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Edited by Dirk Niepelt

Central Bank Digital Currency: Considerations, Projects, Outlook

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Considerations, Projects, Outlook

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Foreword

Central bank digital currencies (CBDCs) are receiving more attention than ever before. Yet the motivations for issuance vary across countries, as do the policy approaches and technical designs. As yet, no major jurisdiction has launched a CBDC, and many open questions remain. Monetary authorities, fearful of being left behind by innovations in the private sector, have increasingly turned from observers into participants.

This book brings together contributions from academics and experts from monetary authorities and international organisations to provide a detailed and insightful overview of the key considerations of current CBDC developments worldwide. Specific chapters discuss the economic, legal and political implications of CBDC implementation, as well as assessing existing initiatives and reflecting on the future of the digital financial landscape.

What is clear from the research is that there are no ‘right’ choices for monetary authorities when considering CBDC. However, the debate has clearly narrowed and the implications are now better understood, with issues of privacy, politics and information increasingly coming to the fore. Concerns have also broadened beyond the domains of payments, monetary policy and financial stability, which have generated a consensus that parliaments and voters – not just central banks – should actively join the debate.

The book is an output from CEPR’s Research and Policy Network on FinTech and Digital Currencies, which was established in 2018 to generate, coordinate and disseminate impactful research about the optimal policies to deal with these fast-moving changes in financial markets. The eBook provides a useful guide for policymakers to navigate the complex and fast-moving world of financial digitalisation and should help to inform the design of pilot projects and the direction of future research.

CEPR is grateful to Dirk Niepelt for his expert editorship of this eBook. Our thanks also go to Anil Shamdasani for his skilled handling of its production, and to Kirsty McNeill for her contributions towards its production.

CEPR, which takes no institutional positions on economic policy matters, is delighted to provide a platform for an exchange of views on this important topic.

Tessa Ogden
Chief Executive Officer, CEPR
November 2021

Introduction

Dirk Niepelt

Study Center Gerzensee, University of Bern and CEPR

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When CEPR's Research and Policy Network on FinTech and Digital Currencies took up its work in 2018, research on retail central bank digital currency (CBDC) was scarce. Discussions in policy circles frequently associated CBDC with cryptoassets, stablecoins or distributed ledger technology (DLT). Only a few early movers among monetary authorities contributed to the debate or ran pilot projects; many central bankers and policymakers rejected CBDC proposals.

Over the last three years, both the pilot projects and a body of new research, including the first eBook published under the auspices of the network (Fatás 2019), have improved our understanding of the issues at stake. Many central banks have concluded that private sector initiatives have taken the status quo option off the table (Niepelt 2019). And as a consequence, more and more monetary authorities have morphed from observers into active contributors, albeit often sceptical ones.

While the discussion about the 'right' CBDC choices – no, or yes and how – is far from settled, the arguments have become sharper and the trade-offs clearer. It has become evident that the implications of CBDC extend far beyond the realms of payments, monetary policy and financial stability. And consequently, there is growing awareness that parliaments and voters – not only central banks – should actively join the debate.

In this eBook, prominent contributors to the CBDC debate share their views and venture to predict the future. The group of authors comprises experts from academia as well as monetary authorities and international organisations including the Bank for International Settlements, Bank of Canada, European Central Bank, Federal Reserve Bank of St. Louis, Federal Reserve Board, International Monetary Fund, Riksbank and Swiss National Bank.¹ Their backgrounds are in financial economics, international economics, law, macroeconomics and monetary economics.

¹ Most contributors are members of the network. The views expressed by the contributors do not necessarily represent the positions of the institutions the authors are affiliated with.

CONSIDERATIONS

The contributions in the first part of the eBook focus on specific aspects or implications of CBDC.

Jonathan Chiu and **Francisco Rivadeneyra** discuss the consequences of CBDC for bank intermediation. They emphasise that CBDC might ‘crowd in’ rather than ‘crowd out’ bank intermediation, by disciplining banks in imperfectly competitive deposit markets; and that this effect may operate even without interest on CBDC. The authors note that bank deposits and CBDC would likely constitute imperfect substitutes and in a world with CBDC, banks might participate in the provision of CBDC-related services. They discuss channels through which this might moderate or exacerbate the impact of CBDC on bank profits.

Todd Keister and **Cyril Monnet** focus on information aspects of digital payment technologies. They explain how bundling, network effects and consumers’ underinvestment in privacy give rise to market power on digital platforms and undermine risk-sharing. The authors argue that a CBDC that allows the purchaser’s identity to be hidden could help improve outcomes by giving consumers control over their data. In addition, CBDC would help preserve financial stability by providing useful aggregated payment information for central banks. They conclude that an appropriately designed CBDC would increase depositor confidence, rendering runs less likely.

Raphael Auer, **Sebastian Doerr**, **Jon Frost**, **Leonardo Gambacorta** and **Hyun Song Shin** similarly emphasise the centrality of data in the context of digital payments. They argue that monetary authorities need to foster competition, ensure data privacy and safeguard the integrity of the payment system. And they suggest that CBDC can help attain these goals as long as it is integrated in a two-tier architecture, is account-based and preserves an innovation-friendly level playing field.

Corinne Zellweger-Gutknecht offers a legal perspective. Placing central bank money in its historic context, she argues that the mandate of central banks to issue cash implies a right – and a duty – to also issue CBDC as a digital equivalent and complement to notes and coins if declining cash circulation makes such a complement necessary. She emphasises that the situation is different for CBDC as a monetary policy tool, as the introduction of CBDC with functionality beyond the one of cash would require a change of law.

Dirk Niepelt emphasises political risks. He argues that central banks can neutralise the effects of CBDC on bank balance sheets, funding costs, credit and investment, but that political pressure may lead them to act differently. He estimates the increase in funding costs that banks might suffer in a (for them) worst-case scenario to be in the order of half a percent of GDP, and cautions that CBDC might lead to further politicisation of banking and central banking. He also discusses other political risks in connection with the introduction of ‘Reserves for All’.

Linda Schilling, Jesús Fernández-Villaverde and Harald Uhlig consider possible implications of CBDC for price stability. They argue that central banks can be subject to ‘spending runs’ where fear of inflation motivates consumers to spend (central bank) money, rendering the fear self-fulfilling. They emphasise that this run risk creates a trilemma if the central bank also engages in maturity transformation: while the threat of central bank induced inflation can deter runs, the goals of price stability, absence of spending runs and maturity transformation cannot be reconciled. The authors also discuss time inconsistency problems and warn of dangers for central bank independence.

Antonio Fatás questions the transformative role of CBDC. He identifies two types of CBDC benefits: one from publicly providing a robust pillar of the monetary system; and the other from supplying an accessible, efficient and resilient alternative to private digital money. He argues that account-based CBDC could provide the monetary anchor, realising the first benefit, while inclusiveness, efficiency and resiliency goals would be hard to reconcile due to conflicting implications for payment infrastructures or public-private partnerships. He concludes that “CBDC is in no way a substitute for the needed reforms to the architecture of payments”.

Similarly, Stephen Cecchetti and Kermit Schoenholtz call for the policy objectives to be clarified. While acknowledging various potential benefits of CBDC, they caution that these benefits come with risks, especially when government institutions are weak. The authors emphasise that it is not sufficient for CBDC to generate positive net gains; after all, alternatives to CBDC may realise the same benefits at lower cost. Accordingly, they conclude that such alternatives need to be assessed more carefully.

Markus Brunnermeier and Jonathan Payne focus on the bundling of money creation and financial services. They argue that CBDC could impair the synergies and valuable incentive effects of bundling deposit (money) creation and bank lending in today’s financial system. And they explain how CBDC as legal tender could undermine the commitment benefits of bundling FinTech token creation and smart contracts, at least in some markets. The authors caution that the implications of CBDC for financial market structure deserve careful attention.

Tobias Adrian and Tommaso Mancini-Griffoli offer an international perspective. They anticipate CBDC benefits from greater efficiency and resiliency of payment systems, financial inclusion and smoother cross-border payments, as well as risks due to bank disintermediation, central bank reputation loss and ‘dollarisation’. The authors discuss measures to limit these risks and emphasise the need for a rules-based international monetary system that avoids a ‘digital divide’ between countries.

In the final chapter of the first part, Quentin Vandeweyer considers the role of stablecoins. He notes three policy positions on stablecoins that emphasise financial stability risks, innovation and complementarities with CBDC, and he compares the contemporary debate about cash reserve assets versus crypto-collateralised or algorithmic stablecoins with the debate about bank notes two centuries ago. He also discusses the role of a two-

tier CBDC for broadening access to central bank liquidity and concludes that stablecoins are here to stay but that an overhaul of the regulatory framework may be needed to fully realise their potential.

PROJECTS

The contributions in the second part of the eBook focus on projects in specific monetary areas or offer an overview over such projects.

Jonathan Chiu and **Francisco Rivadeneyra** report on the Canadian case. They explain how the Bank of Canada's contingency plan builds on the question of what role publicly provided money should play, and how this role can be inferred from the multiple contemporary functions of cash. Against this background they systematically assess the opportunities and risks of CBDC and point to open questions. They conclude that the "decision to issue a CBDC belongs ultimately to Canadians and their elected representatives".

Martin Flodén and **Björn Segendorf** offer a Swedish perspective. They argue that the convertibility of privately issued krona into base money could soon be called into question due to declining cash use; the digital payments landscape might lower the threshold for currency substitution and increase fragility; and the marginalisation of cash could undermine credibility. They describe the Riksbank's responses as well as scenarios for the future, including building a national financial market infrastructure and giving FinTechs direct access to it. Like Chiu and Rivadeneyra, Flodén and Segendorf emphasise the need to involve decision makers outside of the central bank.

Katrin Assenmacher and **Ulrich Bindseil** report from Frankfurt. They describe motivations for and possible consequences of CBDC, both with regards to the payments system and macroeconomic stability. They argue that the design of a digital euro would entail a trade-off between usability for end-users on the one hand, and system-wide stability on the other. And they predict that a digital euro would only be introduced if policymakers were highly confident about their ability to manage possible risks.

Three chapters focus on the US case. **Christopher Waller** questions the usefulness of a CBDC. He argues that cash will not disappear soon; the payment system works well; financial inclusion does not require CBDC; private sector initiatives such as stablecoins could suffice to compress bank markups; and CBDC need not spur innovation, deter the use of crypto-assets or help the US preserve dollar supremacy, while it could generate new types of risk. Waller concludes that absent a clear market failure the government should not compete with private sector financial service providers.

David Andolfatto shares Waller's scepticism but he discounts fears that CBDC might disintermediate banks or promote runs. He cautions that adoption of CBDC should not be taken for granted and even if adoption were widespread, efficient cross-border payments would still require international cooperation. Andolfatto emphasises the market power

of credit card companies and banks, but he concludes that the most promising way forward may not be the introduction of CBDC but rather to promote entry, for instance by granting ‘narrow bank charters’ to new financial services providers.

Darrell Duffie emphasises bank market power and problems in the US payment system. He argues that a public-private CBDC pilot would generate benefits (even if Congress eventually decided against deployment) in the form of learning by doing, technological spillovers, competition and US participation in international discussions. Among the main challenges of CBDC, Duffie identifies the trade-off between privacy and enforced legality of payments; the threat of government stifling innovation; and operational risks, but not disintermediation or runs. Like Waller and Andolfatto, Duffie rejects international currency competition as a convincing motive for a digital dollar.

Andréa Maechler and **Andreas Wehrli** discuss the role of wholesale rather than retail central bank digital currency. They argue that securing the safety and integrity of payments in a DLT-based financial architecture requires a suitable integration of central bank money rather than stablecoins or other private payment instruments. The authors report on two approaches currently being tested in Switzerland: one building on the existing real-time gross settlement system, and the other using wholesale central bank digital currency.

Raphael Auer, **Giulio Cornelli** and **Jon Frost** conclude the second part of the eBook with an overview of ongoing CBDC projects. They report that most central banks view CBDC as a complement to, not a substitute for, cash that they would deploy relying on public-private partnerships rather than by directly engaging with retail users. The authors also report that there is less agreement concerning the importance of improved cross-border payments or the advantages of account- versus token-based CBDC models, while most central banks agree on rejecting architectures based on permissionless DLT.

OUTLOOK

In addition to contributing chapters to this eBook, many authors also submitted responses to five questions about likely future developments. The first four questions conditioned on a scenario in which central banks in developed economies introduce (retail) CBDCs. We asked them to predict:

1. whether the typical CBDC would resemble deposits or cash (considering features like interest, privacy, risk of ‘loss’, etc.);
2. who would interact with end users (e.g., the central bank or commercial banks in some form of public-private partnership);
3. whether the CBDCs would undermine monetary sovereignty in emerging economies; and
4. whether they would reduce the political support for cash.

In the fifth question, we inquired about the consequences of not introducing CBDC:

5. Suppose the central bank in a developed economy does not introduce retail CBDC and cash use declines, reducing the general public's exposure to central bank money. Is there a risk that the general public loses trust in central bank money?

The responses to question 1 differed widely. A majority of the respondents expects the 'typical' CBDC to resemble deposits from the perspective of end-users, but experts disagreed as to whether CBDC would be interest-bearing and whether privacy protection would be stricter than today with deposits.

Regarding question 2, the respondents widely agreed: they expect banks and other private service providers to interact with end-users.

In response to question 3, many experts anticipated some risks for monetary sovereignty in emerging economies; how large these risks would be would depend on international cooperation as well as CBDC design choices in the developed world – for instance, regarding know-your-customer regulation or restrictions on CBDC holdings for foreigners.

The answers to question 4 about dwindling political support for cash differed maximally, ranging from an unconditional “no” to “yes in the medium term” or even “yes, rather rapidly”.

Finally, regarding question 5, several respondents do see a danger that declining cash circulation in combination with no CBDC could undermine the trust in central bank money. Some experts cautioned, however, that such an effect would only arise in the limit once cash effectively disappeared. Others emphasised that price stability would remain the most important determinant of trust in the national currency.

REFERENCES

- Fatás, A (ed.) (2019), *The Economics of FinTech and Digital Currencies*, CEPR Press.
- Niepelt, D (2019), “Libra paves the way for central bank digital currency”, VoxEU.org, 12 September.

ABOUT THE AUTHOR

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PART I

CONSIDERATIONS

CHAPTER 1

Central bank digital currency, bank intermediation and payments

Jonathan Chiu and Francisco Rivadeneyra¹

Bank of Canada

INTRODUCTION

It is commonly believed that the issuance of central bank digital currency (CBDC) could have important implications for the banking and payment industry. In particular, one frequently raised policy concern is that a CBDC, by competing with banks in the provision of payment balances and services, could crowd out banking and reduce deposit and credit creation. To investigate this question, Chiu et al. (2019) construct a theoretical model where the banking sector is subject to imperfect competition. According to the study, introducing a CBDC does not necessarily lead to disintermediation if banks possess market power in the deposit market. By offering an outside option to depositors, the CBDC helps discipline the market power of banks. In general, the impact of the CBDC on banking is non-monotonic in the interest rate paid on the CBDC. Interestingly, the CBDC expands deposit and credit creation when its interest rate lies in an intermediate range and causes disintermediation only if the rate is set too high. Furthermore, even a non-interest-bearing CBDC can help restrain banks' market power as the use of cash continues to decline over time. In this chapter, we summarise the main findings of this paper and suggest several directions for future research on this topic.²

INTEREST-BEARING CBDC CAN CROWD IN BANKING

In the model studied by Chiu et al. (2019), banks are intermediaries that make loans to entrepreneurs and create deposits used by households as a means of payment to trade consumption goods. In addition, the central bank issues two other payment instruments: cash and CBDC. As in the real world, the model features different types of transactions. In some transactions, cash is the only viable payment method (e.g. offline transactions). In some other transactions, cash is not accepted and only deposits are used (e.g. online transactions on the internet). There are also transactions where all payment instruments

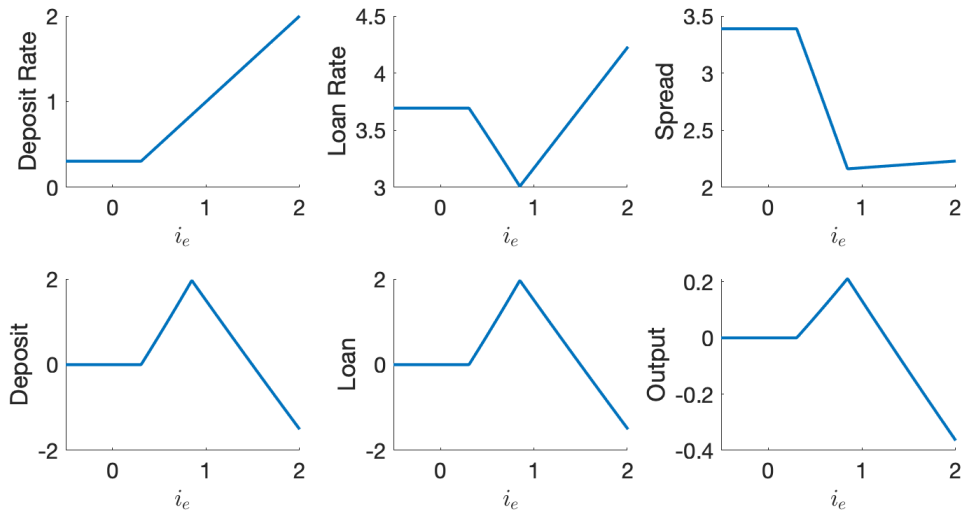
¹ The views expressed in this chapter are those of the authors and not necessarily the views of the Bank of Canada.

² Other papers studying the implications of CBDC for banking include Andolfatto (2020), Brunnermeier and Niepelt (2019) and Keister and Sanchez (2019).

can be used (e.g. transactions in physical retail stores). The authors focus on a deposit-like CBDC which is a perfect substitute for deposits in terms of payment functions and bears an interest rate chosen by the central bank.

An important feature of the model is that banks are subject to imperfect competition.³ The paper finds that, when banks have market power in the deposit market, introducing a CBDC can ‘crowd in’ bank intermediation. The reason is that, in an imperfectly competitive deposit market, banks restrain the supply of deposit to keep the deposit interest rate below the competitive level. By offering an outside option to depositors, the introduction of the CBDC effectively sets an interest rate floor for bank deposits and reduces commercial banks’ incentive to restrain their deposit supply.

FIGURE 1 EFFECTS OF THE INTEREST RATE ON CBDC



Source: Chiu et al. (2019).

Figure 1 illustrates the equilibrium effects of changing the CBDC interest rate (i_e) on the deposit rate, the loan rate and their difference (in the top panels), as well as the percentage changes of deposits, loans and total output relative to the equilibrium without a CBDC (in the bottom panels). When the CBDC rate is set lower than the prevailing deposit interest rate (i.e. the horizontal region in the plots), there are no effects on the equilibrium rates and quantities. Beyond that level, as the CBDC interest rate rises, banks will be forced to raise the deposit interest rate to match that of the CBDC. The higher rate will attract more deposits. This corresponds to the intermediate region where deposits increase gradually to the peak level. As long as the profit margin is positive, banks will be induced to use the extra deposit funding to finance more loans, leading to

³ For empirical evidence, see, for example, Dreschler et al. (2017) and Wang et al. (2018).

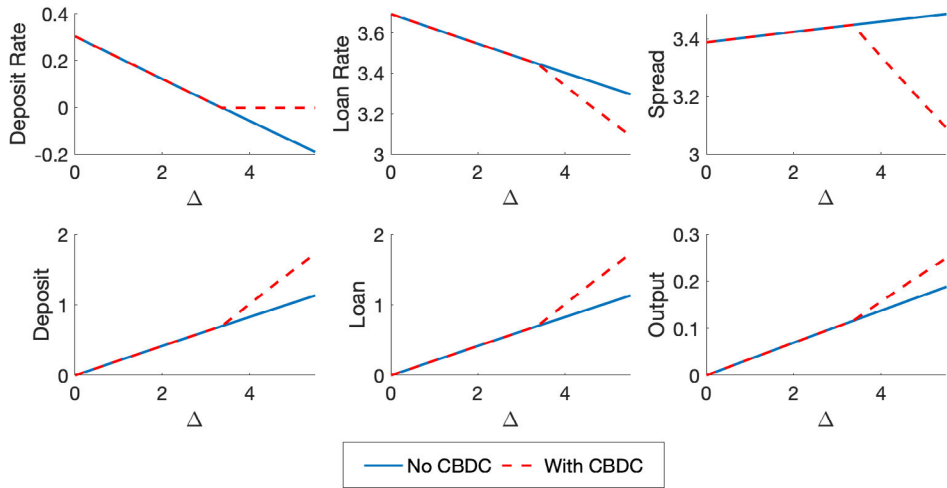
a lower loan interest rate and a narrower spread. Output goes up as a result of the higher investment. Interestingly, in this intermediate region, the mere existence of a CBDC as an outside option can raise deposits, loans and output even if CBDC has no market share. In the third region where the CBDC interest rate is set so high that banks' profits become zero, however, any further increase in the CBDC interest rate will force banks to raise the loan interest rate to break even, lowering deposits, loans and output. To quantify the effects of CBDC, the model is calibrated to the US economy. The exercise suggests that at the maximum, the introduction of a CBDC can increase loans and deposits by 1.96% and the total output by 0.21%.

NON-INTEREST-BEARING CBDC IN A CASHLESS WORLD

The previous section focuses on an interest-bearing CBDC. Some central banks, however, may not offer an interest on their digital currencies. Can a non-interest-bearing CBDC still help discipline banks' market power? Chiu et al. (2019) argue that it can still help when the economy becomes increasingly cashless. Currently, cash competes directly with bank deposits as a means of payments and a store of value. In a world where electronic payments dominate, physical cash could be at risk of not being generally accepted as a means of payments. In that scenario, banks would gain additional market power, potentially leading to higher banking fees, lower interest rates on deposits, and at times lower quality of bank services. The issuance of a non-interest-bearing CBDC with basic payment functionalities could ensure that depositors' outside options would not be worsened relative to the status quo. A CBDC would be a new safe asset that could be used as an outside option, like cash, as a store of value and as a method of payment for transactions. The existence of cash and CBDC could provide competitive pressure, potentially inducing banks to offer better terms and services.

Chiu et al. (2019) capture this idea in their model by assuming that a fraction, Δ , of sellers choose not to accept cash. One interpretation is that some bricks-and-mortar sellers have closed their physical stores and sell exclusively online, implying that more stores accept only electronic payment methods. They compare the equilibrium outcomes with and without a CBDC as Δ rises. In Figure 2, the solid blue line denotes the results without a CBDC. As Δ increases, banks gain extra market power as deposits become a better payment instrument relative to cash. Hence, banks can reduce the deposit interest rate as depositors still choose to hold more deposits which can now be used in more transactions. The dashed red curve denotes an economy with a non-interest-bearing CBDC. Again, the CBDC imposes a floor on the deposit interest rate. When the floor becomes binding, the CBDC prevents the deposit rate from going negative. In that case, banks will find it optimal to create more deposits and make more loans, leading to higher output.

FIGURE 2 EFFECTS OF A NON-INTEREST-BEARING CBDC AS THE ECONOMY BECOMES CASHLESS



Source: Chiu et al. (2019).

OTHER CONSIDERATIONS FOR FUTURE RESEARCH

The analysis above provides a stylised model for assessing the effects of CBDC on bank intermediation. To deepen our understanding of the question, future research can extend the study along several lines discussed below.

Attributes of payment balances

Many studies treat CBDC and bank deposits as perfect substitutes in terms of their payment functions. However, there are other important attributes differentiating a CBDC from bank deposits. In a recent study, Li (2021) models cash, demand deposits and CBDC as product bundles of attributes and estimates households' preferences for these different product attributes. Her empirical study is based on a unique Canadian survey dataset which contains information on households' asset holdings and their perceptions towards different product attributes. The author uses the estimated preference to predict the demand for CBDC with different design features and assesses the impacts of CBDC on cash and demand deposit. Important attributes identified by the author include rate of returns, usefulness for budgeting, anonymity and bundling of bank service. Future research can explore trade-offs in CBDC design along these dimensions. Besides, understanding the industrial organisation aspect of the payment industry (e.g. product

differentiation, switching costs, entry barriers, network effects) could be useful for evaluating the equilibrium impacts of CBDC issuance on banks and other payment service providers.⁴

Bank business model

Many existing studies focus on the impacts of CBDC issuance on banks' funding costs. In reality, a bank runs a more complicated business model and serves multiple, interrelated functions:

- **Payments:** Many models suggest that when a central bank issues CBDC to compete with banks in the provision of payment balances and services, banks' income will likely decline. One potentially important factor is the role of banks in the CBDC system. If banks continue to play a major role in the provision of CBDC (e.g. account administration, distribution, payment transfers), will the negative impacts be mitigated? Will banks even benefit from the issuance of the CBDC, for example by gaining an advantage over their non-bank competitors in the payment market? Will this deter the entry of FinTechs and BigTechs into the payment industry?
- **Credit:** The above analysis examines the linkage between payments and credit provisions and highlights that CBDC can affect credit creation by raising the cost of funding. Another potentially important channel is related to information acquisition. Payment data are a useful input into credit creation in screening loans and monitoring borrowers (Parlour et al. 2020). Will the introduction of a CBDC disrupt this business model by unbundling the complementary payment and credit services offered by banks?
- **Maturity and liquidity transformation:** Banks specialise in creating short-term, liquid liabilities to finance long-term, illiquid investments. By offering a safe account where depositors can park their wealth in crisis times, will CBDC affect the risk and liquidity properties of bank deposits, destabilising the transformation of maturity and liquidity?⁵
- **Account custodianship:** Banks also administer accounts that hold financial assets for their clients. Will introducing a CBDC facilitate or threaten this line of business? Does the answer depend on whether CBDC is value-based or account-based? Do account security, anonymity and interoperability matter? Will a programmable CBDC reduce the demand for custodian service?

