-Computer Interaction* (Springer 2017) 136.

⁵³<<https://www.atlanticcouncil.org/cbdctracker/>>.

Despite offering a medium of exchange, cryptocurrencies and stablecoins were developed outside the scope of financial regulation. Central banks, regulators and lawmakers are therefore still developing regulation of crypto related technologies. As there is a desire to protect consumers, investors, and financial stability, several scholarly debates about the future of digital money have been initiated. Policy makers need to be abreast of these schools of thought.

There are two schools of monetary policy concern with respect CBDCs, as distinct from cryptocurrencies and stablecoins. These are largely accepted as misplaced. The first is that failure to implement them in the first wave will result in a loss of financial competitiveness. Scholars suggests this is not the case.⁵⁴ The second is that being first to implement will result in a loss of financial stability. Other scholars suggest that in times of crisis a central bank can lend all the deposits in CBDC account to commercial banks.⁵⁵ That said, both concerns illustrate that there is a perceived trade-off between cost and speed. The duration of law-making is beyond the scope of this paper, suffice it to say that speed holds both normative and practical importance in a rapidly digitalising world.

The speed of adoption is, however, a policy issue. It is the nature of digital innovation that regulators find it difficult to adapt rules and regulations.⁵⁶ That said, *caveat emptor* ignores the growing importance of digital assets and hence transactions using CBDCs. Further, central bankers are not technologists and there are risks in CBDC usage until tried and tested. It is important to recognise, in this respect, that there are positive use cases for tokenisation, where for example the synchronisation of money transfer can be made with an intermediary. There are also clear use cases in cross border finance and wholesale money markets. The trick for policy makers is to get the balance right.

Clearly, some digital initiatives will fail. In this respect, policy makers should ensure when there is failure, they fail well. In other words, facilitate a framework for an 'orderly failure', with consumer protection and transition back up plans. Similarly, failure can have a systemic consequence if contagion arises. As such, lawmakers need to adopt legislation to ensure the conduct and orderliness of both financial and money markets. This gives rise to:

Policy implication no. 10: whereby any law giving legal recognition to a CBDC should refer to, or delegate powers, to ensure financial stability. Such a law should also specify whether the CBDC is universally accessible, or not.

As mentioned, there are tokenised alternatives to CBDCs. From a policy perspective, it is worth considering the use of tokenisation to achieve a more efficient digital payments environment. Tokenisation is the process of exchanging identifiable financial data for non-identifiable data called 'tokens'. These can take the form of payment/exchange tokens, utility tokens, or security tokens.

Tokenisation facilitates atomic settlement, the instant exchange of assets, which is a function of wholesale markets.⁵⁷ Such settlement requires policy makers to also make

⁵⁴M Chorzempa, 'China, the United States, and Central Bank Digital Currencies: How Important is it to be First?' (2021) 1 China Economic Journal 102.

⁵⁵M Kumhof and C Noone, 'Central Bank Digital Currencies—Design Principles for Financial Stability' (2021) 71 Economic Analysis and Policy 553.

⁵⁶PL Athanassiou, *Digital Innovation in Financial Services: Legal Challenges and Regulatory Policy Issues* (Kluwer 2016).

⁵⁷Y Lee and others, 'Atomic Cross-Chain Settlement Model for Central Banks Digital Currency' (2021) 580 Information Sciences 838.

rules relating to the liquidity, margin and the alignment of records in a real time environment. There are other advantages to tokenisation, namely improving record keeping and transfer of funds outside of the banking system (the latter also being a disadvantage).

This is not just an issue for central banks. There are several private initiatives in respect of tokenisation. These are typically led by the large banks like JP Morgan, often in co-operation with Big Tech. These initiatives are largely focused on G7 and G20 corridors. They are particularly focused on the attraction of programmability. That said, the vision of interoperability between fiat and tokenised forms of money is still some way off. The execution of a smart contract are automatic. This gives rise to:

Policy implication no. 11: whereby the need for potential smart programmability of digital currencies has to be addressed in law.

Whilst this issue is not currently on the radar of most CBDC development, it is a major public concern. There are concerns that CBDCs could be programmed to have spending directed and/or potentially time expired.