4 Huynh et al. (2020) quantify the effects of introducing a CBDC on Canadian consumers' payment choices at the point of sale.

5 Existing work related to this topic include Schilling et al. (2020), Keister and Monnet (2020), and Williamson (2020).

Evolving payments system

Finally, as the payment landscape evolves rapidly, future research should also study the impacts of CBDC on unconventional payment services providers. For example, digital platforms like Alibaba, Amazon, Facebook or Google have ventured into payment services. BigTech companies can exert market power in their core service as a result of network effects and high switching costs (e.g. social media network, search engine). They often run a business model where user activities on their platforms generate valuable data that can be monetised (e.g. ad targeting). While the introduction of payment services can improve a platform's core non-financial business and enhance both data generation and monetisation, their venture into the payment industry can also lead to social welfare costs such as consumer privacy loss, market concentration and disruption of financial stability. Public policy needs to consider whether and how a CBDC should be designed to compete with payment services offered by BigTechs (Chiu and Koepl 2020). Another trend is the fast-growing ecosystem of cryptocurrencies and decentralised finance. New forms of money creation and shadow banks (e.g. USDT issued by Tether, DAI issued by MakerDAO) have been emerging very rapidly to facilitate transactions in the crypto space. Owing to their decentralised and borderless nature, developing appropriate regulations and enforcing them are challenging. Future research should explore the potential role of CBDC in the crypto space.

CONCLUSION

Depending on its design, CBDC could have significant effects on the business model of banks and the future development of the payment ecosystem. While the CBDC will compete with bank deposits, it does not necessarily lead to bank disintermediation. There are still many open questions. To inform future policy discussion, it is crucial that researchers explore further the positive and normative implications of CBDC issuance.

REFERENCES

- Andolfatto, D (2020), "Assessing the Impact of Central Bank Digital Currency on Private Banks", *The Economic Journal* 131(634): 525-540.
- Brunnermeier, M and D Niepelt (2019), "On the Equivalence between Private and Public Money", *Journal of Monetary Economics* 106(6): 27-41.
- Chiu, J, S M Davoodalhosseini, J Jiang and Y Zhu (2019), "Bank market power and central bank digital currency: Theory and quantitative assessment", Bank of Canada Staff Working Paper No. 2019-20.
- Chiu, J and T Koepl (2020), "Payments and the D(ata) N(etwork) A(ctivities) of BigTech Platforms", mimeo.

Dreschler, I, A Savov, and P Schnabl (2017), “The Deposit Channel of Monetary Policy”, *Quarterly Journal of Economics* 132: 1819–1976.

Huynh, K, J Molnar, O Shcherbakov and Q Yu (2020), “Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency”, Bank of Canada Staff Working Paper 20-7.

Keister, T and C Monnet. (2020), “Central Bank Digital Currency: Stability and Information”, mimeo.

Keister, T and D Sanches. (2019), “Should Central Banks Issue Digital Currency?”, Federal Reserve Bank of Philadelphia Working Paper 19-26.

Li, J (2021), “Predicting the Demand for Central Bank Digital Currency: A Structural Analysis with Survey Data”, mimeo.

Parlour, C A, U Rajan and H Zhu (2020), “When FinTech Competes for Payment Flows”, available at SSRN.

Schilling, L, J Fernández-Villaverde and H Uhlig (2020), “Central Bank Digital Currency: When Price and Bank Stability Collide”, available at SSRN.

Wang, Y, T Whited, Y Wu and K Xiao (2018), “Bank Market Power and Monetary Policy Transmission: Evidence from a Structural Estimation”, mimeo.

Williamson, S. (2020), “Central Bank Digital Currency and Flight to Safety”, *Journal of Economic Dynamics and Control*, May: 104146.

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CHAPTER 2

Information, privacy and central bank digital currency

Todd Keister and Cyril Monnet

Rutgers University; University of Bern and Study Center Gerzensee

In a 2012 article in *The New York Times*, Charles Duhigg recounts the story of the father who was angry because Target, a store chain, had sent his teenage daughter coupons for baby clothes and other items appropriate for pregnant women. It turns out that statisticians at Target had been working on an algorithm that used purchase histories to assign a probability of being pregnant to each customer. The algorithm was correct; to her father's surprise, the teenage girl was indeed pregnant.

While it can be surprising how much information about one's personal situation can be inferred from purchase data, the reason Target developed these algorithms is perhaps more interesting. Duhigg explains that people tend to change their purchasing habits in defining moments of their lives, such as marriage or divorce, the start of a new job or – especially – the birth of a child. These events give retailers like Target an opportunity to attract customers as they set new spending patterns that will persist into the future.

DATA AND MONOPOLIES

That story broke in 2012. Fast forward to the present, where people increasingly shop on digital platforms such as Amazon. These platforms have massive amounts of data available to them. Their business relies heavily on data accumulation, both directly and through purchases, and data analysis. These data help build a network of customers, which in turn attracts merchants to the platform. The resulting activities then generate more data, which make the platform even more effective through a virtuous data-network-activities loop (Boissay et al. 2021). While the scale has increased and the techniques are more advanced, the goal remains the same as in Target's earlier efforts: attracting new customers and retaining them in a walled garden.

In recent years, digital platforms and other technology firms have been increasingly moving towards offering payment services, which provides them with an additional source of valuable data. The Covid-19 crisis has accelerated the shift from using cash, which provides some anonymity to customers, to contactless and other electronic payments, which do not. Payments data are often complementary to the information in purchase histories, as they provide insight into an individual's financial situation and spending patterns on other platforms and venues. Platforms can design increasingly

sophisticated models that combine these data with demographic information, as well as with data from other people with similar characteristics, to make inferences about individuals' preferences and willingness to pay for products.

While these advances may bring benefits to both consumers and the platforms they use, there are several reasons for concern.

The most obvious concern is that a concentration of data creates digital monopolies, which may stifle innovation and lead to higher prices as their power grows over time (Garratt and Lee 2021). A platform with more precise information about individual preferences and willingness to pay can price discriminate more effectively, offering different products and prices to different individuals. A platform that provides payment services can also discourage purchases on competing platforms, for example, by offering additional discounts or perks for purchases on the platform, or by charging fees for purchases made elsewhere. It is not difficult to imagine schemes that go further and try to 'poach' consumers who are poised to make a purchase on a competing platform (Fudenberg and Tirole 2000). For example, the payment system could offer a link to a similar item, or the same item at a lower price, on its own platform. This is even more problematic because, as customers, we have little control over who accesses the personal data we have agreed to share (Varian 1997). Overall, the ability to monitor and collect data on payment flows increases the advantage of an incumbent platform and limits the possible points of entry for competing platforms.

A second concern is less obvious but no less important: the algorithms used by platforms create externalities that lead consumers to underinvest in privacy. Consumers can limit the information they provide to platforms by, for example, changing their method of payment and taking steps to browse and shop anonymously where possible. In making these decisions, consumers weigh the inconvenience of taking these steps against the benefit of protecting their own privacy. However, as Garratt and van Oordt (2021) show, information that you disclose also allows platforms to make inferences about other people. Since you do not bear the cost of information you inadvertently reveal about others, you will tend to undervalue protecting your privacy from a social point of view. When everyone undervalues their own privacy, we all provide too much information to the platforms we use, which exacerbates the data monopoly problem.

A third concern arises in situations where the private value of information is higher than the social value, which leads platforms to over-invest in accumulating information about their customers. As first demonstrated by Hirshleifer (1971), additional information may have the perverse effect of undermining risk-sharing arrangements, an outcome known as the *Hirshleifer effect*. For example, lending platforms may use payments data to infer how the financial situation of individual borrowers is evolving, which would allow them to terminate some loans more quickly. While terminating loans that are less likely to be

repaid makes good sense for the lending platform ex post, this action can undermine the ex-ante risk-sharing benefits of the lending arrangement (Xiao 2021). The result can be less lending and the exclusion of some deserving borrowers.

Taken together, these concerns suggest there could be a role for public policy in guiding the amount of personal data accumulated in the course of economic activities, including making payments. Well-crafted and targeted regulation may be able to solve some inefficiencies. Given the time required to adopt and update regulations, however, directly regulating the fast-changing digital economy is a challenge. An alternative approach is to provide consumers with tools for managing their privacy. As Acquisiti et al. (2016) emphasise, “[p]rivacy is not the opposite of sharing — rather it is control over sharing”. The question is not about whether firms/platforms should be prevented from using data, but rather how customers can more effectively control the use of their data by platforms.

ENTER CBDC

One way the public sector might help tilt the balance of power away from digital platforms and back to customers is by making an electronic version of cash available to individuals and businesses. A central bank digital currency (CBDC) could allow consumers to make purchases in a way that does not reveal their identity to the seller, much like physical currency but in a more modern and convenient format. Introducing a CBDC could change the flow of information, and the resulting balance of power, in several ways. First, for some types of purchases, paying with CBDC would allow a customer to remain anonymous to the seller. A seller or platform that wants more information would then need to compensate customers for providing that information (Garratt and Lee 2021). In addition, using a CBDC would make it easier for consumers to keep their activity on one platform invisible to other platforms. Finally, setting the design features of the CBDC, such as the interest rate it pays, may allow policymakers to offset the externalities that lead consumers to underinvest in privacy (Garratt and van Oordt 2021).

While a CBDC would provide consumers with the option to keep their information private from retailers and financial institutions, at least some of that information would instead accrue to the central bank. Some observers worry that this new information could lead to an increase in government surveillance of individuals’ activities. However, emerging technologies may be able to provide consumers with privacy for relatively small transactions using CBDC, while enabling monitoring of larger payments in line with anti-money-laundering regulations (ECB 2019). Moreover, it is worth noting that the public sector has no clear motive to profit from consumers’ payments data in the way that private digital platforms do. For these reasons, a CBDC could effectively function as a convenient, electronic version of cash.

A FINANCIAL STABILITY BENEFIT

While a CBDC may be designed to provide privacy for many individual transactions, the central bank would still gain real-time information about the overall patterns of use and flows of the digital currency. Even relatively coarse information of this type could allow a central bank to better monitor the state of the economy in real time. This new information could lead to improved monetary policy decisions and quicker responses to changing economic and financial conditions, especially in periods of financial stress.

In Keister and Monnet (2021), we focus on one type of information a central bank may be able to infer from CBDC flows: the confidence depositors and other creditors have in their banks. In periods of financial stress, banks and other financial intermediaries have private information about both the quality of their assets and the willingness of their depositors and short-term creditors to continue to provide funding. A bank that is in a weak funding position will often have an incentive to hide this fact from regulators, at least for a while, to avoid triggering supervisory action. This combination of banks' private information and the incentive structure thus causes a delay in policymakers' response to an incipient financial crisis (Keister and Mitkov 2021). Such a delay can increase both the likelihood of a full-blown crisis and the severity of such an event.

In this situation, a CBDC could generate valuable information because it provides banks' creditors with an additional liquid investment opportunity. Suppose, for example, that a bank's short-term creditors learn that the quality of its assets has declined. Currently, if they wish to withdraw funding from the bank, they can shift their funds into another bank or into other liquid assets (for example, government bonds). These withdrawals from the bank might not be immediately observed by regulators and, even if they are, might be difficult to distinguish from the regular inflows and outflows generated by a bank's client transactions.

Once a CBDC is introduced, in contrast, the central bank has a new source of information: the flow of funds into this digital currency. We show that the central bank can use data on inflows into the CBDC to more quickly infer the state of the financial system and, perhaps, of individual institutions. This new information allows the central bank to respond more quickly to emerging problems.

One commonly raised concern is that by providing investors with a convenient, safe alternative asset, introducing a CBDC will make runs on the banking system more likely. This effect is present in our paper, but we show it is offset by the quicker policy response that a CBDC enables. When depositors and other short-term creditors know that the central bank will respond more quickly to an incipient crisis, they have less incentive to withdraw from their banks in the first place. In other words, the ability of the central bank to infer information about depositor confidence has the effect of increasing depositor confidence in equilibrium. In this way, the information a central bank would gain from using a CBDC can increase the stability of the financial system.

CLOSING THOUGHTS

Central bank digital currency has the potential to fundamentally change the flow of information generated by payments data. By providing consumers with a convenient electronic version of cash, it can give them better control in sharing their data. By creating a new source of information for the central bank, it can allow for quicker and more targeted responses to emerging financial strains, and thus help stabilise the financial system. How effectively a CBDC plays each of these roles will depend on a number of design choices that have yet to be made (Auer and Boehme 2020). In making these choices, central banks will consider other policy goals as well, such as improving financial inclusion and the effectiveness of monetary policy. A fundamental challenge ahead is identifying the design(s) that best allow a central bank to simultaneously meet this range of goals.

REFERENCES

- Acquisti, A, C Taylor, and L Wagman (2016), “The economics of privacy”, *Journal of Economic Literature* 54(2): 442–92.
- Auer, R, and R Böhme (2020), “The technology of retail central bank digital currency”, *BIS Quarterly Review*, March.
- Boissay, F, T Ehlers, L Gambacorta, and H S Shin (2021), “Big Techs in Finance: On the New Nexus Between Data Privacy and Competition” in R Rau, R Wardrop and L Zingales (eds), *The Palgrave Handbook of Technological Finance*, Palgrave.
- Duhigg, C (2012), “How Companies Learn Your Secrets”, *The New York Times Magazine*, 16 February.
- European Central Bank (2019), “Exploring anonymity in central bank digital currencies,” *In Focus* No. 4, December.
- Fudenberg, D and J Tirole (2000), “Customer poaching and brand switching”, *RAND Journal of Economics* 31: 634–657.
- Garratt, R J and M J Lee (2021), “Monetizing Privacy with Central Bank Digital Currencies,” Federal Reserve Bank of New York Staff Report 958, revised June.
- Garratt, R J and M R C Van Oordt (2021), “Privacy as a public good: a case for electronic cash”, *Journal of Political Economy* 129: 2157–2180.
- Keister, T and Y Mitkov (2021), “Allocating Losses: Bail-ins, Bailouts and Bank Regulation” Discussion Paper No. 091, Collaborative Research Center Transregio 224, Universities of Bonn and Mannheim, revised January.
- Keister, T and C Monnet (2021), “Central Bank Digital Currency: Stability and Information,” working paper.

Xiao, Y (2021), “Privacy, Payments and Financial Stability”, working paper, Rutgers University, October.

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CHAPTER 3

Central bank digital currencies and data in the digital age: A triple imperative

Raphael Auer, Sebastian Doerr, Jon Frost, Leonardo Gambacorta and Hyun Song Shin

Bank for International Settlements

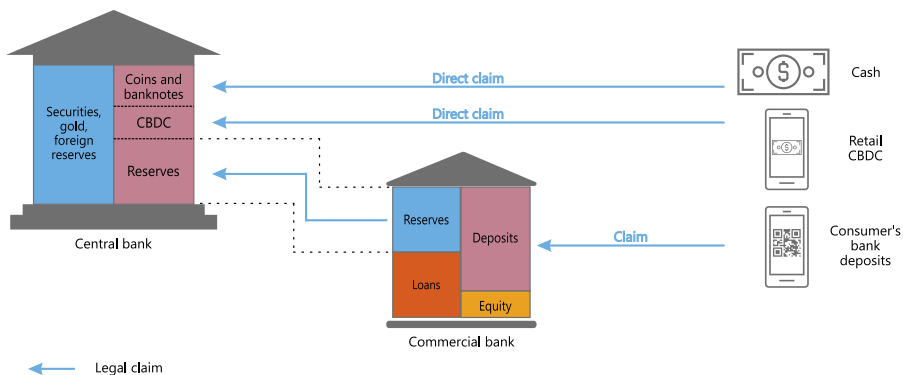
Data are central for the digital economy, and this is especially true in digital payments. As a by-product of digital transactions, huge volumes of personal data are collected and processed as an input into business activity every day. An integral feature of data is their network effects, which present several new challenges for central banks and regulators. First, network effects make the payment system prone to concentration, as they enable the collection of vast troves of data that entrench the market power of firms that have exclusive use of them. Second, data concentration has consequences above and beyond its economic impact – it gives rise to concerns about data privacy and data governance more broadly. And third, data-based digital payment systems must grapple with money laundering, ransomware attacks and other illicit activities.

For central banks, the policy imperative reflects this centrality of data in payments. Indeed, there is a ‘triple imperative’ for the central bank in its role at the foundation of the monetary system: it must foster competition, while ensuring data privacy and maintaining the integrity of the payment system. This triple imperative becomes even more pressing as a wave of technological developments – such as cryptocurrencies, stablecoins and the entry of large technology firms (BigTechs) – may bring far-reaching changes to payment systems across the world. Such innovations could yield benefits in terms of cost and convenience, but their ultimate impact on consumer welfare will depend on the eventual market structure and governance arrangements that underpin them. For example, network effects inherent in the business model of BigTechs can lead to market power and entrenchment that exclude potential competitors (Frost et al. 2019). The combination of transaction, search and social media data also raises concerns about data abuse.

A special chapter of the Bank for International Settlements’ *Annual Economic Report 2021* (BIS 2021a) argues that central bank digital currencies (CBDCs) present an opportunity for the monetary system to overcome such shortcomings of private sector solutions and support the public interest.

CBDCs can be designed for use either among financial intermediaries only (wholesale CBDCs) or by the wider economy (retail CBDCs). As represented in Figure 1, retail CBDCs are a direct claim on the central bank. As an advanced representation of money for the digital economy, they could offer the unique advantages of central bank money in digital form: settlement finality which guarantees that transfers are irrevocably settled; liquidity provisions which ensure that settlements work smoothly; and clear rules and requirements which maintain the system's integrity. This can enable central banks to continue to foster the public good nature of money. To do so, however, they must adhere to three guiding principles in the design of CBDCs.

FIGURE 1 THE MONETARY SYSTEM WITH A RETAIL CBDC



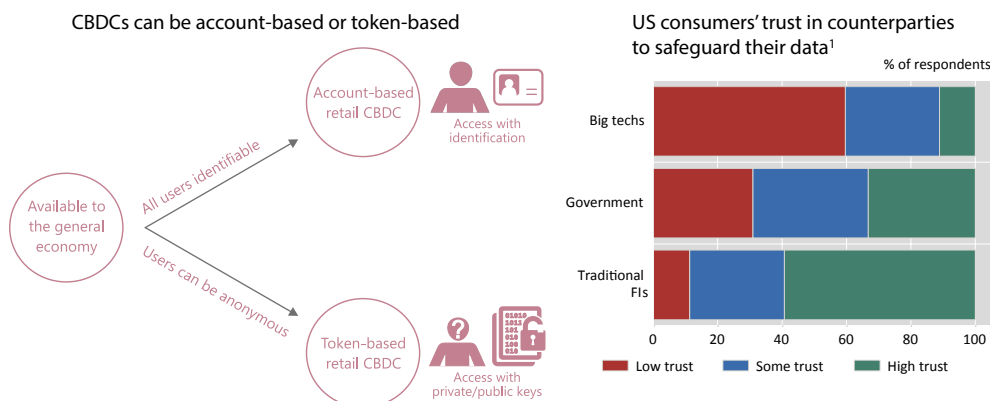
Source: Auer and Böhme (2021).

First, *CBDCs are best designed as part of a two-tier system* where the central bank and the private sector focus on what they do best – the central bank on operating the core of the system by ensuring sound money, liquidity and overall security; the private sector on innovating and using its creativity and ingenuity to serve customers better. CBDCs should therefore be designed to delegate most operational tasks and consumer-facing activities to commercial banks and non-bank payment service providers (Auer and Böhme 2021). These tasks include account opening, account maintenance and enforcement of anti-money laundering/combating the financing of terrorism (AML/CFT) rules. By preserving the two-tier system, the central bank keeps its financial system footprint small, just as cash does today. Central bank money can then retain its core attribute of neutrality.

Second, as laid out in the *BIS Annual Economic Report 2021* (BIS 2021a), *the most promising design is an account-based CBDC*, rooted in an efficient digital identity scheme for users. In principle, retail CBDCs could come in two variants (Figure 2, left-hand panel). One option makes for a cash-like design, allowing for anonymity in payments (sometimes called ‘token-based access’). This option would give individual users access to the CBDC based on a password-like digital signature, without requiring personal identification. Transfers in CBDC would thus not be linked to specific individuals – everybody with the right password could make payments out of a digital

wallet. The other approach is built on verifying users' identity ('account-based access') and would be rooted in a digital identity scheme. This second approach would facilitate the monitoring of illicit activity in a payment system and would still provide options to preserve privacy: personal transaction data could be shielded from commercial parties and even from public authorities by appropriately designing the payment authentication process. Yet, open questions remain as to who would issue and administer such a digital identity, as trust in counterparties to safely handle personal data differs substantially (Figure 2, right-hand panel). Striking the right balance is key to protecting users against data hoarding and abuses of personal data while preserving the system's integrity.

FIGURE 2 IDENTIFICATION IN CBDCs AND TRUST IN COUNTERPARTIES



Notes: AR = Argentina; AU = Australia; BE = Belgium; BR = Brazil; CA = Canada; CH = Switzerland; CL = Chile; CN = China; CO = Colombia; DE = Germany; ES = Spain; FR = France; GB = United Kingdom; HK = Hong Kong SAR; IE = Ireland; IN = India; IT = Italy; JP = Japan; KR = Korea; MX = Mexico; NL = Netherlands; PE = Peru; RU = Russia; SE = Sweden; SG = Singapore; US = United States; ZA = South Africa. ¹ Based on a representative sample of 1,361 US households, September 2020.

The question reads "How much do you trust the following entities to safely store your personal data (that is, your bank transaction history, geolocation or social media data)? For each of them, please indicate your trust level on a scale from 1 (no trust at all in ability to safely store personal data) to 7 (complete trust)". Category "low trust" corresponds to values 1 and 2, "some trust" to 3 and 4 and "high trust" to 5 or higher.

Sources: BIS (2021a); Armantier et al. (2021).

Third, CBDCs should address another challenge arising from the centrality of data in the digital economy – that of *preserving an innovation-friendly level playing field*. The same technology that encourages a virtuous circle of greater access, lower costs and better services could equally induce a vicious circle of data silos, market power and anti-competitive practices. Open payment platforms – for example, facilitated by application programming interfaces (APIs) with open access standards – can enable new entrants to challenge incumbents, fostering competition and private sector innovation. This would benefit consumers through greater user participation (financial inclusion), privacy, lower costs of payments and better services.

To be sure, these characteristics are not unique to CBDCs. They also feature in the latest generation of retail fast payment systems – systems that provide near real-time settlement for users. But CBDCs have the additional feature of extending the unique attributes of

central bank money to the public. CBDCs allow direct settlement on the central bank's balance sheet, without the need for intermediary credit. And they maintain a tangible link with the central bank in the same way that cash does – a salient marker of the trust in sound money itself – even as the use of cash dwindles owing to the increasing adoption of digital payment technologies.

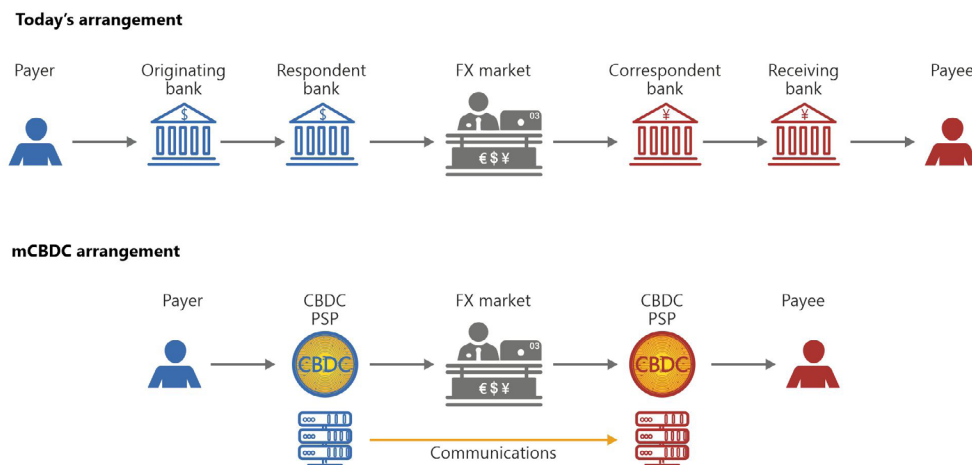
The judicious simplification of the monetary architecture afforded by CBDCs holds the promise of improving cross-border payments, where payment services are often characterised by a lack of competition and thus at times slow, expensive and cumbersome to use. An account-based CBDC may allow for greater control by central banks in both the issuing and receiving jurisdiction. This could help mitigate the risks of 'digital dollarisation', or substitution by a foreign CBDC in domestic transactions and financial contracts. While improvements might also be made by adjusting current systems, starting with a clean slate, unburdened by legacy systems, could yield considerable benefits. So-called multi-CBDC (mCBDC) arrangements, which join up CBDCs across borders, are a case in point (Auer et al. 2021). The greatest potential for improvement is offered by an mCBDC system that features a jointly operated payment system hosting multiple CBDCs.

Central banks around the world have already embarked on developing mCBDC arrangements in close collaboration to foster more efficient cross-border payments. A prime example is the mCBDC Bridge project of the BIS Innovation Hub and its partner central banks in China, Hong Kong SAR, Thailand and the United Arab Emirates. This project explores how CBDCs could help to reduce costs, increase transparency and tackle regulatory complexities in payments (BIS 2021b).

Cross-border payments, especially in correspondent banking, are highly costly due to cross-country differences in legislation, AML/CFT rules, and settlement rules. In this context, CBDCs are seen as an opportunity to simplify the typically long chains in correspondent banking and increase the efficiency of payments to facilitate international trade (Figure 3). This could offer particular benefits to small open economies, which are both more reliant on international remittances and which have recently been hit by a large decline in supply of traditional correspondent banking relationships (EBRD 2020).

The ultimate benefits of CBDCs – and their specific design – will depend on countries' current payment systems, economic development, legal frameworks, user preferences and the policy objectives societies want to achieve (Auer et al. 2020). A recent survey shows that payments safety and financial stability considerations are more important in advanced economies, while central banks in emerging market and developing economies put emphasis on financial inclusion and efficiency (Boar and Wehrli 2021).

FIGURE 3 CBDCs COULD SIMPLIFY THE MONETARY ARCHITECTURE AND SUBSTANTIALLY STREAMLINE THE CROSS-BORDER PAYMENT CHAIN



Source: Elaboration based on Auer et al. (2021).

CBDC is an idea whose time has come. They present an opportunity to design a technologically advanced representation of central bank money, one which preserves the core features of finality, liquidity and integrity that only the central bank can provide. When properly designed, CBDCs could form the backbone of a highly efficient new digital payment system by enabling broad access and providing strong data governance and privacy standards.

REFERENCES

- Armantier, O, S Doerr, J Frost, A Fuster and K Shue (2021), “Whom do consumers trust with their data? US survey evidence”, *BIS Bulletin* No. 42.
- Auer R and R Böhme (2021), “Central bank digital currency: the quest for minimally invasive technology”, *BIS Working Paper* No. 948.
- Auer R, G Cornelli and J Frost (2020), “Rise of the central bank digital currencies: drivers, approaches and technologies”, *BIS Working Paper* No. 880.
- Auer, R, P Haene and H Holden (2021), “Multi-CBDC arrangements and the future of cross-border payments”, *BIS Paper* No. 115.
- Bank for International Settlements (2021a), “CBDCs: an opportunity for the monetary system”, *BIS Annual Economic Report*, Chapter III.
- Bank for International Settlements (2021b), “Multiple CBDC (mCBDC) Bridge”.
- Boar C and A Wehrli (2021), “Ready, steady, go? – Results of the third BIS survey on central bank digital currency”, *BIS Paper* No. 114.

EBRD (2020), *The Transition Report 2020-21*.

Frost J, L Gambacorta, Y Huang, H S Shin, and P Zbinden (2019), “BigTech and the changing structure of financial intermediation”, *Economic Policy* 34(100): 761-799.

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CHAPTER 4

The right and duty of central banks to issue retail digital currency

Corinne Zellweger-Gutknecht

University of Basel

MONETARY MANDATES AND MONEY SUPPLY TO THE PUBLIC (THEN AND NOW)

The state has at all times asserted its sovereign claim to the issuance of money – originally, because it proved to be an excellent fiscal resource. In the case of commodity money, this took the form of seignorage obtained from overvaluation. Later, it was, among others, the issuance of fiat money and, in particular, the inflation associated with its over-issuance that relieved the burden on the indebted state budget and thus took the place of seignorage profits (Mundell 2002). The monopoly for cash issuance and the legal tender status, which have their roots in this period, ensured that the state was not obliged to share the seignorage and that its money was accepted at face value despite devaluation, respectively.

Adverse experiences with inflation or even hyperinflation, however, eventually led to a shift in state funding practices: the more an efficient tax system developed, the less the state had to resort to using the money press for financing. Simultaneously, a growing consensus that a stable monetary system is essential for a prospering economy, its value creation, and ultimately the future tax substrate emerged. At this point, it became necessary to place monetary mandates in the hands of independent central banks.

Accordingly, the reason for issuing state money shifted away from the sovereign's primary interest to the issuance of money as a basic supply of a public good within a publicly sponsored infrastructure (Zellweger-Gutknecht et al. 2021). This was achieved, on the one hand, by directly supplying the public with tangible cash and, on the other hand, by issuing state money, in particular for the purpose of settling non-cash private payment transactions (today in the form of central bank sight deposits, originally also high-value banknotes). This liquidity supply to the general public and selected actors in the financial market is fulfilled today within the framework of payment policy.¹

¹ More recently, the payment policy mandate (and the lender of last resort role originally enshrined therein) has evolved into a separate stability mandate in various monetary systems. See, for example, Article 5(2)(e) of the Swiss National Bank Act (NBA) of October 3, 2003 (951.11): "It [i.e. the SNB] shall contribute to the stability of the financial system" (<https://www.fedlex.admin.ch/eli/cc/2004/221/en>).

However, the issuance of money alone is insufficient. Rather, the supply of money at large (public and private) must operate under conditions that allow the economy to exploit its production potential optimally. Price stability is widely recognised as an indicator that this goal has been achieved. Hence, in addition to the issuance of money, another service of public interest was added: the guarantee of stable prices through monetary policy (e.g. European Commission 2003: para. 20).

THE MULTI-LAYERED AND ESSENTIAL ROLE OF CASH IN MODERN MONETARY SYSTEMS

In monetary systems structured as described above, cash plays an essential, multi-layered role. First, it is a kind of *ideal money*: efficient² and at the same time safe to handle; inclusive (since even children, tourists, and unbanked people can use it); privacy-preserving (for obvious reasons); and above all, practically risk-free (the money's real value corresponds largely to its nominal value).³ Several reasons for this may be cited, but it is largely attributable to the fact that the issuer – the central bank – cannot become insolvent. In addition, the central bank pursues a monetary policy that serves neither the interests of any shareholders nor the interests of the treasury.

Second, and precisely because it is ideal money, cash also serves as a *quality anchor* for privately issued money, particularly commercial bank deposits. From a legal perspective, such deposits are claims denominated in state money and payable on demand. The resulting convertibility into state money means that they all circulate at par, at an exchange rate of 1:1, despite having been issued by different banks with balance sheets that differ significantly in quality (Fox 2016). Of course, prudential regulation and financial safety nets – such as deposit insurance, lender of last resort, and sometimes even bailouts – also help to keep the value of bank deposits uniform among themselves. However, without convertibility into state money, this 'uniformity of money' simply could not be achieved to the same extent. Without convertibility into cash, bank deposits would themselves ultimately be fiat money. In this way, however, cash disciplines the banks, for if they conduct business with excessive risk, they will have to reckon with increased cash withdrawals. The insolvency of Lehman Brothers 2008 is a telling example of this: because customers no longer knew which bank was still safe, they withdrew vast amounts of cash. The Deutsche Bundesbank alone, Germany's central bank, had to issue as many €500 notes in a single month as it would otherwise have done in an entire year (Weidmann 2016).

Third, cash also serves the stability of the financial system owing to its above-mentioned disciplining function. Without this stability or uniformity of money, the effective transmission of monetary policy impulses would be impossible. Thus, the central bank's

2 At least the handling of cash, or at any rate of banknotes, was efficient from the point of view of the time when the issuing of cash issuance was delegated to central banks and appropriately enshrined in central bank and other monetary laws.

3 See details in Zellweger-Gutknecht et al. (2021: 11).

issuance of cash is ultimately an indispensable precondition for monetary policy.⁴ However, it is not itself an instrument of monetary policy and, as far as can be seen, was not envisaged as such by any legislator in any modern monetary system.

However, all three essential functions are under acute threat, as the use of cash for payment purposes is declining at an accelerating pace for various reasons (Zellweger-Gutknecht 2021: 1). By virtue of their mandates, central banks are therefore already not only entitled but also obliged *de lege lata* (under current law) to prepare and put in place the issuance of a digital equivalent and complement to cash – a retail central bank digital currency (rCBDC) – as soon as possible. By contrast, changes in the law are unavoidable wherever digital cash is to be equipped with properties and functionalities that tangible cash lacks.

The section that follows examines two of these aspects in greater detail. First, it discusses why it is irrelevant whether money is issued in the form of digital tokens or account balances and demonstrates that it matters only what digital cash is used for and how access is organised institutionally. Second, in the latter context, it explains why cash in particular must not be used as a monetary policy instrument under current law and that the central bank should not make cash available directly but rather should operate via financial intermediaries that it appoints as part of a hybrid architecture.

ELIGIBLE FORMS OF DIGITAL CASH AND BOUNDARIES FOR ITS USE AND ACCESS

Account balances and tokens

Central banks today issue digital money by providing account balances for selected actors in the financial system and accepting eligible assets as collateral. For this purpose, the central banks are regularly authorised in central bank laws or other monetary laws to open accounts.⁵ However, it must be emphasised that these provisions speak of ‘accounts’ by pure chance simply because when the relevant laws were written, the account, or rather the balance in an accounting ledger, was *the* only technical standard available for rendering a sum of currency units in digital form perceptible to the human senses.

4 See, for example, the opinion of the advocate general Pitruzzella delivered on 29 September 2020 in the joined cases C-422/19 and C-423/19 (ECLI:EU:C:2020:756), para 65 (italics added): “The competence to issue and authorise the issue of euro banknotes ... underpin the *unique* character of the euro currency and are also a *precondition* for the conduct of a single monetary policy.”

5 See, for example, Art. 9 NBA (n 3) in conjunction with Art. 10 of the Swiss Federal Act on Currency and Payment Instruments (CPMI) of 22 December 1999 (941.10). See also Art. 17 of the Statute of the European System of Central Banks (ESCB), Protocol 4 to the Treaty on European Union [2016] OJ C202/203. The article reads as follows: “In order to conduct their operations, the ECB and the national central banks may open accounts for credit institutions, public entities and other market participants and accept assets ... as collateral.”

This situation looks set to change with the availability of distributed ledger technology. Of course, several protocols, such as Ethereum, Quorum, and Ripple,⁶ are still based on accounts and balances, whereby a balance represents money. The balance is variable and changes with every transaction – effected by the traditional transfer mode of debits and credits (Zellweger-Gutknecht 2019). However, other protocols, such as Bitcoin and Corda,⁷ are based on a so-called ‘token’ system.

Unlike account balances, tokens represent an arbitrarily designated amount of money. Once established, however, the token’s value never changes – just like a banknote or coin. However, that is where the similarities with tangible cash end. Digital tokens themselves are not transferred, only the value they represent – again, through debit and credit. Tokens that have not yet been spent are recorded as ‘unspent’ (unspent transaction output, or UTXO, in the Bitcoin protocol) or ‘latest’ (Corda) or similar. A token can only be issued in its entirety at any time (comparable to a \$10 note: a corner is not simply cut off if two dollars are to be tendered). Thus, if one owes, for example, half a bitcoin and wants to pay it with a two-and-a-half bitcoin, the system will mark the whole token as ‘spent’ (under the Corda protocol it would be flagged as ‘old’). In return, the system records a new token of half a bitcoin on the payee’s address and two bitcoins on the payor’s address – both, again, marked ‘unspent’ (fees not considered).

In summary, account balances are money, but tokens are no less so. Both are transferred by debit and credit, since tokens are also invalidated or rather fully debited and newly created or credited with each transaction. The authors of current monetary laws simply had not encountered digital tokens when they drafted the legislation. Therefore, if a provision mentions ‘accounts’, this is not legally a qualified silence in the sense that all other digital forms of representation would be inadmissible. A policy paper recently published by IMF authors reached a different conclusion (Bossu et al. 2020). However, it seems to be based on a rather formalistic and literal interpretation of the relevant laws. A conclusive assessment by academic papers would only be possible, however, if the authors were to publish the raw data used in their analysis, which would be extremely important in view of the issue’s topicality and the weight attached to IMF assessments in general.

Impermissible use as a monetary policy instrument

Today’s central bank mandates clearly limit the purposes for which they may use the money they issue and, related to this, with whom they may maintain direct relations. To illustrate this, the reader is once again directed to the provisions that authorise central banks to open accounts.⁸ It might be tempting to use these provisions as a legal basis for issuing digital cash to the public – at least if such rCBDC were designed to be account-

6 For the distinction to account-based models such as Quorum (used by JPM and project Ubin of MAS) or Ethereum and Ripple see, for example, the overview in Longchamp et al. (2020). However, it is rightly argued that the distinction between token and account (balances) does not necessarily lead to convincing solutions (Lee et al. 2020 and references therein).

7 For example, the Swiss National Bank used the Corda protocol to implement a proof of concept in the area of wholesale payments (BIS Innovation Hub, SIX Group AG and Swiss National Bank 2020).

8 See footnote 5.

based and the provisions were broadly interpreted in terms of who might have access. As demonstrated above, the supposed restriction on accounts is most likely a fallacy. However, these provisions' personal scope of application cannot be extended without amending the law for systematic and teleological reasons.

Provisions on the maintenance of central bank accounts are regularly located in chapters that deal with monetary policy operations, whereas the issuance of cash to the public is regulated elsewhere. For example, Art. 17 of the Statute of the European System of Central Banks (ESCB) regulates the maintenance of accounts for "market participants" in Chapter IV on the "Monetary Functions and Operations of the ESCB". By contrast, Art. 16 on the issuance of cash is located in the preceding Chapter III on the "Organisation of the ESCB", which clarifies the competences.⁹ This is consistent with the systematic location of the corresponding provisions in the Treaty on the Functioning of the EU (TFEU): therein, Art. 128 TFEU regulates the issue of cash separately and independently from Art. 127 on monetary policy tasks.

This systematic positioning is significant and binding. It was put in place for good reason: aside from expectation management via forward guidance, the central bank does not implement its monetary policy in direct contact with the public. In particular, cash issuance is not a tool of monetary policy transactions and was not intended by the legislator to serve as such. This would infringe the price stability mandate (Zellweger-Gutknecht 2021: 33), the well-established two-tier monetary system, and the principle of open market economy, in which the financial intermediaries in competition with one another primarily determine the conditions of the general supply of money.

Consequently, an architecture that avoids direct interaction between the public and the central bank and, in particular, does not create a contractual relationship between them but continues to regulate their relationship solely by public law should be chosen. The issuance and transfer of digital cash will be handled by financial intermediaries on behalf of and for the account of the central bank. As a result, both tokens and account balances will continue to be recorded on the liabilities side of the central bank.¹⁰ This architecture would safeguard the essential risk-free nature of cash and prevent the state from easily obtaining insight into the public's financial transactions, while simultaneously preserving the banks' information about their customers' payment flows, which remain essential for risk-adequate lending (Goodfriend 1990: 11–38, 14, 20, 22, Geva 2019: 247–277, 248, 253 et seq.).¹¹

9 This is precisely what Art. 16 concerns: it distributes the competencies between the Governing Council, the ECB at large, the national central banks (NCBs) and the Member states (with the latter implicitly taken into account in para. 2).

10 See, for example, the legal nature of sight deposits with the Swiss National Bank in the sense of Arts. 2(c) and 3(3) CPMI (fn 11): although they are recorded on the technical platform of the Swiss Interbank Clearing (SIC) System, which is a joint venture of the Swiss Banks and acts as an agent of the SNB, the aforementioned sight deposits are recorded on the liability side of the SNB's balance sheet.

11 If banks are stripped of transaction data, they are no longer in a position to provide information-intensive non-traded loans in a risk-adequate manner.

CONCLUSION

The elementary functions of cash – both for the public and for monetary policy – must be maintained in a world in which the use of cash is increasingly declining. Therefore, wherever the central bank already has a mandate to issue cash, it also has a right – and a corresponding duty – to reinforce tangible cash by issuing a digital equivalent and complement. This mandate does not have to be given by amending the law first. By contrast, according to current law, cash is not an instrument of monetary policy. If it were to be used for this purpose in the future (for example, through positive or negative interest rates), then a change in the law based on a democratic decision by fully informed parliaments would indeed be required. ‘Fully informed’ in this context means that it must be made transparent that a change in the law is necessary not because of the introduction of new forms of representation of monetary value, such as tokens, but rather because the use of cash as an instrument of monetary policy is a novelty and, as explained above, would violate the price stability mandate and the principle of an open market economy. However, careful consideration should be given to whether today’s two-tiered system should in fact be relinquished. I strongly advise against it.

REFERENCES

- BIS Innovation Hub, SIX Group AG, and Swiss National Bank (2020), *Project Helvetia: Settling Tokenised Assets in Central Bank Money*, December.
- Bossu, W, M Itatani, C Margulis, A D P Rossi, H Weenink and A Yoshinaga (2020), “Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations”, IMF Working Paper No. 2020/254.
- European Commission (2003), “Green paper on services of general interest”, 21 May.
- Fox, D (2016), “Cyber-Currencies in Private Law”, in S E Griffiths, M Henaghan, and M B Rodriguez Ferrere (eds), *The Search for Certainty—Essays in Honour of John Smillie*, Thompson Reuters.
- Geva, B (2019), “Cryptocurrencies and the Evolution of Banking, Money and Payments”, in C Brummer (ed.), *Cryptoassets Legal, Regulatory and Monetary Perspectives*, Oxford University Press.
- S Goodfriend, M S (1990), “Money, Credit, Banking, and Payment System Policy”, in D B Humphrey (ed.), *The US Payment System: Efficiency, Risk and the Role of the Federal Reserve*, Kluwer Academic.
- Lee, A, B Malone and P Wong (2020), “Tokens and Accounts in the Context of Digital Currencies”, FEDS Notes, 23 December.
- Longchamp, Y, S Deshpande, and U Mehra (2020), “A Beginner’s Guide to Blockchain Accounting Standards”, 25 June.

Mundell, R A (2002), “Monetary Unions and the Problem of Sovereignty”, *The ANNALS of the American Academy of Political and Social Science* 123.

Weidmann, J (2016), “Eröffnungsrede”, in *3 Bargeldsymposium der Deutschen Bundesbank, Frankfurt Juli 2016*, Deutsche Bundesbank.

Zellweger-Gutknecht, C (2019), “Developing the Right Regulatory Regime for Cryptocurrencies and Other Value Data”, D Fox and S Green (eds), *Cryptocurrencies in Public and Private Law*, Oxford University Press.

Zellweger-Gutknecht, C, B Geva, and S Neva Grünewald (2021), “Digital Euro, Monetary Objects, and Price Stability: A Legal Analysis”, *Journal of Financial Regulation* 1.

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CHAPTER 5

'Reserves for All:' Political rather than macroeconomic risks

Dirk Niepelt

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When it comes to the perils of retail central bank digital currency (CBDC), policymakers tend to stress macroeconomic threats. True, so the argument goes, CBDC holds various promises, but in the worst case it could disrupt banking, undermine financial stability and reduce investment.¹ After all, the introduction of CBDC or 'Reserves for All' would reduce household or corporate deposits, and these deposits fund banks.

This argument is incomplete, however. It neglects the fact that CBDC issuance would also increase central bank funding – funding that must be invested. Whether the introduction of CBDC would be disruptive therefore depends on central bank choices, in particular on the choice of how the CBDC funds are invested.²

MACROECONOMIC NEUTRALITY

In principle, a central bank can completely neutralise the effects of CBDC on bank balance sheets and macroeconomic outcomes when certain conditions are met.³ The main element of the neutral central bank policy is a refinancing operation in which the central bank funds banks at terms that keep both their financing costs and their incentives unchanged. Effectively, under the neutral policy the central bank re-channels CBDC funds back to banks, keeping their choice sets unchanged. Banks continue to engage with the real sector, in particular extending credit; only the composition of their liabilities changes as household and firm deposits are substituted by central bank loans (Brunnermeier and Niepelt 2019).

1 Among the potential benefits, CBDC might enhance competition in the banking sector; foster financial inclusion and monetary sovereignty; help protect consumers from data-hungry private payment providers; and reduce the need for deposit insurance as well as the problems resulting from moral hazard and bank regulation. Tobin (1985, 1987) emphasised the latter point, arguing in favour of 'deposited currency', i.e. widely accessible government issued money "with the convenience of deposits and the safety of currency" (p. 172). Recently, the literature on CBDC has burgeoned. For an overview see Niepelt (2018) and Auer et al. (2021) and the sources cited therein. On the potential consequences of CBDC for monetary and national sovereignty see, for example, Raghuvveera (2020); and for taxes and distortions, Niepelt (2020).

2 For a related view see, for example, Auer et al. (2021: 19): "... the argument that a CBDC increases financial fragility is actually difficult to justify when considering it in a general equilibrium model, with all facets of CBDCs."

3 These conditions concern the properties of CBDC and bank deposits as means of payment: The rate at which users can substitute one means of payment against the other must be constant (but not one-to-one; Brunnermeier and Niepelt 2019) and the total resource requirement to operate the means of payment must not change because of the substitution (Niepelt 2020).

As a stark example, consider a scenario in which all depositors close their bank accounts and transfer the funds to newly established CBDC accounts. By accepting the incoming payments, the central bank acquires claims vis-à-vis the banking sector in exchange and thereby refinances it.⁴ What are key for the macroeconomic consequences in this scenario are the terms and conditions of the central bank's new claims, that is, the interest rates on central bank loans to banks and their elasticities. By appropriately choosing these terms, the central bank can ensure that banks face the same choice sets as prior to the CBDC introduction and as a consequence, it can insulate bank credit, investment and growth from the change in the means of payment that households and firms use.

What interest rate on central bank loans would this neutral policy entail? Estimates for the US suggest that in the last twenty years the rate would have fluctuated widely, depending on market conditions including interest rates on deposits and reserves (Niepelt 2020). Importantly, the rate would have differed from the market interest rate for short-term, risk-free funding without a liquidity premium. For example, just before the financial crisis, the market rate for such funding without a liquidity premium was substantially higher than the hypothetical equivalent loan rate under the neutral policy, which was low because interest rates on deposits were low.

BANK 'FUNDING COST REDUCTION AT RISK'

So, the introduction of CBDC does not necessarily undermine macroeconomic stability because central banks can largely neutralise the consequences. But of course, central banks might choose to pursue different strategies and to opt for policies that differ from the neutral one, implementing different equilibria than in the absence of CBDC. Unless we know with certainty how central banks would act (and we don't), the macroeconomic effects of CBDC thus are far from certain. But the risks do not arise from the laws of macroeconomics; rather, central bank policies and politics take centre stage.

A key question therefore concerns the incentives and constraints of central banks. Would monetary authorities be in a position to pursue the neutral policy? In particular, would they be willing and able to refinance banks at rates that are as low as to replicate cheap deposit rates? In a world with politically influential bank managers or shareholders, this might be conceivable.⁵ In a world with influential taxpayers, in contrast, it might not. Accordingly, the effect of a CBDC on bank funding costs, credit and investment might vary across countries with similar economic fundamentals just because their central banks differ in terms of governance structure or the political exposure of their exponents.

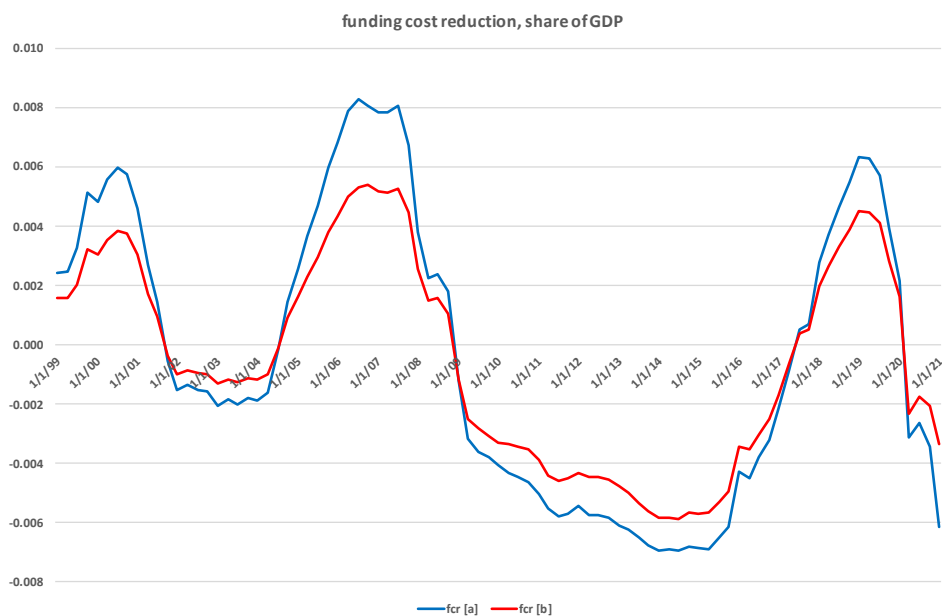
4 If the central bank rejected the incoming payments nothing would happen. If the banks held reserves to start with the new claims would be netted. Banks might also choose to adjust their reserve holdings at the central bank. This does not affect the argument (Niepelt 2020).

5 For a related point see, for example, Cukierman (2019: 7).

The introduction of CBDC in combination with refinancing operations would increase transparency, thereby strengthening the relative political influence of less well-organised lobbies and fostering public scrutiny of central bank policies. The question of whether seignorage revenue benefits the actual ‘creators’ of liquidity would be raised more often, and implicit subsidies for banks would become more difficult to sustain unless they commanded public support. Sovereign money initiatives along the lines of the Swiss Vollgeld proposal to deprive banks of seignorage could be a sign of things to come.