When considering the private sector, it is worth noting that crypto assets are not well suited to provide collateral to counterparties in financial markets. They are unbacked instruments that are extremely volatile. In decentralised finance, it is the code that manages the risk rather than centralised authorities. The robustness and resilience have not been tested at scale and where it has been stressed has shown to be unstable. Moreover, it is often unclear what governance protocols are being followed.

The assumption in financial markets is that any tokenisation should be permissioned and closed.⁵⁸ This is very different from the decentralised and open tokens of cryptocurrencies. It should be pointed out that the distributed nature and the programmability of such tokenisation may have advantages, for example tokenised technology to enhance settlement.⁵⁹ Cryptocurrencies are unsuitable for this as they are unbacked. Stablecoins are potentially unsuitable as they are unlikely to have deposit insurance. This gives rise to:

Policy implication no. 12: whereby the fact that CBDCs will compete with cryptocurrencies means that the status of the latter should also be better defined within law to avoid any ambiguity.

G. Security

A security breach would seriously undermine any CBDC. The security of a CBDC is heavily dependent on its technical architecture and that in turn has policy considerations.⁶⁰ A well-designed and implemented technical architecture can help ensure the integrity and stability of the digital currency, and protect against potential vulnerabilities and threats.⁶¹ A fully functional CBDC is part of a nations essential infrastructure. Using advanced encryption and authentication protocols can help prevent unauthorised

⁵⁸C Lin and others, 'Ppchain: A Privacy-Preserving Permissioned Blockchain Architecture for Cryptocurrency and Other Regulated Applications' (2020) 3 IEEE Systems Journal 4367.

⁵⁹BIS, 'Annual Economic Report' (2022) 75.

⁶⁰C Minwalla, 'Security of a CBDC' Bank of Canada Staff Analytical Note 2020-11.

⁶¹D Shah and others, 'Technology Approach for a CBDC' Bank of Canada Staff Analytical Note 2020-6.

access to the CBDC.⁶² and implementing robust network infrastructure can help ensure that transactions are processed efficiently and without interruption.

At the same time, a poorly designed or implemented technical architecture can leave a CBDC vulnerable to attacks and other security risks.⁶³ For example, if the security protocols used to protect the CBDC are weak or outdated, they may be easily exploited by hackers. Similarly, if the network infrastructure supporting the CBDC is inadequate or unreliable, it could lead to slow transaction processing or even outages.

Overall, the technical architecture of a CBDC plays a critical role in its security, and therefore it is important for central banks and other authorities to carefully consider and design this aspect of the digital currency. Human frailty should also be catered for. What happens, for example, if you lose your password to your digital wallet?

There are key security management methods that can be mandated by policy, such as key custodians, custodial wallets, hot wallets (connected to the internet) and/or cold wallets (not connected to the internet). Likewise, there are approaches to multi signature authentication that look promising from a policy implementation perspective.⁶⁴

In response to these human issues, it is the technical architecture of a CBDC that determines its security. Policy makers should ensure the infrastructure backbone of a CBDC should be available round the clock. It should also support offline payments. A decision has to be made on who can deploy the CBDC, who does the vetting, who carries out the rectification. It should also be resilient to hacking. This gives rise to:

Policy implication no. 13: whereby any cybersecurity challenge should be addressed. There should be a zero trust approach and a multi-layer defence strategy should be built into the CBDC infrastructure.

H. Privacy

Closely allied to security is privacy. Privacy is an important CBDC topic, especially when linked to spending behaviour and source of funds. There is a robust ongoing debate on the topic in legal circles (for example *WhisperCash v MIT Digital Media Lab*). As previously mentioned, CBDCs would require privacy checks and balances to ensure public confidence. The challenge with retail CBDCs is to make them anonymous for small amounts. This gives rise to:

Policy implication no. 14: whereby the privacy of individuals using retail CBDCs, or indeed the extent of that privacy, needs to be protected in law.