The amounts at stake are large, on the order of half a percent of GDP or more. Figure 1, which is taken from Niepelt (2020), illustrates two estimates of the ‘funding cost reduction at risk’ for US banks if all deposits were converted into CBDC and the central bank refinanced banks. The series run from 1999 until today and are expressed as shares of GDP. They are positive when refinancing through short-term, risk-free funds which do not command a liquidity premium would have been more expensive than at the equivalent loan rate under the neutral policy. This was the case, for example, before the financial crisis because market rates for funds without a liquidity premium substantially exceeded deposit rates at the time. During periods of interest rate compression (in the early 2010s) when market rates for funds without a liquidity premium and deposit rates were very similar the time series are negative because operating a deposit business generated additional costs which the equivalent loan rate accounts for.⁶

FIGURE 1 TWO ESTIMATES OF THE ‘FUNDING COST REDUCTION AT RISK’ FOR US BANKS DUE TO CBDC



6 For details, see Niepelt (2020), which also includes alternative estimates according to which the ‘funding cost reduction at risk’ was positive throughout.

OPEN MARKET OPERATIONS AND LENDER OF LAST RESORT FOR ALL

Figure 1 shows that after the introduction of CBDC banks would have time-varying, and at times very strong, incentives to engage with central bank decision makers to influence them, and so would taxpayers. Banking would become even more politicised. But the political risks do not end here. New refinancing operations for banks along the lines described above, in combination with broadened access for households and firms to central bank money, could lead the latter to ask for more. Interest groups might raise the question of why the central bank should restrict open market operations to a select set of counterparties and a select set of assets (Cecchetti and Schoenholtz 2018). Refusal by central banks to accommodate demands for ‘fairness’ or ‘policies in the public interest’ could trigger complaints about double standards for Main Street versus Wall Street, while acceptance would open the door to new credit risks on the central bank balance sheet.⁷

What’s more, insolvent companies could demand ‘lender-of-last-resort’ support based on the argument that they suffer from liquidity rather than solvency problems, are systemically important, and should not be treated differently than ‘systemically important’ banks (Tucker 2017: 9). Under intense political pressure to save jobs and keep businesses alive, central banks would have to assess the negative externalities from insolvency, not only in the financial sector but across industries; in times of widespread distress, they might choose to submit to the demands. The macroeconomic consequences *ex ante* and *ex post* would be far reaching.

FISCAL DEMANDS, CASH AND THE EFFECTIVE LOWER BOUND

Independently of whether central banks would just refinance banks or succumb to pressure to do more, their balance sheets would grow and with them the power to generate seignorage revenues. The voices demanding high and stable central bank profit disbursements could become louder, as the example of Switzerland shows. And the interests of taxpayers, creditors and central bank debtors concerned with seignorage, low inflation and cheap financing, respectively, could collide.

Moreover, ‘Reserves for All’ might enlarge the power of monetary authorities in new ways. By reducing the circulation of notes and coins (as a consequence of both direct substitution and of network effects; Agur et al. 2019), the introduction of CBDC could undermine the strong public support that cash still enjoys in many societies. As a

7 For a related discussion, see Fernández-Villaverde et al. (2021).

consequence, privacy in payments would suffer and the effective lower bound on policy rates which constrains monetary policymakers today would decline if not disappear, opening the way for more muscular and conflictual monetary policies.⁸

CONCLUSION

From a macroeconomic perspective, central banks can largely neutralise the consequences of CBDC. What is highly uncertain, however, is whether they would choose to do so – the political risks of ‘Reserves for All’ are first-order. The decision for or against CBDC thus should not only reflect the assessment of economic trade-offs, but also whether societies are confident in their ability to efficiently manage conflicts of interest. If not, and if they fear that the introduction of CBDC could further politicise banking and central banking, then the introduction of CBDC might constitute a risky regime change. It will be interesting to see how different judge this risk.

REFERENCES

- Agur, I, A Ari and G Dell’Ariccia (2019), “Designing central bank digital currencies”, mimeo, International Monetary Fund, October.
- Auer, R, J Frost, L Gambacorta, C Monnet, T Rice and H S Shin (2021), “Central bank digital currencies: Motives, economic implications and the research frontier”, forthcoming in *Annual Economic Review*.
- Bordo, M and A Levin (2017), “Central bank digital currency and the future of monetary policy”, NBER Working Paper 23711.
- Brunnermeier, M and D Niepelt (2019), “On the equivalence of private and public money”, *Journal of Monetary Economics* 106: 27–41.
- Cecchetti, S and K Schoenholtz (2018), “Universal central bank digital currency?”, *Money & Banking*, April.
- Cukierman, A (2019), “Welfare and political economy aspects of a Central Bank Digital Currency”, CEPR Discussion Paper 13728.
- Fernández-Villaverde, J, D Sanches, L Schilling and H Uhlig (2021), “Central bank digital currency: Central banking for all?”, *Review of Economic Dynamics* 41: 225–242.
- Kahn, C, J McAndrews and W Roberds (2005), “Money is privacy”, *International Economic Review* 46: 377–399.

⁸ On the costs and benefits of privacy in transactions see e.g. Rogoff (2016) and Kahn et al. (2005), respectively. Bordo and Levin (2017) emphasize the benefits of abolishing the effective lower bound on policy rates. In principle, interest rates could be reduced below the effective lower bound even without legal restrictions on cash use, by means of cash carry taxes or a flexible exchange rate between cash and reserves; see Niepelt (2018) for a review of the arguments.

Niepelt, D (2018), “Reserves for All? Central Bank Digital Currency, Deposits, and their (Non)-Equivalence”, CEPR Discussion Paper 13065.

Niepelt, D (2020), “Monetary policy with reserves and CBDC: Optimality, equivalence, and politics”, CEPR Discussion Paper 15457.

Raghuvveera, N (2020), “Design choices of central bank digital currencies will transform digital payments and geopolitics”, Atlantic Council, April.

Rogoff, K (2016), *The Curse of Cash*, Princeton University Press.

Tobin, J (1985), “Financial innovation and deregulation in perspective”, *Bank of Japan Monetary and Economic Studies* 3: 19–29.

Tobin, J (1987), “The case for preserving regulatory distinctions”, Chapter 9 in *Restructuring the Financial System, Proceedings of the Economic Policy Symposium, Jackson Hole*, Federal Reserve Bank of Kansas City, pp. 167–183.

Tucker, P (2017), “The political economy of central banking in the digital age”, SUERF Policy Note 13, June.

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CHAPTER 6

Facing the central bank digital currency trilemma

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How societies organise their monetary systems is a consequence of the interaction of ideas (e.g. should a central bank target price stability?) with technology (e.g. how good are we at issuing money that is hard to counterfeit?). This interaction is dynamic: improvements in technology drive how we think about money and, vice versa, changes in our ideas about money lead to developing new monetary technologies. Also, it is a punctuated interaction: periods of rapid change are intersected among long years of stability. Right now, we are living in one of those times of quick transformation. The internet, advanced cryptography, and fast computational power mean that it is well within the realm of feasibility to completely change our financial system. And these technologies have led the private sector to introduce new ideas in the form of digital currencies, from bitcoin to Facebook's diem.

In response to this technological and private sector pressure, central banks are considering a move from a structure where they operate only with large depository institutions to a system where they interact with the public at large ('central banking for all') through the issuance of central bank digital currencies (CBDCs). Even just 20 years ago, the logistical challenge of a central bank running hundreds of millions of checking accounts and tens of thousands of branches would have made the concept of a central bank open to all risible. Today, it is possible.

But something being possible does not make it desirable from society's perspective. As more central banks rush into considering CBDCs, we must step back and weigh the costs and benefits of this new dispensation. That is why, in our recent work (Schilling et al. 2020, Fernández-Villaverde et al. 2021), we have highlighted how central banks that issue a CBDC will need to confront classic banking issues: achieving maturity transformation while providing liquidity.

One first thread in our work is that central banks, contrary to the perception of many, are also subject to runs, which we call 'spending runs'. If the agents in the economy believe that the price level will increase soon (regardless of whether this belief is based on solid facts), they will run to get rid of their holdings of central bank liabilities – whether they be cash, deposits or CDBC – as soon as they can. Since the total amount of goods existing

in the economy is essentially fixed in the very short run, the consequence of a spending run will either be an immediate increase in prices, thus self-fulfilling the concerns about inflation that triggered the run, or shortages due to the stocking out of goods.

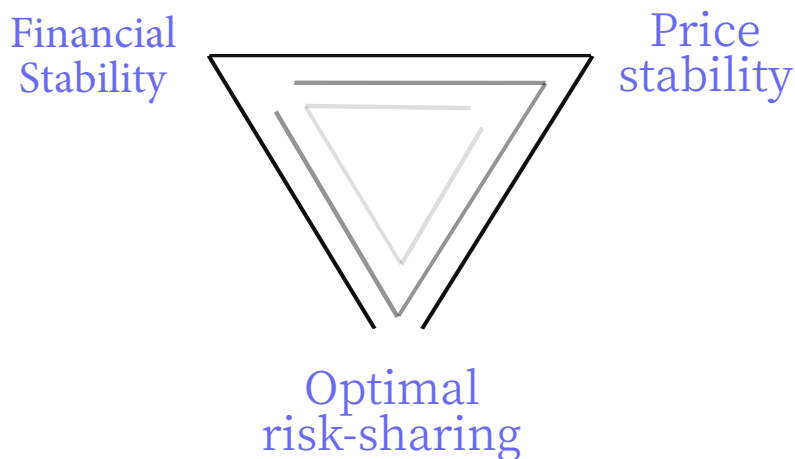
Such spending runs occurred often during the 20th century. For instance, in May 1990, the faltering Soviet government proposed an increase in retail prices. Although this proposal was never approved, it nonetheless led to a massive run on the ruble. Shops, either state-owned or in the growing private sector, soon stocked out (Ellman 2014: 78). Similar spending runs occurred in Latin America during the 1970s and early 1980s whenever rumours of a devaluation spread. Interestingly, when a spending run occurs, the central bank's ability to issue unlimited nominal liabilities (an alleged fool-proof barrier against financial crises) is counterproductive: additional nominal liabilities only aggravate the situation, as agents will have even more incentive to spend those nominal liabilities as soon as possible.

Note that a spending run is not about exchanging a CBDC for cash or deposits; these are just other nominal liabilities of the central bank, either directly (cash) or indirectly (deposits convertible into cash). A spending run is about getting rid of the CBDC and any other central bank nominal liability by transforming them into real goods or assets (rolls of toilet paper, a car, a house) before inflation erodes the rate of exchange between nominal liabilities and real goods.

Spending runs are not unique to CBDCs. We know since at least Obstfeld and Rogoff (1983) that self-fulfilling hyperinflation is inherent to government-issued monies. Fernández-Villaverde and Sanches (2019) show that the same problem plagues privately issued cryptocurrencies. But a CBDC puts the central bank on the spot because the speed of electronic transactions makes it possible to have a spending run nearly instantaneously.

A second main thread of our work is that, because of the existence of nearly instantaneous spending runs, central banks face what we call the *CBDC trilemma*. In general, one would like a central bank to deliver three goals. First, we want **financial stability** – that is, to avoid the spending runs we described above. Second, we want **efficiency** – that is, that the economy achieves the optimal risk-sharing between patient and impatient agents (or, equivalently, the optimal maturity transformation between short-run deposits and long-run investment projects). Third, we want **price stability** – that is, prices do not change too fast and disrupt allocations, for instance because most contracts are expressed in nominal terms.

FIGURE 1 THE CBDC TRILEMMA



Note: For the central bank, it is impossible to attain all three objectives at a time. When prioritising one objective, at least one other objective must be sacrificed.

In Schilling et al. (2020) we argued that, unfortunately, a central bank that operates a CBDC can only deliver two of these three goals. Figure 1 summarises the idea that, when prioritising one objective, at least one other objective must be sacrificed.

We formally prove our argument by building a nominal version of the classical model of Diamond and Dybvig (1983). We pick this model because it emphasises banks' role in maturity transformation: banks pool resources and finance long-term projects with demand deposits that can be withdrawn at a short time horizon to meet liquidity shocks by impatient agents. By offering risk-sharing, banks enable allocations that are not attainable under autarky. Yet, the optimal amount of risk-sharing requires banks to be prone to runs. While our results are cast in terms of our Diamond and Dybvig model, we conjecture that the CBDC trilemma appears in a large class of models of banking, as it captures essential trade-offs that reach beyond the details of a concrete model.

We depart from the original formulation of the Diamond and Dybvig model in a crucial aspect. While Diamond and Dybvig (1983) consider intermediation with private banks, a CBDC implies central bank intermediation. In fact, to make our model as stark as possible, we just assume that the central bank operates all real technology and provides all the economy's deposit functionality.¹ This difference is consequential because a central bank can control the price level. For example, a central bank can issue additional units of a CBDC to cover losses in its loan portfolio, implicitly diffusing the costs of the credit losses among all holders of the currency. To further simplify the analysis, we also assume that a central bank can influence (within some constraints) how many goods are offered

1 In an extension, we analyse how our results extend to the case where the central bank shares the deposit market with private banks. Our main results hold with some minor qualifications.

in the economy in the short run. This assumption is not too different from, for example, the standard assumption in New Keynesian models where central banks determined output in the short run by setting a nominal interest rate.

As the first part of the trilemma, we prove that the central bank can always implement the socially optimal allocation in dominant strategies while deterring runs by credibly threatening high inflation whenever nominal spending is excessive. This threat is implemented by limiting the supply of goods in the case of a run, thereby rendering early spending by patient agents (i.e. those who do not receive utility from consuming right now) suboptimal ex post. Since holders of a CBDC are rational, the central bank's inflation threat deters runs ex ante, such that high inflation only occurs off the equilibrium path. This result contrasts with the Diamond and Dybvig model, where banks do not have the option of changing the aggregate price level in response to a run. Hence, there, runs can occur as equilibrium phenomena, in which case the social optimum does not obtain.

On the second part of the trilemma, the threat of inflation may not be credible for modern central banks given their commitment to price stability, which is often reinforced in their governing charters or imposed by the political process. If we take the central bank's commitment to price stability seriously and we enforce it as the primary objective within the model, either the allocation is suboptimal or a spending run on the central bank currency can no longer be ruled out.

Our CBDC trilemma does not appear because central bankers are pursuing their private interests; in our environment, central bankers try their very best to deliver the goals we impose (financial stability, optimal risk sharing and price stability) but face inescapable trade-offs. Nonetheless, CBDCs might also complicate the political economy of central banking in ways that are not fully appreciated. The CBDC trilemma becomes much more significant under these political-economy pressures.

In Fernández-Villaverde et al. (2021), we sketch some of these concerns. We prove that a central bank can offer the socially optimal deposit contract through CBDCs, just as commercial banks do (an 'equivalence result'). But we also show that a central bank can exploit two fundamental aspects of public law in nearly all legal systems: the seniority of the debt to the central bank and the protection it enjoys against forced liquidation. The central bank can take advantage of these two features to offer contracts with a higher expected rate of return than that which commercial banks can offer and displace them from the market. This displacement occurs even when the central bank does not have any fiscal backing from the government. But this monopoly power can endanger the supply of the first-best amount of maturity transformation in the economy by allowing the central bank to deviate from offering the socially optimal deposit contract. In other words, the 'equivalence result' is fragile.

Can central banks resist this temptation? Political-economic reasons make us doubt it. In July 2020, the ECB approved its new monetary policy strategy.² A central aspect of the new strategy is an ambitious climate change action plan that answers growing political pressure across Europe. Indeed, if the central bank has market power, it can divert investment toward environmentally friendly technologies, for instance by diverting the profits generated by market power toward firms with lower CO₂ emissions through more advantageous financial contracts. Is this the best way to fight climate change?

The political-economic pressures are endless: diverting investment toward firms that lead in gender and racial equality, diverting investment toward firms to bridge the rural-urban divide, diverting investment toward poorer regions, diverting investment toward firms that offer a better balance of family and work life, diverting investment toward ‘strategic’ sectors of high added value, diverting investment toward ‘national champions’, and so forth. More worrisome, we are concerned with the ubiquity of less benign reasons, such as diverting investment to firms owned by the cronies of the political party in power.

We must realise, therefore, that CBDCs represent a risk to how central banks operate. By forcing central banks into policy issues beyond their core purview, CBDCs create mechanisms that might induce the political process to reconsider central bank independence. If a central bank is increasing financial inclusion (an explicitly stated goal of many defendants of CBDCs), many voters might ask why it should enjoy a higher level of independence while implementing this goal than, for example, a regular ministry of finance. Where are the time-inconsistency considerations that motivate granting independence to a central bank narrowly focused on conducting conventional monetary policy? While these might not be unsurmountable challenges to the introduction of CBDCs, they are, nonetheless, essential considerations to keep in mind.

Central banks will face, in a world with CBDCs, a whole new set of challenges. In our work, we have characterised what we think is the most important: the CBDC trilemma of financial stability, optimal risk sharing, and price stability. But the implications of this CBDC trilemma run deeper, to the core of central banking. We want to be sure of what we do before we open the door to CBDCs.

REFERENCES

Diamond, D W and P H Dybvig (1983), “Bank Runs, Deposit Insurance, and Liquidity”, *Journal of Political Economy* 91: 401–419.

Ellman, M (2014) *Socialist Planning*, 3rd edition, Cambridge University Press.

Fernández-Villaverde, J, and D Sanches (2019), “Can currency competition work?”, *Journal of Monetary Economics* 106: 1–15.

² <https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708-dc78cc4b0d.en.html>.

Fernández-Villaverde, J, D Sanches, L Schilling, and H Uhlig (2021), “Central bank digital currency: Central banking for all?”, *Review of Economic Dynamics* 41: 225–242.

Obstfeld, M, and K Rogoff (1983), “Speculative Hyperinflations in Maximizing Models: Can We Rule Them Out?”, *Journal of Political Economy* 91: 675–687.

Schilling, L, J Fernández-Villaverde and H Uhlig (2020). “Central Bank Digital Currency: When Price and Bank Stability Collide”, CEPR Discussion Paper 15555.

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CHAPTER 7

Can central bank digital currency transform digital payments?

Antonio Fatas

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An increasing number of central banks are exploring the possibility of creating their own version of digital money, typically referred to as central bank digital currency (CBDC).¹ By now there is a clear consensus on the potential benefits and costs of CBDC, even if there is an ongoing debate on their relative size (e.g. Bank of England 2020). Most of the initial discussions were focused on the potential risks of bank disintermediation, in particular in times of crises (Andolfatto 2021, Brunnermeier and Niepelt 2019, Niepelt 2020). While the debate on the significance of these costs might not be fully resolved, it has produced a set of viable proposals to limit this risk.²

In this chapter, I focus on the other side of the arguments – the benefits of CBDC. The list of potential benefits is quite diverse but can be grouped into two big themes:

- the need for a public form of money that ensures financial inclusion and is a key pillar of the monetary system; and
- the importance of offering an alternative that competes with newly created forms of private digital money.

I argue that achieving each of these goals might require very different instruments and that the creation of retail accounts at the central bank can only deliver a small subset of the claimed benefits. For the others, we need an overhaul of the way the payments rails work in a digital world, one that involves different tools that are, to a large extent, orthogonal to the creation of CBDC.

THE EASY PART

Central banks guarantee the value of the unit of account through their management of monetary policy and the provision of an asset – physical currency – that is the cornerstone of that trust (BIS 2021c). Private forms of money – bank deposits – coexist with physical

1 Recent surveys by the Bank for International Settlements suggest that more than 85% of central banks are actively engaging in the analysis and development of CBDC, up from around 65% three years earlier (Auer et al. 2021, Boar and Wehrli 2021).

2 Either by setting a cap on CBDC balances or by allowing for tiered interest rates to dissuade the general public from transferring large bank deposits to CBDC accounts (Bindseil 2020, BIS 2021b).

currency, but individuals always have an option to redeem those assets for cash. In addition, central banks provide finality in payments by settling claims between banks when individuals make use of private money for payments.

As payments become more digital and the role of physical currency decreases, central banks are concerned about their diminishing role and the potential impact on trust in the monetary system. The Riksbank, an early mover in this area, summarises it well: *“There is a risk of basic trust in the Swedish krona and the monetary system being undermined when it is no longer possible for the general public to change their banks deposits into state money”* (Söderberg 2019). Or in the words of the ECB (2020), CBDC is the *“natural transition from currency”*.

The creation of retail CBDC accounts will fully address this concern. It will create a digital alternative to physical currency that will maintain the role of central banks in ensuring the value of the unit of account.³ In addition, achieving this goal does not require that CBDC becomes widely used. Today, in many countries, individuals mostly rely on digital forms of payments, but the existence of cash and its availability still provides an anchor to the unit of account.

THE HARD PART

Central banks want more than just a replacement for cash. They also want an alternative to private forms of payments to ensure a competitive landscape, one that includes everyone, is efficient and adds resilience. To reach these objectives, CBDC would need to be widely used, accepted everywhere. And if resilience is indeed a required goal, it would need to run in parallel with private forms of payments.

To achieve this goal, central banks need a lot more than just creating accounts at the central bank. For digital money to become a successful means of payment, it needs to be used everywhere (peer-to-peer (P2P) transfers, accepted as payment by merchants). Here is where central banks find themselves in a difficult position. In principle, central banks could aim to create an efficient, ubiquitous parallel infrastructure for payments.⁴ But, for many good reasons, central banks do not want to do this. Recreating a parallel system of payments for the sake of resilience seems wasteful and central banks might lack the necessary capabilities to do so (ECB 2020). As central banks recognise these limitations, they are exploring hybrid solutions (Auer and Böhme 2020, BIS 2021d). A hybrid solution requires collaboration with private entities that serve as intermediaries, facilitate customer-facing tasks, provide the last mile of the payment system and compete with each other.

3 Of course, central bank money already exists in digital form as reserves of commercial banks at the central bank. But the fact that the public does not have direct access to it means that it cannot be seen as a digital replacement to currency.

4 Some have suggested that making CBDC legal tender would be a key step to ensure its adoption. But the notion of legal tender for digital payments is not a practical one and it is unlikely to be effective (Bossu et al. 2020).

But relying on the private infrastructure of payments will hinder the ability of CBDC to achieve all its goals. For example, central banks recognise that *“resilience benefits would need to be assessed against the costs”* required to provide it. The same can be said about inclusion: private payment providers might still lack the incentives to provide affordable services everywhere, so *“legislation requiring basic access could be proposed”* (BIS 2021d).⁵

More fundamentally, what about the goal of making CBDC a widely used efficient payment technology? Here is where things get more challenging. Digital payments are as much about the underlying assets as about the payment technology that facilitates the transaction (Fatas and Weder di Mauro 2018). A modest goal could be to facilitate P2P transactions within CBDC accounts, replicating what private platforms such as Venmo or WeChat do today. But this is not enough to satisfy many of the CBDC goals.

Making CBDC an everyday payment technology requires full integration and interoperability with all the networks of the current ecosystem of payments. This is highlighted in the recent report by BIS and seven major central banks that emphasises the importance of interoperability for CBDC success (BIS 2021d). But achieving this goal requires a substantial rewriting of the payment rules and a rethinking of what the future infrastructure should look like.

Today, interoperability between banks is guaranteed through the combination of a single settlement system run by the central bank (all ‘wallets’ are connected through a node) and a set of unique digital identifiers (bank accounts). But as we add additional electronic wallets or payment rails run by FinTech and BigTech firms, the payments ecosystem becomes very complex. Today, transfers or payments across networks are facilitated mostly by banks operating as intermediaries, with the help of credit card companies that often provide the infrastructure. In some jurisdictions, banks and credit card companies hold substantial market power that results in inefficiencies and high costs. FinTech and BigTech are challenging this power by attempting to lure individuals into their own ecosystem. But that comes at the cost of more complexity and limited interoperability. This is the environment in which CBDC will be launched. Reaching the goal of interoperability requires a broad rethinking of the rules, the roles of intermediaries, the potential market power of incumbents or the power that BigTech could build over time.

As an example of the difficult trade-offs, one could argue that CBDC and interoperability might, in some cases, increase the market power of BigTech firms. Today, in regions such as the US and Europe, BigTech has not gained much traction when it comes to digital payments because of the power that banks and credit card companies exercise over the network of payments. What would happen if payments could easily be done using any form of digital money? And what if CBDC became the pillar for private providers to deliver an

5 It is also unclear what is required to achieve inclusion in digital payments. BIS (2021a) cites as a factor the fact that in a country like France, 13% of adults do not own a mobile phone. How will CBDC change that?

efficient settlement or to design successful stablecoins around it?⁶ In that environment, interoperability and safety of the underlying assets would mean that individuals would be indifferent between different electronic wallets. The decision to use one or the other would entirely depend on the benefits that the payment technology offers. Some of these benefits are likely to be linked to other digital activities originating in the ecosystem where the payments take place. BigTech firms are likely to have the upper hand when it comes to this race. CBDC could not compete with them.⁷

CONCLUSION

For central banks concerned about the disappearance of currency and the need to have a public form of digital money, retail CBDC is the solution. Accounts at the central bank available for everyone will become the digital equivalent of currency.

But when it comes to the goal of ensuring a competitive, efficient and inclusive payment system, the issues are more complex and they have to do more with the regulatory and technology environment of payment systems. CBDC is in no way a substitute for the needed reforms to the architecture of payments. In fact, we have seen, without CBDC, great progress in some countries when it comes to the payment infrastructure.⁸ Fast payments, access of non-banks to the central bank settlement system, the use of digital IDs to improve interoperability or even the promise of seamless cross-border payments by connecting national payment systems are all examples of increased efficiency, inclusivity and competition in payments. On the positive side, the creation of CBDC could become a catalyst for all these changes even if the tools required to reform the payment system are, to a large extent, orthogonal to the creation of CBDC. The biggest risk is that the attention on and energy put into CBDC becomes a distraction for central banks and regulators, moving the focus away from the necessary regulatory and technology changes.

REFERENCES

- Andolfatto, D (2021), “Assessing the impact of central bank digital currency on private banks”, *The Economic Journal* 131(634): 525–540.
- Auer, R and R Böhme (2020), “CBDC architectures, the financial system, and the central bank of the future”, VoxEU.org, 29 October.
- Auer, R, G Cornelli and J Frost (2021), “Central bank digital currencies: Drivers, approaches, and technologies”, VoxEU.org, 28 October.

6 This is not just a hypothetical question. Diem (formerly Libra) in its white paper suggests that the creation of CBDC would facilitate the operation of its stablecoin (Diem Association 2020).

7 Safety of CBDC is unlikely to be a strong argument. Privacy is another one that is mentioned as a potential advantage (ECB 2021), but it is a complex issue as regulation might also impose strict privacy restrictions to private forms of digital payments.

8 India and Singapore just announced that in 2022 their fast payments systems will be linked through a set of unique account identifiers (www.mas.gov.sg/news/media-releases/2021/singapores-paynow-and-indias-upi-to-link-in-2022).

Bank of England (2020), “Central Bank Digital Currency: Opportunities, challenges and design”, Discussion Paper.

Bindseil, U (2020), “Tiered CBDC and the financial system”, ECB Working Paper Series.

BIS – Bank for International Settlements (2021a), *CBDCs: An opportunity for the monetary system*, Annual Report.

BIS (2021b), *Central bank digital currencies: financial stability implications*.

BIS (2021c), “Central bank digital currencies - executive summary”.

BIS (2021d), *Central bank digital currencies: System design and interoperability*.

Boar, C and A Wehrli (2021), “Ready, steady, go?-Results of the third BIS survey on central bank digital currency”, BIS Papers 114.

Bossu, W, M Itatani, C Margulis, A D P Rossi, H Weenink and A Yoshinaga (2020), “Legal aspects of central bank digital currency: Central bank and monetary law considerations”, IMF Working Paper.

Brunnermeier, M K and D Niepelt (2019), “On the equivalence of private and public money”, NBER Working Paper 25877.

Diem Association (2020), “White Paper 2.0”.

ECB – European Central Bank (2020), *Report on a digital euro*.

ECB (2021), *Eurosystem report on the public consultation on a digital euro*.

Fatas, A and B Weder di Mauro (2018), “Making (some) sense of cryptocurrencies: When payments systems redefine money”, VoxEU.org, 7 May.

Niepelt, D (2020), “Digital money and central bank digital currency: An executive summary for policymakers”, VoxEU.org, 3 February.

Söderberg, G (2019), “The e-krona – now and for the future”, Sveriges Riksbank Economic Commentaries No 8, October.

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CHAPTER 8

Central bank digital currency: Is it really worth the risk?

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As we write in October 2021, central banks around the world are considering whether to issue retail digital currencies for individual use. According to the Atlantic Council's tracker,¹ five small Caribbean nations have taken the plunge, 14 much larger countries are running pilots (including China and Sweden), and dozens of others are studying the possibility.

At one level this seems odd. For residents of advanced economies, the transition from physical to digital payments instruments is essentially complete. Virtually all their financial transactions use privately run payments networks to transfer the digital liabilities of private commercial banks (see Figure 1). For example, in the United Kingdom, where the total quantity of M₃ is 148% of GDP, demand and time deposits – digital entries on the ledgers of banks – account for 97% of the total (or 144% of GDP). For the euro area, 91% of M₃ is digital. And, in China, where broad money exceeds 200% of GDP, 96% of it is digital.

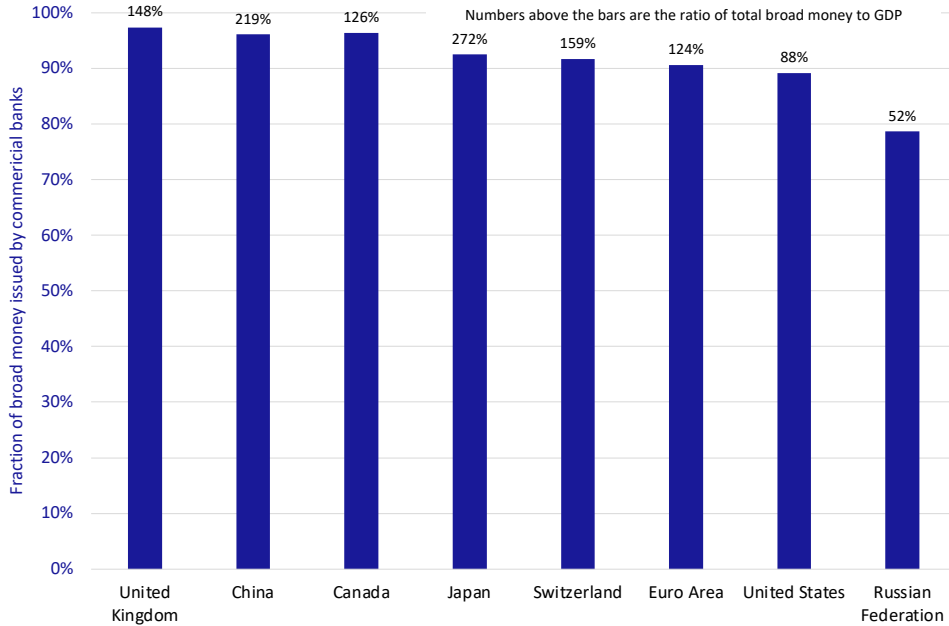
So, as we look at the evolution of the financial system, we are led to ask the following question: *Why would a central bank want to issue retail digital currency? Do the benefits outweigh the costs?*

Before we get to that, we need to define what we mean by central bank digital currency (CBDC). Our view is that it is a universally accessible system in which individuals can hold unlimited amounts of interest-bearing central bank liabilities. To ensure that it is not facilitating criminal activity, the system will be account-based in which holders are identifiable to the government.² Assuring that private bank liabilities used for transactions are convertible into central bank money under virtually all conditions requires an elastic supply of CBDC. And, since wholesale central bank liabilities (financial intermediaries' deposits) are already remunerated, it would be politically difficult to avoid paying interest on retail CBDC.

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

2 We agree with Carstens (2021) that the important of identity verification strongly suggests that CBDC must be account-based rather than token based. Furthermore, we do not distinguish between accounts that are held directly at the central bank and those held by agents who aggregate accounts into what is in essence a narrow bank. See the discussion in Auer and Boehme (2021).

FIGURE 1 FRACTION OF BROAD MONEY ISSUED BY COMMERCIAL BANKS AND THE RATIO OF BROAD MONEY TO GDP, 2020 (PERCENT, YEAR-END)



Sources: Bank of England (M3), People's Bank of China (Money + Quasi Money), Bank of Canada (M3), Bank of Japan (M3), Swiss National Bank (M3), Eurostat (M3), Bank of Russia (M2), Federal Reserve (M2), and FRED.

POTENTIAL BENEFITS OF CBDC

Many of the costs and benefits arise from a combination of externalities, market power and public goods that cause market failures. For example, network externalities lead the private payment system to be highly concentrated, allowing customer exploitation. Similarly, a currency with a stable value is a public good that is difficult for private agents to provide in all states of the world.³

From this perspective, the list of potential benefits is relatively long. Here we briefly describe eight key benefits:

- **Reduce costs of and improves access to domestic and cross-border payments.** In many parts of the world, even the United States, domestic payments remain expensive. For cross-border remittance, the costs are even higher. Allowing individuals to clear payments directly over central bank balance sheets, either within their own country or through an inter-operable multi-country system, could reduce costs and improve access.

³ See the discussion in Cecchetti and Schoenholtz (2021).

- **Broaden access to the financial system more generally.** According to the World Bank's Findex survey, in 2017, roughly half of the four billion adults (16+) in low- and lower-middle-income countries did not have an account at a financial institution. Even in the United States, the FDIC estimates that in 2017 one-fourth of households were 'unbanked' or 'underbanked'. By offering no-frills, low-cost accounts at the central bank, it should be possible to reduce the size of the unbanked and underbanked population.
- **Facilitate the distribution of government benefits.** In the midst of natural disasters, governments can find it difficult to transfer resources to those in need. Distributing benefits during the pandemic was a particular challenge. If households and businesses were to have accounts at the central bank (either directly or through an authorized agent), such transfers would be faster and more reliable.⁴
- **Relax the zero lower bound constraint on the policy interest rate.** Absent paper currency alternatives with a zero nominal interest rate, the central bank could set deeply negative nominal interest rates. Furthermore, commercial banks would be able to follow suit (Bordo and Levin 2017).⁵
- **Substitute for undesirable cryptocurrencies and risky stablecoins.** Today, there are thousands of private token-based currencies – commonly known as *cryptocurrencies*.⁶ There also are dozens of unregulated stablecoins backed by various combinations of assets. The value of these is now large and rising, with many having market capitalisation above \$1 million.⁷ Authorities fear that fluctuations in the value of these instruments could be sources of broader financial instability. CBDC could displace these, helping to promote financial resilience.
- **Help counter tax evasion and criminal uses of currency.** Identification of the holders of account-based CBDC would improve tracking of financial transactions both domestically and internationally. This could enhance authorities' ability to ensure tax compliance as well as prevent money laundering and terrorist finance.
- **Prepare for competition from other official suppliers of CBDC.** For all but the largest jurisdictions, issuance of CBDC could help limit the further substitution from domestic currency into currencies such as the US dollar, the euro or the renminbi. By issuing their own attractive and convenient digital currency, smaller countries could guard against the potential loss of monetary sovereignty.

4 Included in this category are direct money-financed fiscal expansions in which central bank money is transferred directly to individuals—what is known as “helicopter money.” See Prasad (2021) and Cecchetti and Schoenholtz (2016).

5 Note that, in the absence of paper currency, the chief alternative to using a negative-interest rate currency for transactions is barter, a deeply inefficient technology, or using a foreign currency that introduces exchange rate risk.

6 See Carstens (2021) for a description of the difference between token- and account-based digital currencies.

7 <https://coinmarketcap.com/> (accessed on 13 October 2021). Total market capitalisation of cryptocurrencies now exceeds \$2 trillion and that of stablecoins is well over \$100 billion.

- **Reduce the cost of deposit insurance.** To the extent that CBDC displaces insured deposits in private banks, it could reduce the need for government-supplied deposit insurance.

POSSIBLE COSTS OF CBDC

Balancing these potential benefits are five costs:

- **Disintermediation of depositories and the risk of creating a massive state bank.** While inertia (combined with interest rate increases and service improvements) might keep funds in the banking system for some time, financial strains eventually would prompt uninsured (and possibly insured) deposits to flee private banks for the central bank.⁸ As funds shift, sources of private credit will dry up, driving the central bank to become a commercial lender. Over time, this state bank will be tempted to substitute for the discipline of private lenders and markets, inviting political interference in the allocation of capital and slowing economic growth.⁹
- **Currency substitution from less trustworthy jurisdictions.** Highly trusted central banks that operate in relatively stable political and financial jurisdictions likely will receive inflows from abroad. Given the current high foreign demand for US paper currency, imagine what would happen if the Fed offered universal, unlimited accounts.¹⁰ The consequences could be catastrophic for the financial and monetary systems of emerging market and developing economies.
- **Loss of privacy.** The flipside of improved tax compliance is a loss of privacy. CBDC is traceable, allowing governments to monitor virtually all individual transactions. In democratic societies, it will be essential to have credible safeguards to ensure that this information is not used by malevolent official sector actors.
- **Compliance with know your customer (KYC) and anti-money laundering (AML) rules.** Someone will have to ensure that the users of CBDC are law abiding. Such KYC and AML monitoring is costly. As regulated guardians of the private payment networks, commercial banks currently perform these tasks. In a CBDC regime, who will supply these costly services? One approach is to create ‘intermediated CBDC’, in which regulated brokers (or banks) charge a fee to provide individual account services, guard privacy, monitor compliance and aggregate balances into accounts at the central bank.

8 We would also expect to see investors flee nonbank intermediaries that offer uninsured liquid liabilities, such as money market funds and some open-end mutual funds, putting the proceeds into their CBDC account.

9 The central bank could recycle funds to the private sector through enhanced lending operations. But since central banks only lend on a collateralised basis, the haircut and margin structure of their collateral frameworks will provide powerful tools for indirect intervention in credit allocation.

10 Judson (2017) estimated that roughly 60 percent of what was then \$1.5 trillion of U.S. currency was held abroad.

- **Diminish payments competition and discourage entry of efficient private providers.** By supplanting private liabilities, CBDC will reduce the competition in payments and issuance of other private liabilities that generally serve as money. The result could be a lack of innovation and an increase in costs to individuals.

KEY QUESTIONS TO RESOLVE BEFORE ISSUING CBDC

Before issuing CBDC, a central bank should carefully weigh these costs and benefits. Critically, policymakers need to ask if there are other, less costly ways to achieve the benefits. We see the following questions:

- **Are there ways to improve the payment system?** We already see public and private sectors moving to provide cheaper, faster, more reliable, and more accessible systems that operate both within and across borders.¹¹
- **Are there ways to improve access?** Here, we find the case of India is instructive. Started in 2014, the Pradhan Mantri Jan Dhan Yojana (PMJDY) provides no-frills bank accounts without charge, using the country's universal biometric personal identification to lower compliance costs. The lesson we take away is that improving access requires government involvement and subsidies.¹²
- **How can we improve the efficient distribution of government benefits?** Governments already have information on their citizens' financial accounts both for tax purposes and for the payment of benefits. Why can't they use it?
- **Are there other means to enhance the effectiveness of monetary policy at the zero lower bound?** Over the past decade, central bankers devised a broad array of policy tools to allow them to ease policy further when the nominal interest rate hits zero. Would there be sufficient public support for deeply negative interest rates on widely held central bank and private bank liabilities to make the tool usable? Are there additional tools to employ? If not, should fiscal expansion be preferred to deeply negative interest rates?
- **How can we make cryptocurrencies and stablecoins safe?** This is a key question regardless of whether central banks issue digital currency. As these become potential sources of financial instability, governments will have to act. Strategies include outright bans, registration requirements, standardised disclosures, and regulation of exchanges and broker-dealers, to name just a few.

11 To take just one example, the euro area has the TIPS system, with a processing time of 10 seconds at a cost of €0.002 per transaction. Over the next few years, the ECB will extend this to other currencies.

12 See Cecchetti and Schoenholtz (2017) for more detail on the Indian programme.

- **What is the best way to counter tax evasion and criminal use of money?**
Account-based CBDC will surely make it more difficult for criminals to transact and for people to evade taxes. Absent CBDC, are there efficient ways to identify and prevent these actions under the evolving payments framework?

In every one of these cases, we see alternatives that limit disintermediation, currency substitution and the intrusion of governments into privacy of individuals, while preserving incentives for welfare-enhancing financial innovation. So, if central banks eventually move to issue digital currency, they will need to state their objectives clearly and explain why CBDC is the lowest-cost and least-risky means of achieving those goals. Ultimately, their decisions will shape the financial system of the future.

REFERENCES

Auer, R and R Boehme (2021), “Central bank digital currency: the quest for minimally invasive technology,” BIS Working Paper No 948.

Bordo, M D and A T Levin (2017), “Central Bank Digital Currency and the Future of Monetary Policy,” NBER Working Paper No. 23711.

Carstens, A (2021), “Digital currencies and the future of the monetary system,” speech at the Hoover Institution policy seminar, 27 January.

Cecchetti, S G and K L Schoenholtz (2016), “A Primer on Helicopter Money,” www.moneyandbanking.com, 27 June.

Cecchetti, S G and K L Schoenholtz (2017), “Banking the Unbanked: The Indian Revolution,” www.moneyandbanking.com, 6 November.

Cecchetti, S G and K L Schoenholtz (2021), “Central Bank Digital Currency: The Battle for the Soul of the Financial System,” www.moneyandbanking.com, 21 June.

Judson, R (2017), “The Death of Cash? Not So Fast: Demand for U.S. Currency at Home and Abroad, 1990-2016,” International Cash Conference 2017 – War on Cash: Is there a Future for Cash?, Deutsche Bundesbank.

Prasad, E (2021), *The Future of Money: How the Digital Revolution is Transforming Currencies and Finance*, The Belknap Press of Harvard University Press.

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CHAPTER 9

Central bank digital currency, FinTech and private money creation

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Currently, central banks issue physical money in the form of cash that anyone can hold and digital money in the form of reserves that only commercial banks can hold. Retail digital money creation has been left to the financial sector, which bundles it with the provision of other financial services. Prominent examples are the bundling of digital money with lending in the commercial banking sector and the bundling of digital money creation with smart contracting in the nascent FinTech industry.

A number of policy proposals aim to end the dichotomy between access to physical and digital public money. One example is the introduction of a central bank digital currency (CBDC), which is a digital token supported by a ledger maintained by the central bank. An alternative would be to allow non-banks to have accounts with the central bank and provide transaction services without a banking license.

Making public money widely accessible will trigger a restructuring of the financial sector. Competition from CBDC will undermine the commercial banking sector's deposit franchise and potentially limit the development and flexibility of FinTech innovation. This will likely lead to the unbundling of digital money creation from other financial services. In this chapter, we attempt to understand whether this unbundling is socially desirable.

UNBUNDLING MONEY FROM LENDING

Commercial banks are in the business of lending to firms and households as well as in the business of creating deposits, i.e. (inside) money. The lending activity is reflected on banks' asset side of the balance sheet, while deposit taking is on their liability side.

A priori, it is not obvious why both activities should be bundled together and offered by the same institution. One could easily envision an arrangement in which banks specialise. Some banks specialise in the lending activity, funding themselves on funding markets, while other banks focus on deposit/money creation. The latter are often referred to as 'narrow banks'; they issue deposits and park the receipts in a central bank account or hold government bonds.

In a world where banks specialise, the introduction of CBDC (or accounts at the central bank) creates new direct competition for ‘narrow’ banks, but it does not directly affect lending activity. By contrast, in a world in which commercial banks combine lending and digital money creation, the broadening access to public digital money can alter lending as well. To evaluate the implications of such policy measures, it is important to understand the underlying rationale for the bundling.

SYNERGIES AS A RATIONALE FOR BUNDLING

Explicit synergies between lending and deposit creation are a powerful argument for bundling of both activities. Kashyap et al. (2002) argue that economies of scale in liquidity management create synergies between lending and deposit creation. They observe that banks face unpredictable outflows of funds when depositors withdraw their deposits and when borrowers draw down on their credit lines. To manage possible outflows, commercial banks hold liquid assets, but this is costly because liquid assets have a low yield. If deposit demand shocks and credit line demand shocks are not perfectly positively correlated, then a bank providing both deposits and credit lines can manage liquidity more cheaply than other financial intermediaries.

Central banks have a superior technology for providing a medium of exchange because they do not need to hold liquid assets; they can simply print the money. Hence, in principle they could crowd out commercial banks from the deposit business. As pointed out by Piazzesi and Schneider (2020), unless the central bank also provides credit lines, this will make credit line provisioning more expensive because the commercial banking sector can no longer take advantage of the synergy between deposits and credit lines.

The main policy conclusion of the synergy rationale is not necessarily to rule out CBDC but to condition how CBDC should be designed. By paying a lower interest rate or capping holdings, the central bank should be able to balance the benefit of cheaper money creation with the cost of higher credit line creation and improve welfare.

FRANCHISE VALUE AS A RATIONALE FOR BUNDLING

A second rationale for bundling lending and deposit taking within the banking sector is to give banks market power in providing transaction services and so extract charter rents from setting deposit interest rates below the policy rate. Although it may seem counterintuitive to view bank rent extraction as desirable, the literature has suggested several potential benefits to giving banks a positive franchise value.

1. **Limiting excessive risk taking.** Banking activities are difficult to monitor and bank managers have limited liability for their losses. This has frequently led to excessive risk taking. One way to discourage risk taking is to promise banks future rents through their deposit franchise so that banks are more concerned about bankruptcy.
2. **Creating an incentive to stay within a regulatory perimeter.** Banks within the regulatory perimeter are heavily constrained and so have a permanent desire to shift their activity to the less regulated shadow banking universe. Granting private banks rents for being in the regulated sector counteracts this urge. Put differently, the ‘carrot’ of being able to create deposit money is given to ensure that banks are willing to subject themselves to the ‘stick’ in the form of supervision and regulation (e.g. Gorton 2010).
3. **Overcoming financing frictions.** Banks might have superior investment opportunities, but other frictions limit their ability to take advantage of these opportunities without sufficient net worth. These superior opportunities might arise because banks have better risk management and diversification technologies (as in Brunnermeier and Sannikov 2018) or outright better lending opportunities (as in Keister and Sanches 2021). Granting a deposit franchise increases bank net worth and allows them to take advantage of the opportunities.
4. **‘Moral suasion’.** Governments often force commercial banks to fund projects with various political objectives (e.g. promoting home ownership) or simply to hold government bonds to limit government’s funding costs. These rents are an indirect compensation for funding these government objectives through the backdoor (e.g. Calomiris and Haber 2014).

The rationales for banks franchise value leave one fundamental question unanswered. Why should the rents, and hence the franchise value, be granted through deposit monopoly rents? It is not obvious that the subsidy should be derived from bundling with market power in deposit taking. Designing the subsidy through money creation is especially suboptimal from a cyclical perspective. Subsidy should be higher in crisis times and possibly negative in boom phases, when the above arguments bite less. However, exactly the opposite occurs when subsidy is granted through deposit-taking market power, measured as the difference between the policy rate and deposit interest rate. It is low in a low interest rate environment and high in boom phases when interest rates are high.

DISCIPLINING BANK RUN RATIONALE

Calomiris and Kahn (1991) and Diamond and Rajan (2001) argue that bundling of lending and deposit taking might help discipline bank risk taking even if the banks are not earning rents in the deposit market. Giving depositors the option to withdraw financing

and forcing liquidation disincentivises bank managers from engaging in malfeasance. If the introduction of CBDC leads banks to finance using non-demandable long-term liabilities, then investors lose this disciplinary power.

This theory is not uncontroversial. It is not clear why money-like claims are needed rather than short-term debt which comes with rollover risk. More importantly, it is not clear that a sufficient proportion of depositors have the information and skills to exert the disciplining role by threatening to run. Bank supervisors of central banks have much more detailed information about bank activities than a retail deposit holder. Most importantly, the prevalence of deposit insurance across many countries mutes the channel.

POLICY IMPLICATIONS FOR CBDC DESIGN

Of course, CBDC and FinTech access to the central bank's balance sheet can be designed to make it more or less competitive to commercial banks. For example, CBDC would be an inferior substitute for banking services if interest paid on CBDC is low or the amount that can be held in CBDC is capped. Likewise, one can vary the attractiveness of digital wallet providers to have access to the central bank balance sheet. This can affect the competition for transaction service provision.

To answer these questions, one has to have a clear understanding of the various rationales for bundling financial services and for granting special rents to commercial banks.

UNBUNDLING MONEY FROM FINTECH: CBDC AS LEGAL TENDER

So far, we have discussed bundling between money creation and lending. However, the emerging FinTech industry is bundling token creation possibly in two ways: with a retail platform and with open source contracting ('smart contracting') through a blockchain ledger.¹

1. **Bundling a token platform with a retail platform: Lock-in due to exchange rate fee.** Retail platforms have an incentive to bundle the token with retail services since tokens can create lock-in effects, which grant the retail platform market power over their customers. One way to lock-in customers to a private token platform is to restrict interoperability between currencies by charging an exchange rate fee for swapping private tokens into another currency. This creates a 'virtuous cycle' for the incumbent token platform where buyers want to purchase using the tokens they received from their earlier sales on the platform, and new sellers want to accept tokens because they know they will have high future purchasing power.

1 This section is based on the formal analysis in Brunnermeier and Payne (2021).

Locking in customers discourages entry by a new token platform since it would have to compensate the buyers and the sellers for switching to a new token. This gives the incumbent platform market power over its customers. If the payment platform is bundled with a retail platform, then it can use this market power to chart mark-ups for physical goods transactions.

- 2. Bundling a payment token platform with a smart contracting.** Connecting tokens with smart contracting is a different form of bundling. Allowing FinTechs to control their own currency ledger and write smart contracts brings benefits. Consider an individual who wants to borrow against her future sales revenue. She may face the classic problem of limited commitment. If, in addition, the potential lender faces a limited enforceability problem, only a fraction of the borrower's revenue is collateralisable and hence borrowing is limited. A digital platform can extend the loan and write an enforceable 'smart' forward contract. The borrower advertises her product or service on the matching platform and whenever she sells it, the tokens she receives are automatically transferred to the lender. This is possible since the lending platform observes and controls the token ledger. Having control over the token ledger allows the platform to lend to the borrower in the first place.