As explained, CBDCs would also have to comply with KYC, and this extends to AML regulations. The implementation of a CBDC could potentially have an impact on AML efforts. On the one hand, a CBDC could potentially make it easier for authorities to track and monitor financial transactions, as all transactions would be recorded on a digital ledger that is accessible to the central bank. This could help authorities identify and investigate

⁶²A Prakash and U Kumar, 'Authentication Protocols and Techniques: A Survey' (2018) 6 *International Journal of Computer Sciences and Engineering* 1014.

⁶³M Robinson, 'The SCADA Threat Landscape' in *1st International Symposium for ICS & SCADA Cyber Security Research 2013* (ICS-CSR 2013) 30.

⁶⁴H. Xue and others, 'Efficient Online-Friendly Two-Party ECDSA Signature' in *Proceedings of the 2021 ACM SIGSAC Conference on Computer and Communications Security* (2021) 558.

suspicious activity more effectively. On the other hand, a malicious government may take advantage of this.

It should be noted that there is a trade-off between the efficiency and the complexity introduced by such procedures. On the other hand, the anonymity and accessibility of a CBDC could potentially make it easier for criminals to launder money.⁶⁵ Additionally, if a CBDC is widely adopted and easily accessible, it could provide more opportunities for money launderers to move and hide illicit funds.

Overall, the relationship between AML and CBDC implementation is complex and will likely depend on the specific design and features of the CBDC. It will be important for authorities to carefully consider the potential impacts as they develop and implement a CBDC. This gives rise to:

Policy implication no. 15: whereby in order to ensure privacy, any retail CBDC requires a central bank privacy protocol.

Such security protocols are typically a user interface, with a connected wallet that allows users to interact with it. This includes a command-line interface, a graphical user interface, and/or a mobile application.⁶⁶

I. Conclusion

This paper detailed the complex payments landscape and illustrated how the move to digital forms of currency has fifteen key policy implications that need to be addressed by lawmakers and regulators. These were identified by a review of the literature with a focus on scholarly papers on privacy, regulation, technology platforms and the risks to the disintermediation of the banking sector.⁶⁷

The identified implications include the need for a clear legal definition of the nature and substance of digital currencies, the recognition and proper placement of CBDCs within regulatory structures, differentiation between currencies issued by central banks and decentralised entities, and the differentiation between retail and wholesale use of CBDCs. There is also a need to address the programmability of digital currencies in law and to better define the status of cryptocurrencies to avoid ambiguity with CBDCs.

To support trust in the use of retail CBDCs, they should be supported by privacy legislation with checks and balances in place. Good digital infrastructure, and back up, is also a prerequisite. Wholesale CBDC innovation and testing should be supported by removing unnecessary regulatory burdens, and cybersecurity challenges should be addressed through a zero trust approach and multi-layer defence strategy. The privacy of individuals using retail CBDCs should be protected in law, and central banks should consider whether CBDCs should be interest-bearing and how the interest rate would be determined.

Lawmakers need to address the legal status to the CBDC. This involves delineating their status vis-à-vis alternatives, differentiating between retail and wholesale use, detailing the taxonomy, delegating the powers of oversight, allowing for future programmability, and

⁶⁵For example, if a CBDC allows for anonymous transactions, it could be more difficult for authorities to trace the origins of funds.

⁶⁶The interface allows users to perform actions such as sending and receiving tokens, accessing their stored tokens, and setting up two-factor authentication. In addition, you would need to integrate the wallet with a point-of-sale system for transactions (as is done with the e-CNY in China).

⁶⁷D Sanches and T Keister, 'Should Central Banks Issue Digital Currency?' (2021).

removing regulatory burdens. Overall, the aim should be regulating the behaviour around CBDC usage, not the CBDC itself. Whilst it is not yet clear whether CBDCs will be token or account based, or indeed retail and/or wholesale in nature, it is clear that all have policy decisions that need to be made at the outset.

It is concluded that the introduction of a CBDC requires careful planning, testing and implementation. This necessitates an accommodative policy environment, and changes in legislation in order to remove legal ambiguity. In other words, to mandate a legally constructed entity with an appropriate method of transfer of ownership. Whatever the digital future, the policy and technology adopted to support the introduction of CBDCs will have important legal and macroeconomic consequences.

Disclosure statement

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