POLICY DESIGNS

The two different types of bundling lead to different forms of currency non-interoperability that have opposite welfare effects. Bundling the token and retail platforms leads to platforms restricting interoperability through exchange rate fees in order to create market power and charge markups on the retail platform. This type of 'exchange non-interoperability' is typically socially undesirable unless competition across platforms is so fierce that it stifles innovation in payment systems. Bundling the smart contracts with a token platform restricts which currencies can be accepted as payment. This type of 'non-interoperability of use' is typically socially desirable because it helps increase the collateralisation of future sale revenue across a retail sales network.

Optimal policy needs to understand what kind of interoperability it incentivises. We consider two policies: outlawing exchange rate fees, and introducing CBDC as legal tender.

- 1. Outlawing exchange rate fees.** Enforcing interoperability by outlawing the exchange rate fees would restore competition across tokens and eliminate the lock-in effect. The incumbent platform constantly faces the threat of being replaced by an entrant payment platform. Without exit fees on the payment platforms, the bundled retail platform cannot benefit from the token lock-in effect.

2. **CBDC as legal tender.** Another way to enforce interoperability across various tokens and public money is to make CBDC a legal tender. Any seller on any platform would have to accept CBDC as well. However, such a legal requirement would remove both the connection to the retail platform as well as the link to the smart contract between payment platforms and borrowers. To see why the CBDC as legal tender destroys the smart contract benefits, note that the borrower can now sell her product for CBDC instead without the token platform noticing. Consequently, the smart lending/forward contract can no longer be implemented.

IMPLICATIONS FOR MARKET STRUCTURE

Introducing CBDC as legal tender handicaps a (matching) platform market structure and favours an intermediary arrangement. As discussed, legal tender CBDC undermines the ability of matching platforms (B2B or C2C, such as eBay) to offer enforceable smart contracts. In contrast, market structures in which market makers act as intermediaries (like Amazon) can still offer enforceable lending contracts. In an intermediary market structure, the borrower sells her product not directly to the buyer but to the intermediary, who sells it to the ultimate buyer. This means an intermediary can enforce repayment, even when the ultimate buyer pays with CBDC.

UNBUNDLING BEYOND CBDC

In this chapter, we have focused on unbundling digital money creation and lending involving CBDC. There are arguably other important changes besides the introduction of CBDC that are at least as important. Allowing non-banks, such as BigTech firms, to enter the market will lead to innovations to a system that lacks dynamism compared to other sectors in the economy. Also, other developments can foster competition among existing banks as they reduce consumers' switching costs. 'Open banking' that will allow customers to transfer their data across banks is one prominent example. These developments could end up having a larger impact on competitiveness than the unbundling due to the introduction of CBDC.

REFERENCES

Brunnermeier, M and J Payne (2021), "Platform, Tokens, and Interoperability", working paper.

Brunnermeier, M and Y Sannikov (2016), "The I Theory of Money", NBER Working Paper 22533.

Calomiris, C and S Haber (2014), *Fragile by Design: The Political Origins of Banking Crises & Scarce Credit*, Princeton University Press.

Calomiris, C and C Kahn (1991), “The Role of Demandable Debt in Structuring Optimal Banking Arrangements”, *The American Review* 81(3): 497–513.

Diamond, D and R Rajan (2001), “Liquidity Risk, Liquidity Creation, and Financial Fragility: A Theory of Banking”, *Journal of Political Economy* 109(2): 287–327

Gorton, G (2010), *Slapped by the Invisible Hand: The Panic of 2007*, Oxford University Press.

Kashyap, A, R Rajan, and J Stein (2002), “Banks as Liquidity Providers: An Explanation for the Co-Existence of Lending and Deposit-Taking”, *Journal of Finance* 57(1): 33–73.

Keister, T and D Sanches (2021), “Should Central Banks Issue Digital Currency?”, Working Paper 19-26, Federal Reserve Bank of Philadelphia.

Piazzesi, M and M Schneider (2020), “Credit Lines, bank deposits or CBDC? Competition and efficiency in modern payment systems”, Working Paper.

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CHAPTER 10

How will digital money impact the international monetary system?

Tobias Adrian and Tommaso Mancini-Griffoli

International Monetary Fund

How will digital technologies transform the international monetary system? A profound transformation is already under way. From private sector-led innovations like cryptoassets and stablecoins to public-sector-designed programmes like the Bahamas' issuance of the Sand Dollar and China's experiment with a 'digital yuan', digitalisation is changing our understanding of what 'money' is and how it operates.

This chapter is focused primarily on central bank digital currencies (CBDCs), which are now being explored by over 70% of the IMF's 190 member countries. Approaches differ according to each country's particular circumstances, with most still cautiously analysing the policy motive for issuance and a few actively prototyping various options in safe 'sandbox' environments or launching live pilot programmes. Central bankers everywhere are closely following the experience in the Bahamas, trying to discern the lessons from the actual issuance of the Sand Dollar.

We can already see that there are many potential benefits from CBDC – along with several likely risks. Let's take a look at the top three benefits and the top three risks, and then consider how those risks can be reduced.

Let's start with the benefits.

- First, CBDC has the potential to make payment systems more cost-effective, competitive and resilient.
 - Due to its digital nature, CBDC could reduce the cost of managing physical cash – which can be substantial, especially in countries with a vast land mass or many islands that are widely dispersed.
 - By offering a low-cost alternative, CBDC can help discipline payment markets, which are often highly concentrated.
 - CBDC could also improve the resilience of payment systems, through the establishment of an alternate decentralised platform.

- Second, in countries that have large numbers of people who are ‘unbanked’, CBDC could help enhance financial inclusion, especially if it is paired with a digital identification system. Access to payments is often the first step towards greater participation in the financial system. Not only do the unbanked gain a safe place for their savings, but the digital availability of micro-payment data offers a way to gain access to credit and other financial services.
- Third, CBDC can be leveraged to improve cross-border payments, which are currently often slow, costly, opaque and not easily accessible. Cross-border payments largely rely on multi-layered correspondent banking relationships, which create long payment chains.

CBDCs could instead be traded more directly to the extent that they share common technical standards, and data and compliance requirements. They could thus benefit from a common platform to allow for cross-border trading between intermediaries or end-users directly.

The IMF is collaborating with the Bank for International Settlements (BIS), the Committee on Payments and Market Infrastructures, and the Financial Stability Board to establish relevant guidelines.

Now, let’s turn to the risks.

The first risk is potential banking sector disintermediation. Deposits could be withdrawn, perhaps abruptly, from commercial banks if people decide to hold CBDC in significant volume. Banks would then have to raise interest rates on deposits to retain customers, or they would have to offer better payment services. Banks could experience a compression of margins, or they could have to charge higher interest rates on loans. The result could be a contraction in credit to the economy.

Second is the potential reputational risk for central banks. Offering CBDC requires central banks to be active in, or at least oversee, several steps of the payments value chain (including interfacing with customers, building front-end wallets, picking and maintaining technology, monitoring transactions, and being responsible for anti-money-laundering processes). The failure to satisfy any of these functions – whether due to technological glitches, cyber-attacks, or simply human error – could undermine public faith in the central bank’s operations.

Third are the macro-financial risks that can occur with the cross-border use of CBDC. As costs to hold, and transact in, foreign currency decrease, countries with weak institutions, high inflation and volatile exchange rates could see an increase in currency substitution.

In most cases, the risks from CBDC can be restrained through appropriate design. For instance:

- CBDC holdings could offer a lower rate of interest than the policy rate – if they provide any interest at all. Alternatively, holdings could be taxed or capped, with surplus funds swept into bank accounts every night.
- Similarly, transaction limits could be imposed, helping reduce the risk of the disintermediation of banks.
- CBDC could also be distributed through existing financial institutions, using the customer onboarding processes that are already in place.
- In addition, countries whose central banks issue CBDC could restrain ‘currency substitution’ by limiting the holdings by non-citizens.

Looking beyond CBDC specifically, questions naturally arise about how cryptoassets and stablecoins are changing the global financial system. The IMF, along with the BIS and other research centres, is studying that matter closely, trying to foresee how the optimal monetary system of the future would operate.

Let’s first examine some ways that cryptoassets and stablecoins are unlike CBDC.

Cryptoassets are digital representations of value, are privately issued (rather than issued by sovereign entities), are secured by cryptography, and leverage decentralized ledger technology (DLT) which allows for peer-to-peer transactions without necessarily going through an intermediary. Cryptoassets, like bitcoin, are not backed by official government assets. Moreover, as we have seen in recent months, cryptoassets have very volatile prices.

Stablecoins share many of the features of cryptoassets, but are typically issued by a legal entity. They attempt to offer price stability by linking their value to a fixed asset – such as a fiat currency like the US dollar or commodities like gold.

The share of cryptoassets and stablecoins in relation to the money supply (so-called M₁) is currently small. Thus, their impact on the monetary and financial system is – at this point – limited.

However, the adoption and use of cryptoassets and stablecoins could increase rapidly. Cryptoassets, for one, are increasingly becoming an attractive investment asset, including for institutional investors. Meanwhile, stablecoins have the potential to become global if issued by BigTech firms with large existing user bases that span countries.

If wide adoption does indeed occur, cryptoassets and stablecoins could have significant implications for the international monetary system. That could introduce a wide range of serious concerns:

- Widespread ‘currency substitution’ would undermine governments’ control of monetary policy and would have an impact on domestic financial conditions.
- Capital flow management measures (CFMs), which are used by the majority of IMF member countries, could be more easily circumvented. Independent exchange rate regimes could be harder to maintain.
- Capital-flow volatility could increase, as could gross foreign asset positions. Such factors could trigger balance-of-payments problems.
- Global stablecoins in their own denomination raise significant new risks, including the lack of available safe assets and a credible safety net.
- The risk of fragmentation into regions, each with their own payment systems, is stark, as is the risk of a global ‘digital divide’ between countries depending on their access to new payment technologies and their capacity to leverage and regulate them.

Amid the uncertainties introduced by cryptoassets and stablecoins, let’s recall a few basic principles useful for policymaking.

The international monetary system must continue to rely on rules and conventions covering, for instance, monetary and exchange rate arrangements, cross-border payments for capital account transactions, and capital flows and related management measures. The system must continue to rely on mechanisms allowing for effective and timely balance-of-payments adjustments and a global safety net (including access to financing from the IMF). And the system must continue to rely on robust institutions that ensure that rules and mechanisms will be enforced.

Moreover, there is an unshakeable commitment that the international monetary system must remain stable and efficient. Digital money must be regulated, designed and provided such that countries maintain control over monetary policy, financial conditions, capital account openness and foreign exchange regimes. Payment systems must grow increasingly integrated – not fragmented – and must work for all countries, to avoid a ‘digital divide’. Moreover, reserve-currency configurations and backstops must evolve smoothly.

That brings us to the question of how authorities should approach cryptocurrencies and stablecoins – inevitably, with the stakes so high for international financial stability, with determination and clarity, and a strong dose of scepticism.

Some might be tempted to ask: “What would central banks need to do to develop a global monetary system based on CBDC?” But posing the question that way might be getting the reasoning backwards. Instead, CBDC should be designed such that it helps support a stable and efficient international monetary system.

As they consider the rewards and risks of CBDC, central banks are surely keeping some fundamental factors in mind.

- They should leverage CBDC to improve connections between countries' payment systems, while avoiding fragmentation in cross-border payments.
- The cross-border use of CBDC can potentially solve many of the current 'pain points' of cross-border payments.
- Under some conditions, CBDC can also foster financial inclusion – helping bring cross-border payments to the unbanked, and helping reduce the cost of sending remittances.
- The impact of CBDC could be direct, but it could also be indirect. The presence of cross-border CBDC will induce other payment providers to improve services and lower costs.

Cooperation among central banks will be pivotal in building CBDC with features that help contain spillovers and help facilitate backstops. For example:

- To curb currency substitution, countries that decide to issue CBDC could explore the option of limiting CBDC transactions and holdings for foreigners. Or they could allow foreign countries to introduce such limits on their own territory.
- CFMs, which might involve restrictions on certain cross-border transactions, could be built directly into the CBDC specification.
- The programmability of CBDC could also be used, in a positive way, to facilitate the regional pooling and sharing of reserves, and their disbursement.

As for 'private digital cash substitutes', we do not think that developing alluring CBDC to 'crowd out' those substitutes is the answer. Instead, privately issued digital money will need to be regulated appropriately.

Let us remember that most of the money that we use today is issued by the private sector – in the form of commercial bank deposits. This form of money has been innovative, and it continues to serve users well. Moreover, it is safe because issuers are very closely supervised, they benefit from government backstops and they are required to adhere to clear legal and regulatory frameworks.

Those same factors must also hold firm for private issuers of digital money. Clear legal frameworks must be developed to determine whether they are, for example, deposits, securities or commodities. Clear regulations must be enacted so these forms of money fully address risks to financial stability, financial integrity, consumer protection and market contestability.

Once those rules are clearly written, some providers will surely drop out of the market – but others will remain, and they will exist side-by-side with CBDC. We should not see the future as an ‘either-or decision’ – between either CBDC or privately issued forms of money. The two will probably coexist, wherever CBDC eventually exists.

Consider, in addition, that private solutions can build functionality on top of CBDC, and potentially can even receive CBDC in exchange for a private payment token. The future is likely to see a continuum that includes various forms of money – just as we see today within the confines of a clear legal and regulatory perimeter.

We are at an exciting moment in the evolution of currencies – and indeed, in the evolution of our very concept of what ‘money’ is and what benefits ‘money’ should deliver. If we design digital currencies with caution and with precision – and if we frame their adoption within legal and regulatory systems that maximise their benefits and minimise their risks – we could be on the verge of an era that fulfils the promise of transformation.

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CHAPTER 11

Stablecoins as alternatives for central bank digital currency?

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Stablecoins are cryptocurrencies designed by private individuals or institutions to remain stable vis-à-vis an official currency. These schemes have gained popularity in the last couple of years and become a core element in the emergence of decentralised finance (DeFi) applications. As central banks are considering the opportunity to launch their own digital currencies (CBDC), a serious cost-analysis benefit ought to acknowledge these private initiatives as alternatives, but also potentially as complement to CBDCs. In this chapter, I offer a subjective and partial summary of the state of the debate, drawing from my readings and discussions with academics, policymakers and market practitioners. While most opinions that I came across were more nuanced, I organise these positions across three polarised ideal types. A first position stresses the financial stability risk of unregulated stablecoins and highlights central banks' comparative advantage in providing final settlement. A second position is sceptical about government leading initiatives to drive innovation and would like to restrain its footprint to allow space for the development of welfare-enhancing new private payment technologies such as stablecoins. A third position highlights the potential for synergies between public CBDC and private stablecoins within two-tiered systems, which would allow each technology's comparative advantages to be revamped.

It is worth starting this discussion by investigating the intellectual roots of these positions within a comparable controversy two centuries ago in the United Kingdom on the governance of a then-new innovative technology with many similarities to today's stablecoins: the banknote. While it is difficult today to imagine banknotes as a controversial and revolutionary technology, we should remember that the usage of banknotes beyond the close-knit circle of merchants only started around the end of the 17th century in Europe. This development was made possible by technological advances such as signatures and holography, as well as innovations in the British legal system such as the expansion of merchant law to the Common Law.

By the 19th century, British economists had gained enough knowledge from a century of mixed-success experiments with banknotes to form an opinion on how this technology should be regulated. On the one hand, proponents of the 'Banking School', such as Adam Smith, Thomas Tooke, and James William Gilbart, were advocating for a liberal banking policy allowing chartered institutions to issue banknotes at will; arguing that

gold convertibility should be sufficient to avoid over-issuance and preserve pecuniary stability (Giannini 2011). These authors reached this conclusion while having in mind the success of the Scottish free banking system and the multiple failures of earlier initiatives involving the state, such as John Law's famous venture with the King of France. The doctrine would be summarised by Adam Smith in his *Wealth of Nations*:

“If bankers are restrained from issuing any circulating banknotes, or notes payable to the bearer, for less than a certain sum; and if they are subjected to the obligation of an immediate and unconditional payment of such banknotes as soon as they are presented, their trade may, with safety to the public, be rendered in all other respects perfectly free.”

An important part of their argument was that banks' ability to extend the currency was needed to allow the British economy to pursue its industrial revolution in a context of a secular deflation driven by the natural scarcity of gold.

On the other side of the debate, proponents of the 'Currency School', with David Ricardo and Henry Thorton as prominent members, were worried about inflationary and financial stability risks stemming from unregulated banknote issuance. As explained by Curzio Giannini (2011):

“While the value of metallic money was guaranteed by its content, the banknote was a debt payable to the bearer, its value depending on the convertibility clause being respected. Since banknotes could change hands any number of times before being converted back into metallic money, there was the risk that the issuer could behave imprudently, if not fraudulently, safe in the knowledge that the banknote had uncertain legal status and, in the more developed legal systems, was protected by the limited liability regime.”

In the face of the many country bank bankruptcies of the 1810s and 1820s, Thorton argued that, considering that banknotes would be used as a substitute for coins in monetary transactions, the instruments should be fully backed by existing gold.

The dispute was eventually resolved in favour of the Currency School in the Bank Charter Act of 1844, which would limit the ability of country banks to issue additional banknotes and create a fixed ratio between the gold reserves held by the Bank of England and the notes that the Bank was authorised to issue. The legislation also effectively granted the Bank of England a monopoly over note issuance. This monopoly model would eventually be adopted almost universally. However, the victory for the Currency School was short-lived as a new disrupting payment technology arose: bank deposits transferable through cheques. Bank deposits took over from banknotes to become the fastest growing development in banking for most of the end of the 19th century and all of the 20th century – a development on which proponents of the narrow-banking and 'bill only' doctrines never managed to fully impose their views that deposits should be entirely backed by currency and short-term commercial papers, respectively.

Today, stablecoins enter the picture as a new payment technology that shares characteristics with both banknotes and deposits and blurs the distinction between the two. As with bank deposits, stablecoins are digital assets that are recorded in the accounting system of an institution or decentralised organisation. The decentralised nature of this accounting system, referred to as a distributed ledger technology (DLT), is a key technological improvement. As with banknotes, stablecoins are instruments that are instantaneously transferable with certainty over finality of the transfer. Moreover, in most schemes (although not all), stablecoins are redeemable on demand against either cash in the pegged currency or any other asset that is held as collateral to back up the value of the stablecoin. In practice, stablecoin schemes vary widely when it comes to their design and, in particular, their pegging mechanism. Some stablecoins, such as Tether or USDC, are supported by institutions with a legal existence that holds cash reserve assets as collateral to ensure convertibility. Within this category, institutions differ on what they consider as cash reserves. For instance, while USDC keeps its cash holdings as deposits in multiple banks, thereby following a narrow-banking approach, Tether appears to follow the more liberal 'bill only' principle by holding assets of short maturities but subject to various levels of credit risk such as corporate commercial papers.

Another class of stablecoins, usually referred to as crypto-collateralised or algorithmic stablecoins,¹ has recently been gaining in popularity. In terms of innovation, algorithmic stablecoins go further when compared to the ones cited above by having their whole balance sheet exist entirely on some decentralised ledger. This property confers on the designers of the scheme the ability to program the pegging strategy in a transparent and decentralised manner. A stablecoin called DAI, for instance, allows any user of a subset of cryptoassets living on the Ethereum platform to pledge these cryptoassets as collateral in a virtual bank referred to as a collateralised debt position (CDP). Users may withdraw DAIs from their CDP up to a certain limit and then sell these to other users; thereby effectively leveraging their positions in the cryptoasset, such as Ethereum. While the value of these cryptoassets is typically highly volatile – this volatility being one reason d'être of the stablecoins – the peg is maintained through a complex set of safety mechanisms, including the automatic liquidation of the CDP when its collateralisation ratio (the inverse of the leverage) falls below a certain threshold. The advantages of algorithmic stablecoins over other stablecoin schemes with collateral assets outside the DLT reside in the complete transparency of both their (algorithmic) procedures and (perfectly observable in real-time) accounting taking place on the ledger. On this ground, these stablecoins are closer to the philosophy that initially motivated the creation of the first cryptocurrencies such as bitcoin. They combine cryptography and mechanism design to create a payment technology without having to rely on trust in existing institutions.

1 The term 'algorithmic stablecoin' is sometimes also used to refer exclusively to schemes that do not use any asset as collateral but rather rely on a dynamic supply adjustment to maintain the peg. I find this characterisation misleading and instead use 'algorithmic stablecoin' to denote all stablecoins that exist entirely on some distributed ledger.

On the flip side, the risks of algorithmic stablecoins are related to the inherent volatility of assets held as collateral. In particular, there is currently no possibility for algorithmic schemes to directly hold central bank money in the DLT.

Unlike their counterparts of the past, modern central banks do not have to maintain any parity with a unit of account. Their liabilities are the unit of account – a property that puts central banks in a unique position as providers of means of payment. Until very recently, a consensus had emerged that the best design for the system is two-tiered. According to this arrangement, the central bank ensures price and financial stability by providing just the right amount of currency elasticity, while the private banking system remains responsible for providing retail payment services. The emergence of distributed ledger technology has since pushed central banks to question this consensus and consider launching CBDCs that retail customers would be able to hold more or less directly.

The intellectual descendants of the Currency School see a maximalist CBDC design as a way for central banks to preserve their monopoly over currency issuance in the face of the rapid development of stablecoins and other cryptocurrencies. In particular, launching a CBDC would help revamp the benefits of the DLT technology² while crowding out run-prone stablecoins and other volatile cryptocurrencies, thereby improving on financial stability and monetary resilience. Meanwhile, proponents of the (crypto-)Banking School argue that stablecoins are still in their infancy, with large unrealised potentials. In particular, it is still unclear what applications will emerge from booming DeFi initiatives. If central banks and governments were to act too promptly, they might undermine potential new innovations with possibly largely negative consequences for consumer welfare and the ability of a given country to maintain its leadership in a growing industry.

Alternatively, a possible evolution of the system could be found in a renewed two-tier system centred around some form of CBDC as a modernisation and extension of the current interbank Fedwire system open to a wide range of non-bank institutions. Through this connection to the central bank, private stablecoin schemes – as well as other retail payment companies – would benefit from the ability to directly hold central bank liquidity as reserves. Just as for depository institutions, the counterpart for this access should be more stringent regulation, allowing for healthy competition on a level playing field with other institutions providing payment services. Within this perspective, CBDCs and stablecoins would act synergistically to improve both financial stability and the payment system.

Overall, the development of stablecoins, and more generally cryptocurrencies, is part of a secular mutation of the financial system away from the traditional banking sector following waves of technological changes. This trend needs to be monitored and central banking practices adapted to safeguard the stability of the financial system. The recent

2 Discussed elsewhere in this chapter and potentially including financial inclusion, cost-efficiency and security of the payment system.

introduction of the standing repo and reverse repo facilities by the Fed are steps in this direction, providing some of these ‘shadow banking’ institutions with access to its balance sheet. A two-tier CBDC could be an opportunity for central banks to go beyond these punctual adjustments and create infrastructures allowing multiple institutions to connect to their liquidity provision services, and to flexibly adapt to new unforeseen evolutions of the payment system without having to take responsibility for its entire functioning. An important and challenging step in this endeavour would be the overhaul of the financial regulatory framework.

REFERENCES

Giannini, C (2011), *The Age of Central Banks*, Edward Elgar Publishing.

Smith, A (2002) *The Wealth of Nations*, Bibliomania.com.

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PART II

PROJECTS

CHAPTER 12

An overview of the Bank of Canada CBDC project

Jonathan Chiu and Francisco Rivadeneyra¹

Bank of Canada

INTRODUCTION

Most central banks around the world are pondering the motivations for issuing a central bank digital currency as well as the design and the implications of issuing it (Boar and Wehrli 2021). The Bank of Canada has been a pioneer in such exploratory work, starting in 2012 with a targeted economic research agenda on electronic money and payments, and later on with ‘hands on’ technical experimentation with its Jasper projects (Chapman et al. 2017).

As academic and policy discussions about CBDCs accelerated, the Bank of Canada published in 2020 its contingency plan which articulated the public policy objectives that could motivate the issuance of a Canadian CBDC and the scenarios under which issuance could be warranted (Bank of Canada 2020, Lane 2020). The Bank does not see a need to issue a CBDC at this moment, but given that issuance would likely require years of careful evaluation and planning, the Bank is building the capabilities to be able to do so. The rest of the introduction describes the Bank’s contingency approach, while the following sections discuss the Bank’s research and policy work aimed at assessing the opportunities and risks of CBDCs.

Objectives of public money

The question underlying the debate about CBDC is: What is the role of public money in a modern monetary system? A natural starting point is to understand the role that cash plays today. The contingency plan of the Bank identified the following roles: (1) providing a risk-free store of value and low-cost medium of exchange; (2) providing universal access to a basic payment instrument; (3) helping protect privacy in payments; (4) adding resilience to the payments ecosystem; (5) promoting competition and efficiency; and (6) underpinning monetary sovereignty.

¹ The views expressed in this paper are those of the authors and not necessarily the views of the Bank of Canada.

In Canada, cash is still frequently used for transactions, particularly for lower value and face-to-face ones. But as the use of cash for point-of-sale transactions continues to fall and new forms of private digital money enter the marketplace, the question of what role public money should play becomes more salient. This is the context in which the Bank of Canada is evaluating the risks and opportunities of a CBDC.

Issuance scenarios

The Bank of Canada has articulated two scenarios under which the issuance of CBDC might be desirable. The first is a situation where cash is not widely used or accepted for a wide range of transactions, especially if this situation leads to adverse consequences for disadvantaged groups. In Canada, cash remains almost universally accepted but usage at the point of sale has been falling significantly (Huynh et al. 2019).

The cashless scenario is concerning largely for its distributional effects: while a vast majority of Canadians might willingly move away from cash altogether and towards exclusively electronic means of payments, some groups in society might not have the option to make that transition. The inability to transition to electronic means of payments could be, among other reasons, a function of a group's socioeconomic factors such as income or geographical location.

The second scenario envisions a situation where one or more alternative digital currencies – public or private – become widely adopted in Canada, threatening monetary sovereignty. In this scenario, the alternative digital currency would be denominated in a unit of account different to the Canadian dollar and would use settlement systems out of reach for Canadian regulators. At the moment, however, the likelihood of widespread adoption of any alternative digital currencies seems small.

The Bank has stated that the two scenarios described here are not meant to be an exhaustive list of all circumstances under which the Bank would consider issuing a digital currency. Further, the scenarios are not strict triggers for issuance as wider risks and alternative policies would have to be considered even if these scenarios had materialized.

ASSESSMENT OF THE OPPORTUNITIES

Monetary policy

In academic circles, one of the most discussed motivations for a CBDC is its potential to improve monetary policy (Bordo and Levin 2017). The Bank of Canada has examined this motivation and concluded that while in theory an interest-bearing and universally accessible CBDC could be a versatile policy instrument – lowering the effective lower bound and allowing the policy interest rate to be contingent on balances – the expected benefits might be unlikely to be realised in practice (Davoodalhosseini et al. 2020). This scepticism arises partly from implementation challenges. First, cash would need to be removed from circulation. The Bank in fact has stated the opposite policy: it intends to

support cash for as long as Canadians demand it. Second, if the CBDC system is expected to allow off-line payments, the interest-bearing capability brings security challenges (Shah et al. 2020). Off-line payments might be important for resilience and universal access.

Universal access

One way to understand a monetary system is as a public good that provides the basis for exchange in a market economy. Today, this public good is provided by a mix of public and private payment instruments (cash, debit and credit cards, etc.). As technological change shifts the boundary between the private and public components in the monetary system (Kahn et al. 2020a), some groups in society might be at risk of exclusion from this public good, for example because cash is no longer usable for important economic transactions or because the cost or features of new electronic payments do not consider some groups in society. Therefore, maintaining universal access to a safe and low-cost means of payments is becoming a possible motivation for CBDC (Lane 2021). Because a central bank does not have a profit motive, it can credibly fulfil the universal access objective by appropriately designing and distributing its digital currency.

To function as a universally accessible means of payment, CBDC would require features that consider (to the extent allowed by technology and costs) the different needs people of all ages, different physical abilities and income levels, the circumstances of individuals without bank accounts or an established credit history, or without reliable network coverage or during power outages (Mediema et al. 2020). To understand the needs of all users, the Bank routinely conducts method-of-payment surveys (Henry et al. 2017) and is studying the needs of different stakeholders, for example First Nations (Chen et al. 2021).

Privacy

The protection of privacy in payments has gained attention as an important benefit of cash, particularly now that the ability to collect large amounts of payments data favours business models that can monetise these data (Chiu and Koepl 2020). Private payment providers routinely use payments data to predict behaviour for marketing purposes or influence behaviour. Similarly, corporations with data-intensive business models, such as Facebook, are seeking to expand into payments.

Recent research has highlighted the public good nature of privacy in payments, which is at risk of being underprovided by the private sector (Garratt and Van Oordt 2021). The potential for externalities might warrant certain interventions like regulations on payment providers or offering a privacy-preserving CBDC. As the central bank does not have an incentive to sell or exploit the payments data, a CBDC could, for example, prevent situations where data revealed by one person could be used to make inferences about the purchasing habits of other individuals with similar profiles.

A CBDC system could provide higher levels of privacy than some commercial products (Darbha and Arora 2020). It has also been suggested that some new cryptographic techniques open up the possibility for the central bank to preserve users' privacy while being compliant with current regulation, for example by using a technique called zero-knowledge proofs that allow a claim about the data to be proven without revealing the data themselves. These techniques, however, are still in the early stages of development and will need a few years to be mature for a national system. Other techniques imply impractical operational costs or complexity that could mask vulnerabilities.

The Bank of Canada is developing principles to guide the choice of the appropriate level of privacy in any future CBDC system. These principles should recognize that privacy must be provided transparently and credibly, and in relation to two different types of actors: private sector (e.g. wallet providers, payment processors, merchants) and public sectors (the Bank itself and law enforcement).

Competition and innovation

The discussion about the possible impact of CBDC on competition and innovation in the market for payments services is in its early stages. The Bank of Canada does not have a mandate in these areas, but understanding the potential effects of any future CBDC is nevertheless important. One important consideration is that to be successful as a product, a CBDC would need to compete with other payment platforms for consumers and merchants; it might also need some degree of interoperability with its competitors. Most Canadians already have multiple digital payments options offered by the private sector, but this does not mean that they are, or will remain, as competitive or innovative as they could be. Our research suggests that by offering an alternative to private payment options, a CBDC could help promote payments competition and efficiency (Chiu et al. 2021, Usher et al. 2021).

As in other jurisdictions, the digitalisation of the Canadian economy (online commerce and payments) and the convergence of digital platforms and financial services (offering stablecoins and other means of payments) is increasing the risk that the current or proposed payments architecture might not be sufficiently supportive of financial stability or economic efficiency, or sufficiently accessible or private. For example, competition in markets where digital platforms become dominant could be impaired if their scale and ability to monetise data allow platforms to exert market power on consumers and foreclose competitors. Further, growth in online commerce (where cash is not an option) and customers choosing electronic payments at physical locations (driving some merchants to not accept cash altogether) could provide more scope for incumbents to exert market power.

Another aspect of competition is with respect to alternative digital currencies. A CBDC could, at least under certain circumstances, help to protect Canada's monetary sovereignty and reinforce the use of the Canadian dollar in the face of growing adoption of alternative units of account like private digital currencies, stablecoins and foreign CBDCs.

Research on the relationship between CBDC and innovation is also in its early stages; most has been asking if CBDC has a role to play in the ecosystem of smart contracts and machine-to-machine payments. Smart contracts – a method to efficiently create and execute contingent contracts usually with distributed ledgers– seem to have large applicability in many economic activities. The underlying question is if there are any market failures that a CBDC could prevent, for example by creating a bridge between different distributed ledgers that otherwise would not be interoperable (Townsend 2021).

As mentioned in our companion chapter in the first part of this book, there is a need for research that provides policymakers with an assessment of the potential effects of CBDC on the industrial organisation of the payments market, especially models that help evaluate between the choice of features of the CBDC product and platform, and the different distribution channels.

Offline payments

The resilience of cash is one of its distinguishing characteristics: it works during power outages, in remote locations without network or power coverage. Offline payments with digital instruments have always presented security challenges, however new research is exploring novel features that, in combination with other institutional features, could make CBDC more convenient than cash. Kahn et al. (2021) analysed the possibility of introducing an expiry date for offline balances which could automate personal loss recovery.

One practical way to balance the benefit of offline capabilities with the security risks would be to have 'registered' and 'unregistered' versions of CBDC. These would differ in the identification requirements of the users and in the balance and transfer limits. An unregistered version could be a device that can work with other devices to transfer a limited amount of value. The Bank is exploring approaches such as this.

ASSESSMENT OF THE RISKS

Financial stability

One of the main concerns of policymakers is that, by competing with bank deposits as a payment instrument, a CBDC could increase commercial banks' funding costs and reduce bank deposits and loans, leading to bank disintermediation. The literature is currently exploring the channels through which CBDC could affect bank lending, and

not surprising this depends greatly on the assumptions about the market structure. Our research suggests that introducing a CBDC does not necessarily lead to disintermediation if banks have market power in the deposit market (Chiu et al. 2019).

Empirical work focusing on Canadian banks does not suggest that the first impact of a CBDC on their liquidity and profitability would result in material financial stability risks (Garcia et al. 2020, Gorelova et al. forthcoming). For example, in the case of the six largest banks and the medium-sized banks, the study by Garcia et al. (2020) concluded that their regulatory liquidity ratios would remain above thresholds under most scenarios. Similarly, the return on equity of the six largest banks would decline by less than one percentage point.

While these initial results are encouraging, there are still important gaps in the literature that need to be investigated, for example what would be the effect of CBDC on the payments business of banks and how would CBDC affect the flight of deposits in a crisis (see our companion chapter in the first part of this book).

The impact of CBDC on banks, financial stability and the payments ecosystem in general hinge to a large extent on the level of adoption *and usage* that CBDC would attain. Huynh et al. (2020) and Li (2021) have estimated adoption and usage rates based on assumptions of the features of the instrument (for example, cash-like or deposit-like), suggesting that usage costs and design of a CBDC would be crucial for its success.

Compliance risks

There is a risk that CBDC could be used for some illicit activities, just as cash and electronic transfers are used today. An important policy and design question is how to balance the demand for privacy and other features with compliance with all applicable laws and regulations. Compliance extends to privacy laws, know-your-customer, anti-money laundering, and combating the financing of terrorism regulations. Compliance considerations would impose constraints on some of the potential features of a CBDC, like privacy and the size of balances or transactions that could be carried out. Therefore, the Bank is exploring in particular what is the actual range of options available, taking as given Canadian privacy and compliance laws and regulations.

Security risks

As a widely available and electronic means of payments, CBDC would be faced with security risks like cyber and consumer protection risks (Minwalla 2020, Kahn et al. 2020b). The economics of the security risks of a CBDC and cash are different because of lower entry costs of attempting to find vulnerabilities in the system and a potentially higher reward in a national system (Kahn et al. 2020a). An approach here is to find the distribution of responsibilities between the different participants in the ecosystem (the Bank, distributors, and users themselves) that create the incentives to manage the risks appropriately. This remains an important area of technical research.

CONCLUSIONS

The decision to issue a CBDC belongs ultimately to Canadians and their elected representatives, and would require wide consultations with stakeholders and the public. This chapter describes some of the economic and technical research that the Bank of Canada is conducting as part of the discussions about the motivations, design, and implications of a Canadian CBDC. The work ahead will be challenging but exciting for researchers, technologists, and policymakers.

REFERENCES

- Bank of Canada (2020), “Contingency Planning for a Central Bank Digital Currency”.
- Boar, C and A Wehrli (2021), “Ready, steady, go? - Results of the third BIS survey on central bank digital currency”, BIS Working Paper.
- Bordo, M D and A T Levin (2017), “Central bank digital currency and the future of monetary policy”, NBER Working Paper No. 23711.
- Chapman, J, R Garratt, S Hendry, A McCormack and W McMahon (2017), “Project Jasper: Are distributed wholesale payment systems feasible yet?”, *Bank of Canada Financial System Review* 59.
- Chen, H, W Engert, K Huynh and D O’Habib (2021), “An Exploration of First Nations Reserves and Access to Cash”, Bank of Canada Staff Discussion Paper 2021-8.
- Chiu, J and T Koepl (2020), “Payments and the D(ata) N(etwork) A(ctivities) of BigTech Platforms,” mimeo.
- Chiu, J, S M Davoodalhosseini, J Jiang and Y Zhu. (2019), “Bank market power and central bank digital currency: Theory and quantitative assessment”, Bank of Canada Staff Working Paper No. 2019-20.
- Darbha, S and R Arora (2020), “Privacy in CBDC technology”, Bank of Canada Staff Analytical Note 2020-9.
- Davoodalhosseini, M, F Rivadeneyra and Y Zhu (2020), “CBDC and Monetary Policy”, Bank of Canada Staff Analytical Note 2020-4.
- Garcia, A, B Lands, X Liu and J Slive (2020), “The potential effect of a central bank digital currency on deposit funding in Canada”, Bank of Canada Staff Analytical Note 2020-15.
- Garratt, R J and M R C Van Oordt (2021), “Privacy as a public good: a case for electronic cash”, *Journal of Political Economy* 129(7).
- Gorelova, A, B Lands and M teNyenhuis (forthcoming) “Resilience of bank liquidity metrics in the presence of CBDC”, Bank of Canada Staff Analytical Note.

Henry, C, K Huynh and A Welte (2017), “Methods-of-Payment Survey Report”, Bank of Canada Staff Discussion Paper 2018-17.

Huynh, K, G Nicholls and M Nicholson (2019), “Cash Alternative Survey Results”, Bank of Canada Staff Discussion Paper 2020-8.

Huynh, K, J Molnar, O Shcherbakov and Q Yu (2020), “Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency”, Bank of Canada Staff Working Paper 2020-7.

Kahn, C M, F Rivadeneyra and T-N Wong (2020a), “Should the central bank issue e-money?”, *Journal of Financial Market Infrastructures* 8(4): 1-22.

Kahn, C M, F Rivadeneyra and T-N Wong (2020b), “Eggs in One Basket: Security and Convenience of Digital Currencies”, Bank of Canada Staff Working Paper.

Kahn, C M, M R C van Oordt and Y Zhu (2021), “Best Before? Expiring Central Bank Digital Currency and Loss Recovery”, mimeo, Bank of Canada.

Lane, T (2020), “Money and Payments in the Digital Age”, speech, Bank of Canada.

Lane, T (2020), “Payments innovation beyond the pandemic”, speech, Bank of Canada.

Li, J (2021), “Predicting the Demand for Central Bank Digital Currency: A Structural Analysis with Survey Data”, mimeo, Bank of Canada.

Miedema, J, C Minwalla, M Warren and D Shah (2020), “Designing a CBDC for universal access”, Staff Analytical Note 2020-10.

Minwalla, C (2020), “Security of a CBDC”, Bank of Canada Staff Analytical Note 2020-11.

Shah, D, R Arora, H Du, S Darbha, J Miedema and C Minwalla (2020), “Technology Approach for a CBDC”, Bank of Canada Staff Analytical Note 2020-6.

Townsend, R (2021), “Delegation of Programmable Contracts to the Private Sector: Is there a Public Sector Role?”, remarks delivered at the 7th Joint Bank of Canada and Payments Canada Symposium on Shaping the Future of Payments, September.

Usher, A, E Reshidi, F Rivadeneyra and S Hendry (2021), “The Positive Case for a CBDC”, Staff Discussion Paper 2021-11.

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CHAPTER 13

The role of central banks when cash is no longer king: Perspectives from Sweden

Martin Flodén and Björn Segendorf

Sveriges Riksbank and CEPR; Sveriges Riksbank

The Riksbank has been exploring a central bank digital currency (CBDC), the e-krona, for some time (Skingsley 2016, Sveriges Riksbank 2017). The e-krona project should be seen in the context of a rapid transformation of the Swedish payments market. With a mandate to promote safe and efficient payments, the Riksbank must adapt to this transformation. We will briefly discuss the e-krona project towards the end of this chapter. But we first describe current developments in the Swedish payments market and challenges related to these developments.

SWEDEN: A CASHLESS ECONOMY

Sweden has effectively become a cashless economy. Over the last decade, the share of cash transactions at point of sale (POS) has fallen from nearly 40% to below 10%. A majority of people use cash a few times per year or not at all.

One reason for this development is the high penetration of cards and the high acceptance of cards at the POS. Debit cards dominate and can be used almost everywhere, and Sweden has one of the highest number of card transactions per capita in the world.¹ Digital technology has enabled the development of person-to-person payments in real time. With more than 80% of adults regularly using the mobile payment service Swish, it has largely replaced cash in those situations (Betalningsutredningen 2021).

The market for payment services is typically a two-sided market with distinct groups of users (often consumers and businesses) where network externalities go from one side to the other. For example, as more consumers use cards, it becomes more attractive for businesses to accept cards. This logic also works the other way around – retailers, hotels and restaurants have, to an increasing degree, stopped accepting cash (Arvidsson et al. 2018). The cost of maintaining the cash distribution infrastructure is therefore shared among fewer and fewer parties. As the use of cash is decreasing, continuing to accept

1 See Committee on Payments and Financial Market Infrastructures, Red Book Statistics for CPMI Countries, [Table CT6C](#).

cash will become less economically rational over time. The trend of falling use of cash is also fuelled by demography, as cash is rarely used by younger generations. Recently, Covid-19 and increased e-commerce have accelerated the development.

Even banks are becoming cashless, at least in the meaning of not handling cash at their branches. Of the five major banks, only one is still offering cash services at some (a handful) of its branches.

Most Swedes see many advantages with this development, and face no major problems with the cashless economy. One reason is that almost every Swede has a bank account, a debit card and a smartphone, including children, who can have debit cards and Swish with their parents' permission.

But there are a few exceptions, such as recently arrived asylum seekers, illegal immigrants and homeless people. And some lack access to digital technology or are unable to use it in full. According to some estimates, this latter group may constitute up to 10% of the population or more.² Moreover, although only one third of Swedish consumers use cash on a somewhat regular basis, two thirds of them value having cash as an option.

The transformation to a cashless economy is thus not without friction. We will in the remainder of this chapter get back to some concerns that the Riksbank has with the development.

WHERE IS THE SWEDISH PAYMENTS MARKET HEADING?

Absent public intervention, the Swedish payment market will likely continue to develop in the direction discussed above. The retail payments market is already dominated by different forms of private money, foremost issued by commercial banks. Without strengthened legal support for the acceptance of cash and related withdrawal and deposit services, it will become more and more difficult not only to use cash, but also to get hold of cash and to deposit it. Access to central bank money will then in practice be restricted to banks, implying a limited convertibility of privately issued krona into krona issued by the Riksbank.

The payment services that are used to transfer privately issued money are likely to be provided by a mix of banks and other, more lightly regulated, companies in the FinTech sector. The technological development and payment initiation services, enabled by the Payments Service Directive 2 (PSD2), will continue to break down the silo structure of the old payments market. As an example, card payments used to dominate at the POS and in e-commerce, but today one can easily build a POS payment service using direct debits or instant payments.

² Six percent of the population does not use internet or do so very seldom, but some 20% say that they need help to use it. Digital exclusion is highest among those that are old, live in single households or have low income (Internetstiftelsen 2020).

The Swedish retail payments market will also be affected by a consolidation of financial infrastructure and of major players. The consolidation is driven by the desire to exploit economies of scale and network effects, and thus to stay competitive. This consolidation will take place on three levels: regional, European and global.

On the regional level, the major banks are active on all the Nordic markets and in the northern part of the continent. And a group of large Nordic banks have joined forces to develop a pan-Nordic clearinghouse (P27).

On the European level, we are likely to see a migration of non-euro currencies to the settlement systems of the Eurosystem (T2, TIPS, T2S) that become multi-currency systems.

On the global level, the global card schemes are likely to remain important for the European market in general, and the Swedish market in particular. But international payments today are often channelled through systems of correspondent banks, and tend to be slow, non-transparent and expensive (CPMI 2018, Financial Stability Board 2020a). There are a number of private initiatives to address this inefficient infrastructure, for example Facebook's ambition to create a global stablecoin.

We do not, however, anticipate a prominent role for stablecoins or other cryptocurrencies on the Swedish payments market. Swedish banks have been quick to adapt to new technologies and to develop new FinTech products.³ Stablecoins are more likely to gain initial ground in economies where banks either are not responding to the FinTech developments or, because of low financial inclusion, have problems reaching out to the population.

MONEY AND THE ROLE OF THE CENTRAL BANK

The Riksbank's mandate is to ensure price stability and to promote a safe and efficient payment system.

The mandate implicitly means that there must be a national currency controlled by the Riksbank and that is widely used for payments, since the Riksbank would otherwise not be able to conduct monetary policy to ensure price stability. Moreover, the Riksbank can only promote a safe and efficient payment system if this national currency is used in payment systems that the Riksbank has some control over.

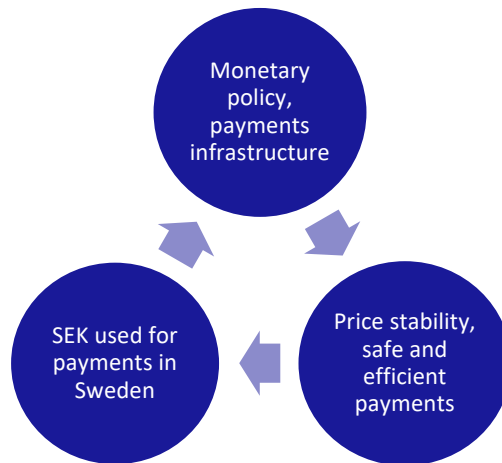
In other words, for the Riksbank to be able to live up to its mandate, it is crucial that the krona remains the dominant money used for payments in Sweden and that the Riksbank has some control of the domestic payment systems.

³ They have, for example, reduced the number of branches substantially and pushed customers to digital banking. They have also engaged prominently in FinTech activities, for example by developing the Swish instant payment system and a uniformly accepted digital id, BankID.

And if the Riksbank lives up to its mandate so that inflation is low and stable, and payments are convenient, inexpensive, fast and safe for everyone at all times, then there is a good chance that the krona will remain the dominant form of money used in domestic transactions.

The two tasks in the Riksbank's mandate, together with the implicit understanding that the krona shall be used for payments in Sweden in payment systems under some control, are thus closely intertwined, as illustrated in Figure 1.

FIGURE 1 THE RIKSBANK CAN ONLY DELIVER ON ITS MANDATE IF THE KRONA IS DOMINATING THE SWEDISH PAYMENTS MARKET; AND THE KRONA WILL ONLY DOMINATE THE SWEDISH PAYMENTS MARKET IF THE RIKSBANK DELIVERS ON ITS MANDATE



The developments on the payments market that we summarised above introduces some challenges for a central bank.

We have seen in history that failure to deliver on the price stability mandate can result in a currency being abandoned, often in favour of the US dollar. This risk is thus not new, but we suspect that the threshold for currency substitution is lower in the presence of alternative digital currencies, in particular in an economy where payments are already digital.

Moreover, the new digital payments landscape is fragile. It hinges on a few, centralised IT systems managed by a few agents (the central bank, clearing organisations, commercial banks, FinTechs, IT service providers, etc.) and the systems are often interconnected. There are thus a few single points of failure, meaning that technical problems or cyber-attacks can lead to severe disruptions in economic activity.

This stands in contrast to the traditional cash infrastructure provided by the Riksbank. Settlement in cash is decentralised, less dependent on technology and more robust. Even though cash has long played a relatively minor role on the Swedish payments market, there was until recently an existing infrastructure that could be scaled up in times of crises. Arguably, this is no longer the case.

The digital payments landscape is also rapidly evolving with new, more effective, products and new entrants. This introduces competition on the payments market, not only at the retail level but also on the market for payment systems and their infrastructure.

All this means that central banks cannot only fail in delivering on price stability but also in promoting a system where payments are safe (i.e. reliable and always available for everyone) and efficient (i.e. easy to use, fast and inexpensive).

THE RIKSBANK RESPONDS TO THE NEW PAYMENTS LANDSCAPE

The Riksbank has responded to these challenges in a number of ways.

First, it has argued for a strengthened legal status for cash and supported new legislation requiring banks to provide a minimum of cash services. The ambition is to introduce speed bumps so that the transformation of the market is orderly and gives everyone a chance stay on board. Everyone must have access to basic payment services. Despite the new legislation, the legal status for cash remains weak and the Riksbank receives a fair number of complaints from the general public, especially on the lack of deposit services.

Second, the payments infrastructure has important elements of network effects and tends to develop into a natural monopoly. In the hands of the private market, the infrastructure may be an obstacle to competition and innovation. Moreover, robustness of the payment system is at danger if it relies on the continued services from one or a few private agents. Our view is therefore that the core payments infrastructure, in particular settlement in Swedish krona, is a public good that should be provided by the Riksbank rather than by the market.

Today, the Riksbank runs a real time gross settlement system (RTGS) that is open for banks during office hours on weekdays and which is designed to only process a limited number of transactions per day. The Riksbank also provides custom-made solutions supporting settlement of Swish instant payments (in private money) and Euroclear Sweden's securities settlements.⁴ These are, however, not solutions for the future. The Riksbank must provide a modern and cost-effective infrastructure that promotes safety as well as efficiency, innovation and competition on the payments market.

4 The settlement infrastructure behind the Swish system, BiR, is indirectly owned by the large banks. Transactions are settled in BiR money backed by central bank money, resulting in liquidity management that is costly and puts restrictions on transaction volumes when the RTGS system is closed. Regarding Euroclear Sweden, the Riksbank lets Euroclear operate Riksbank accounts in its securities settlement system which reduces settlement risks through delivery-versus-payment settlement.

Consequently, since instant payments will continue to grow in importance, the Riksbank must provide an infrastructure that can settle instant payments 24/7. Settlement in that system shall be in Swedish krona and central bank money. The Riksbank has concluded that the best way forward is to adopt the Eurosystem's TIPS platform. This solution will be cost-effective and robust, and will promote international competition and potentially facilitate some cross-currency payments (Flodén 2019). For similar reasons, the Riksbank has communicated its ambition to also use the Eurosystem's T2 and T2S platforms for, respectively, RTGS-services in the Swedish krona and Swedish securities settlements.

Third, the Riksbank has joined forces with other central banks and with international organisations to address the shortcomings in the market for international payments. For example, the G20+ based Committee on Payments and Market Infrastructure (CPMI) is now investigating what building blocks that are needed to establish more efficient solutions for international payments (CPMI 2020, Financial Stability Board 2020b).

A remaining challenge is access and convertibility to central bank money. Price stability and a safe store of value must apply to the monies used by households and businesses. Different types of private money must have the same value and this value must be equal to the value of public, central bank money. As an example, krona deposits held at Bank A must have the same value as a corresponding deposit at Bank B. These deposits must also have the same value as the corresponding amount held in central bank money, either in the form of banknotes or reserves.

The marginalisation of cash threatens convertibility between private and public money.⁵ One question that the Riksbank is struggling with is whether universal access to public money is an important element for the credibility and safety of the monetary system. Another question that we are struggling with is whether a digital payment system run by the private sector is sufficiently robust.

AT A CROSSROADS

The transformation to a cashless society takes Sweden and the Riksbank to a crossroads. One road leads towards a society where the general public has no access to central bank money and can only use privately issued money. The other road leads to a society where the Riksbank issues a digital version of central bank money available to the general public. No-one can predict the consequences of these choices, and yet we must choose.

⁵ In Sweden, convertibility of commercial bank money to central bank money is not well regulated and hence not guaranteed. Banks are required to offer withdrawal services to a specified extent, but this is almost exclusively done through ATMs where restrictive withdrawal limits make it difficult to convert more than small amounts of commercial bank money to central bank money at will. There is no corresponding requirement to offer deposit services.

Our view on the first road is somewhat different from that of Gorton and Zhang (2021: 41) who conclude that “as stablecoins evolve further, the stablecoin world will look increasingly like an unregulated version of the Free Banking Era – a world of wildcat banking”.

As we explained above, we do not anticipate that unregulated stablecoins would take over the Swedish payments market if the Riksbank remains passive. More likely, the retail payments market would remain dominated by different forms of commercial-bank money. This commercial bank money could be described as a *regulated* stablecoin in Swedish krona. It is regulated since banks are regulated and must live up to strict capital requirements to cover credit losses and ensure enough liquidity for the bank to meet its obligations. This ‘stablecoin’ is not only backed by the asset side of the issuing bank’s balance sheet, but also by deposit insurance that cover most household deposits.

Note, however, that there would be no real convertibility to central bank money – not even from the deposit insurance. The deposit insurance only converts one type of commercial bank money into money issued by another bank.

However, an important element along this road that takes us in the direction of backing by public money is the bank resolution regime. Systemically important banks will not be allowed to go bankrupt but will instead be put in resolution, thereby – at least temporarily – converting insured deposits into public money.

The consequences of choosing the other road – issuing a central bank digital currency – are even more difficult to predict. It is, however, a question that the Riksbank has been analysing since 2017.

THE E-KRONA PROJECT

The Riksbank has pursued two main workstreams in its work on a central bank digital currency, an e-krona. The first workstream is analytical, addressing issues like those we have discussed above. The second workstream is technical, exploring how an e-krona could be designed and what functionality it could have (Sveriges Riksbank 2017, 2018, 2021).

The Riksbank’s current stand on a possible e-krona is that, to be meaningful, it should meet three main objectives: it should give the general public access to central bank money; it should strengthen the robustness and continuity of the payments market; and it should promote competition and innovation.

The first objective – access to central bank money for the general public – is an inherent feature of any retail CBDC. As we discussed above, such access may provide an important anchor for a unified monetary system. It is unclear how the general public would perceive a loss of this access.

Above, we also discussed the fragility of the digital payments infrastructure. Robustness of the retail payments market needs to be reconsidered in the digital era. To meet the second objective, the e-krona needs to have its own core infrastructure where it offers an alternative route for some payments if other infrastructure is unavailable. The project also attempts to build functionality for offline payments, i.e. to allow for payments at the point of sale even if the e-krona core infrastructure is unavailable. This would only work for a limited period of time but could enable consumers to buy basic goods such as food, fuel and medicine.

The emergence of payment initiation services has increased diversity and competition on the surface of the retail payments market but less so in the layers below, and many FinTech companies complain about the lack of access to the payments infrastructure. An e-krona can potentially contribute by giving the FinTech sector access to its infrastructure and thus reduce their dependence on banks. This would facilitate competition with established, and sometimes dominant, payment services.

The Riksbank's current thinking on the e-krona is that the Riksbank should be responsible for the core infrastructure and the rulebook. Banks and FinTechs should act as intermediaries and distribute e-krona to their customers and build and provide e-krona payment services. This is in line with the current division of tasks and responsibilities between the Riksbank and the private sector. The e-krona, if launched, would be built to serve the Swedish market. The target group is likely to be EU and EES citizens with an economic tie to Sweden. Payments could be initiated by cards, mobile apps, dedicated hardware gadgets and so on, depending on how market actors integrate the e-krona in their choice of initiation technology.

Many central banks have recently intensified their work on CBDC (e.g. ECB 2020, Bank of Canada et al. 2020, 2021, G7 2021). An e-krona would have to relate to this international work. One area that has recently attracted growing interest is how CBDCs can facilitate cross-border payments. International progress in this area needs to be considered in the e-krona design.

It is important to point out that the Riksbank has not decided whether or not to introduce an e-krona. The project is still analysing the possibilities to provide more robustness and promote competition. There are also a number of other questions that must be addressed before a decision on the e-krona can be made. Two questions are particularly pertinent.⁶

First, is there a business case for private intermediaries to participate in its distribution and what would be the impact on the Riksbank's finances? As noted above, there are economies of scale and network effects on the payments market. Providing a parallel infrastructure and promoting competition would work against these natural forces.

6 The Riksbank will continue to look into other questions as well, such as implications for monetary policy. This will often be done in cooperation with other central banks.

The e-krona would imply both fixed and variable costs for participating intermediaries, for example related to IT systems and anti-money laundering (AML) and know your customer (KYC) procedures. Fees for payment initiation and complementary services could potentially cover some of the costs, but payment related data would likely be in the centre of the business models of the private sector. Finding a good balance between privacy and use of data would not be easy.

The Riksbank would carry costs from building and operating the core e-krona infrastructure, monitoring usage and services, and so on. Seigniorage would likely have to be the main source of revenue. But there will be little or no seigniorage if either the demand for holding e-krona is low or e-krona holdings are remunerated at the market interest rate. The objective of a central bank is not to generate a profit, but its costs must be managed if it is to maintain its financial independence, something that is typically seen as a fundamental requirement for being able to conduct an effective monetary policy.

Second, an e-krona could challenge the funding model used by traditional banks, as households and businesses could choose to hold e-krona instead of bank deposits. A substantial e-krona uptake would therefore lead to an important transformation of the financial markets. The Riksbank's mandate is not to sustain a particular bank funding model, but implications for financial stability would have to be carefully considered. Some recent studies indicate that this transformation would be manageable, but the question is not yet settled (Bank of Canada et al. 2021b).

CONCLUSION

Standing at the crossroads, a number of difficult questions and trade-offs arise. The consequences of these choices concern the whole society. It is, ultimately, a question about how we want to arrange the future monetary system, the role of the state in that system and the role of the central bank.

This is why the Riksbank has been so transparent in its exploration of an e-krona. This is also why the Riksbank wrote a petition to the Swedish parliament in 2019 asking for a broad inquiry about the state's role in the future payment and monetary systems (Sveriges Riksbank 2019). The inquiry, launched by the government in December 2020, is expected to publish its final report in November 2022.⁷ The inquiry will give an important public policy aspect on the e-krona which, together with the work by the Riksbank, will constitute the basis for a future decision.

7 For more information on the inquiry, see Statens roll på betalningsmarknaden - Regeringen.se.

REFERENCES

Arvidsson, N, J Hedman and B Segendorf (2018), *När slutar svenska handlare att acceptera kontanter?*, Research Report 2018:1, The Swedish Retail and Wholesale Council, January.

Bank of Canada, ECB, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements (2020), *Central bank digital currencies: foundational principles and core features*, Report No. 1, October.

Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements (2021a), "Central bank digital currencies: An executive summary", September.

Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements (2021b), *Central bank digital currencies: financial stability implications*, Report No. 4, September.

Betalningsutredningen (2021), "Undersökning om betalningsvanor och synen på utvecklingen på betalningsmarknaden", Government Offices of Sweden, September.

CPMI – Committee on Payments and Market Infrastructures (2018), "Cross-border retail payments", CPMI Paper No. 173, Bank for International Settlements, April.

CPMI (2020), *Enhancing cross-border payments: building blocks of a global roadmap*, Stage 2 report to the G20, July.

ECB (2020), *A digital euro*, October.

Financial Stability Board (2020a), *Enhancing Cross-border Payments: Stage 1 report to the G20*, April.

Financial Stability Board (2020b), *Enhancing Cross-border Payments: Stage 3 roadmap*, October.

Flodén, M (2019), "Should the Riksbank's payment system be open 24/365?", speech, Sveriges Riksbank, 12 June 12,

G7 (2021), "Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs)", October.

Gorton, G B and J Zhang (2021), "Taming wildcat stablecoins", mimeo, Yale School of Management.

Internetstiftelsen (2020), *Digitalt utanförskap 2020 Q1*.

Skingsley, C (2016), “Should the Riksbank issue e-krona?”, speech, Sveriges Riksbank, 16 November.

Sveriges Riksbank (2017), *The Riksbank’s e-krona project*, Report 1, September.

Sveriges Riksbank (2018), *The Riksbank’s e-krona project*, Report 2, October.

Sveriges Riksbank (2019), “The state’s role on the payment market”, Petition to the Swedish Riksdag 2018/19 RB:3, April.

Sveriges Riksbank (2021), “E-krona pilot phase 1”, April.

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CHAPTER 14

The Eurosystem's digital euro project: Preparing for a digital future

Katrin Assenmacher and Ulrich Bindseil¹

European Central Bank

Digitalisation is pervasive in today's economy and is changing the way we pay. While digital money has traditionally been provided by banks, other means of digital payments have emerged more recently. This has prompted questions about the role of central banks in supplying digital money to the general public. In light of these developments, the Governing Council of the European Central Bank decided on 14 July 2021 to formally launch a project to get ready for the possible issuance of a digital euro. The digital euro would complement cash and not replace it, as the Eurosystem remains committed to continuing to supply cash. A decision to actually launch a digital euro would be taken only at a later stage and not before the investigation phase of the project has been concluded (ECB 2021).

THE PAYMENTS PERSPECTIVE

Why prepare for a digital euro?

For decades, the private sector has deployed ever more convenient digital retail payment solutions, while the format of central bank money available to the general public – paper banknotes – has remained unchanged. The digital revolution has transformed our lives. We use the internet constantly via our laptops and mobile phones; we order more and more via e-commerce; we interact through social media and instant messaging applications. The Covid-19 pandemic has accelerated this trend. According to the ECB's 2020 payments survey, euro area digital payments overtook cash payments in value terms in for the first time in 2019. Extrapolating the current trends also means a growing predominance of electronic payments for the euro area.

Another major trend is the global scale of competition in digital payments. Payments are subject to strong network effects: the more users a payment system or solution (or a set of fully interoperable solutions) has, the more attractive it becomes to new users. Visa, MasterCard, and PayPal have attracted a growing share of European consumers – obviously because of their attractive product offering. Market power provides room for

¹ The views expressed are those of the authors and do not necessarily reflect those of the ECB.

non-competitive price setting and rent extraction. Regulation might partially address this, but it is rarely fully effective and may have side-effects. Europe has underperformed in recent years in the global competition among payment instruments. The lack of payments integration in the euro area has helped foreign providers (or subsidiaries of foreign parent companies) to take the lead. While openness to global competition is crucial to foster innovation, excessive dependency on a few foreign private or public digital means of payment and technologies can lead to rent extraction from European citizens and merchants, and strategic dependence. The evolving global context, with an observed deterioration in international relations, have increased the potential risks to payments, monetary, and potentially political sovereignty.

As a consequence, on 2 October 2020 the ECB published its first report on a possible ECB-issued central bank digital currency (CBDC), called the digital euro, “for use in retail transactions available to the general public – that is, including citizens and non-bank firms – rather than only being available to traditional participants (typically banks) in the large-value payment system managed by the central bank” (ECB 2020a: 6).

The continued co-existence of central bank and private (commercial bank) money

As argued in Bindseil et al. (2021), central banks are considering issuing CBDC given their responsibility to sustain confidence in their currency by maintaining public access and full usability of central bank money in a world in which consumers and firms are turning more and more to electronic payments. Commercial bank money (and other regulated forms of money such as electronic money) are the liability of different private issuers. They are perceived by the public to be interchangeable at the same value. This is because commercial bank money is ‘anchored’ to central bank money – i.e. the form of the currency that defines the unit of account. This anchoring is necessary for central banks to preserve monetary and financial stability. It is sustained by a set of mechanisms, one of which is the public’s confidence that they can exchange bank deposits for cash upon demand. If demand to use cash for payments continues to decline, the anchoring is debilitated as the convertibility into central bank money becomes more and more a theoretical construct instead of a daily experience. The liquidity of cash will fade slowly if the spheres of commerce in which it can be used shrink over time (for example, with the growth of e-commerce or after the impact of the Covid-19 shock). With CBDC, central banks seek to preserve the usability of central bank money in a changing world in which more and more people and merchants prefer the convenience of electronic means of payments. A wide adoption of stablecoins would also undermine the anchoring to central bank money, depending on their design and systemic nature. Stablecoins issue their own money with the promise of a stable value with regards to some currency, basket of currencies or even commodities (by stating they will invest in relevant assets, not

necessarily through the commitment to convert into assets or even into central bank money) and a wide network for payments (by leveraging on the existing customer base of large technology firms and the corresponding incentives to establish closed loops).

Synergies of a digital euro with, and reliance on, the private sector

In its report on a digital euro, the ECB expresses the idea that a possible digital euro would be distributed with the help of supervised entities, in particular banks. This would have a number of advantages, such as providing a way to convert commercial bank money into central bank money and vice versa. It would also mean that customer authentication by commercial banks and their client relationships could be relied on to address customer questions and problems. This still raises a variety of policy and technical questions which would need to be answered in one way or another. How can the design of the digital euro be as open as possible in terms of the way intermediaries can integrate it into their existing solutions, while still guaranteeing safety and integrity? What categories of supervised entities could offer digital wallets in digital euros? Should the ECB ensure that market power by single providers of wallets remains limited in the distribution of the digital euro? Would it be an issue from the perspective of monetary sovereignty if non-European firms or subsidiaries of non-European firms were to play an important role in distributing the digital euro? What degree of concentration in single non-European firms, and in foreign firms in total, would be acceptable? What services in the context of fraud prevention and refundability for e-commerce transactions would be foreseen?

How much functionality for the digital euro?

Designing a digital euro from scratch obviously creates the temptation to give it the most comprehensive and state-of-the-art functionality, based on the most innovative technology. For example, it has been suggested that a digital euro should (1) allow for fully anonymous payments to protect privacy, while respecting anti-money laundering rules; (2) allow for offline payments; (3) allow for instant credit transfers and direct debits, (4) be programmable and allow for 'smart contracts' for advanced use cases in industry and commerce; (5) ensure financial inclusion (meaning potentially also usable by the non-banked and those without mobile phones); (6) be as convenient to use as existing private sector solutions; and (7) include card, mobile, and internet/desktop access. The payments industry provides many examples of promising approaches and technologies which ultimately did not take off for reasons that could not have been foreseen, and it might be argued that what is not on offer now may not be successfully deployed by a digital euro either. While there are merits to designing a new instrument like CBDC in a comprehensive way to add as much value as possible for society, this ambition would also create significant project risk, and in any case would increase the duration and costs of preparing for CBDC issuance. The fact that the ECB has committed to continuing to issue banknotes with no time limit and both the ECB and the European Commission

have also expressed their commitment to ensuring that cash remains usable is another reason to possibly accept a digital euro with somewhat more limited initial functionality. The possibility of anonymous off-line payments using central bank money should remain in place for years anyway, and it may thus be argued that the necessity of such payments being offered by a digital euro is lower. Last but not least, a very comprehensive functionality (if really successfully deployed) would also maximise the footprint of the digital euro and possibly lead to a crowding out of the private sector, which might be deemed excessive.

The launch of the digital project investigation phase

On 14 July 2021 the ECB decided to launch the investigation phase of a digital euro project and explained its key objectives in a press release, also highlighting that this was not a decision to actually issue a digital euro in the future. The investigation phase will last 24 months and aims to address key issues regarding design and distribution. During the project's investigation phase, the Eurosystem will determine a possible functional design that is based on users' needs. It will involve focus groups, prototyping and conceptual work. The investigation phase will examine the use cases that a digital euro should provide as a matter of priority to meet its objectives: a riskless, accessible and efficient form of digital central bank money. The investigation phase will also identify the changes to the EU legislative framework which might be needed, whereby the ECB will continue to engage with the European co-legislators and will conduct further technical work with the Commission. Moreover, the investigation phase will define a business model for the digital euro ecosystem (i.e. possible compensation for distribution and other services, possible low merchant fees, cost recovery objectives and public good factor). The views of prospective users and distributors of a digital euro will be sought during the investigation phase to ensure a user-friendly and viable integration of the digital euro into the payments ecosystem.

MONETARY POLICY AND FINANCIAL STABILITY CONSIDERATIONS

From a monetary policy perspective, the issuance of a digital euro would help anchor the availability of central bank money in an increasingly digital world. It would, however, also involve a host of design decisions that can affect monetary policy transmission, the Eurosystem's balance sheet and the financial sector in general. According to the foundational principles that were derived in a Bank for International Settlements report by a coalition of seven central banks (Bank of Canada et al. 2020), a digital euro should be designed in such a way that it should "do no harm" to central banks' monetary and financial stability mandates. As highlighted in Panetta (2021), a digital euro – if it were not properly designed – could affect monetary and financial stability on three fronts: (1) financial intermediation, financial stability and capital allocation in normal times; (2) financial stability in times of crisis; and (3) the functioning of the international financial system. In the following, we will briefly discuss these main areas.

Financial intermediation, financial stability and capital allocation

By providing citizens with a digital means of payment, a digital euro would be a close substitute to private digital money that currently exists mostly in the form of bank deposits and which constitutes an important source of bank funding. At an aggregate level, CBDC adoption could alter the composition of banks' liabilities and possibly also affect the asset side of banks' balance sheets. A large-scale substitution of bank deposits for digital euros therefore could have consequences for bank profitability and the transmission of policy rate changes to market interest rates (ECB 2020a). This type of deposit disintermediation, described as a risk for CBDC issuance, could also occur with other private forms of money such as stablecoins, which would provide lower public benefits.

On a more general level, a reduction of the intermediation capacity of the banking sector could lead to funding being shifted to new platforms beyond the regulated sector, which could raise new issues related to supervision and macro-financial stability. A greater reliance of banks on central bank borrowing could also affect credit allocation across borrowers. Banks are specialised in lending to small borrowers while central banks typically lend against high-quality collateral (often sovereign debt), meaning that banks cannot simply shift such credit claims to the central bank to obtain funding. As data on the potential demand for a CBDC do not yet exist, these effects are difficult to quantify and subject to high uncertainty.

Financial stability in times of systemic stress

While the previous paragraphs discussed bank disintermediation risks of a digital euro in normal times, the impact of substitution of bank deposits with a digital euro could become more acute during a crisis. In the event of a systemic financial crisis, bank deposits could be more easily converted into digital euros than into cash, which could make systemic bank runs worse (Bindseil and Panetta 2020). This would particularly be the case if the digital euros were supplied in unlimited quantities, with fixed remuneration and no risk of loss.

Measures to mitigate financial stability and monetary policy risks

These considerations suggest that, in order to manage any potential adverse effects on monetary policy and financial stability, safeguards should be in place to steer demand and mitigate potentially disruptive developments. Panetta (2018) and Bindseil (2020) propose a tiered remuneration system, in which individuals can hold a limited amount of CBDC at favourable conditions as a means of payment, while larger holdings would be discouraged by less favourable rates. Assenmacher et al. (2021) analyse the effectiveness of different safeguards such as the remuneration of a CBDC, haircuts on assets held against

CBDC or a cap on CBDC holdings in a DSGE model with search frictions. The authors find that such safeguards are effective in steering the demand for CBDC, although they reduce welfare relative to the first-best allocation.

Overall, the design and calibration of safeguard measures would require balancing trade-offs between limiting risks to financial stability and ensuring that a CBDC serves its intended purpose.

International financial system

If a CBDC were available for cross-border use or in unlimited quantities to foreigners, it could alter the structure of the international financial system and generate international financial spillovers. An internationally traded CBDC could strengthen the cross-border transmission of shocks, thus increasing exchange rate volatility and affecting capital flow dynamics. There are other economic forces that determine currency choices in international trade and finance which are not specific to the existence of a digital version of a currency. For economies with less stable financial systems, however, the domestic use of a foreign-issued CBDC could lead to currency substitution, especially in times of crises. In the extreme, this could lead to a loss of monetary sovereignty, with the central bank losing its ability to influence the domestic economy and to act as a lender of last resort. International coordination between central banks could be a tool to govern such externalities and reap the full benefits of technological innovation, for example by discussing interoperability between different CBDC platforms or common technical standards.

Ferrari et al. (2021) show that the existence of a foreign CBDC would potentially give rise to stronger international monetary policy spillovers. Large holdings of a foreign CBDC could complicate policy trade-offs for economies not issuing a CBDC, resulting in potentially stronger exchange rate movements and capital flows in response to domestic monetary policy shocks with a CBDC if business cycles are not synchronised across economies.

CONCLUSIONS

The financial sector has adapted successfully to financial innovation and structural change on several occasions. Should a digital euro be introduced, policymakers will make sure that they have sufficient tools to manage the transition. To this end, safeguards could be considered to ensure a smooth introduction of a digital euro. They could also be applied on a permanent basis to mitigate any remaining risks. A decision about whether or not to issue a digital euro will be made only when all of these risks have been addressed (Panetta 2021).

Central bank money has been at the heart of the monetary system and provides the anchor for monetary stability and settlement of payments. When analysing the costs and benefits of a digital euro, it has to be considered that a future financial system could look very different from that which we observe today, and central banks need to be prepared to prevent socially undesirable outcomes.

REFERENCES

Assenmacher, K, A Berentsen, C Brand and N Lamersdorf (2021), “A unified framework for CBDC design: remuneration, collateral haircuts and quantity constraints”, ECB Working Paper No. 2578.

Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors Federal Reserve System and Bank for International Settlements (2020), *Central bank digital currencies: foundational principles and core features*, Report No 1.

Bindseil, U (2020), “Tiered CBDC and the financial system”, ECB Working Paper No. 2351.

Bindseil, U and F Panetta (2020), “CBDC remuneration in a world with low or negative nominal interest rates”, VoxEU.org, 5 October.

Bindseil, U, F Panetta and I Terol (2021), “CBDC – functional scope, pricing and controls”, forthcoming.

ECB (2020a), *Report on a digital euro*, October.

ECB (2020b), “Study on the payment attitudes of consumers in the euro area (SPACE)”, December.

ECB (2021), “Eurosysteem launches digital euro project”, Press Release, 14 July.

Ferrari, M M, A Mehl and L Stracca (2020), “Central bank digital currency in an open economy”, ECB Working Paper No. 2488.

Panetta, F (2018), “21st century cash: central banking, technological innovation and digital currency”, in E Gnan and D Masciandaro (eds), *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions*, SUERF Conference Proceedings 2018/2, pp. 23-32.

Panetta, F (2021), “Evolution or revolution? The impact of a digital euro on the financial system”, speech at a Bruegel online seminar, 10 February.

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CHAPTER 15

Central bank digital currency: A solution in search of a problem?

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Christopher J. Waller¹

Board of Governors of the Federal Reserve System

The payment system is changing in profound ways as individuals demand faster payments, central banks including the Fed respond, and nonbank entities seek a greater role in facilitating payments. In all this excitement, there are also calls for the Federal Reserve to ‘get in the game’ and issue a central bank digital currency (CBDC) that the general public could use.

This topic is of special interest to me, since I have worked on monetary theory for the last twenty years and researched and written about alternative forms of money for the last seven.² This chapter focuses on whether a CBDC would address any major problems affecting our payment system. There are also potential risks associated with a CBDC, and I will touch on those too. But at this early juncture in the Fed’s discussions, I think the first order of business is to ask whether there is compelling need for the Fed to create a digital currency. I am highly sceptical.

In all the recent exuberance about CBDCs, advocates point to many potential benefits of a Federal Reserve digital currency, but they often fail to ask a simple question: What problem would a CBDC solve? Alternatively, what market failure or inefficiency demands this specific intervention? After careful consideration, I am not convinced as of yet that a CBDC would solve any existing problem that is not being addressed more promptly and efficiently by other initiatives.

Before getting into the details, let me clarify what I mean by ‘CBDC’. Put simply, a CBDC is a liability of the central bank that can be used as a digital payment instrument. For purposes of this discussion, I will focus on *general purpose* CBDC – that is, CBDC that could be used by the general public, not just by banks or other specific types of institutions. A general purpose CBDC could potentially take many forms, some of which

1 This chapter is based on a speech delivered on 5 August 2021 to the American Enterprise Institute. Not long before, the European Central Bank said it would spend the next two years studying the question of whether to issue a digital currency, and the topic continues to be of great public interest. The chapter was written after the Bank of International Settlements issued a paper that was fairly enthusiastic about the prospect of central bank digital currencies and shortly before the Board of Governors published its own paper on central bank digital currencies, which raised some of the issues and concerns addressed in what follows. The views in this chapter are my own and do not represent any position of the Board of Governors or other Federal Reserve policymakers.

2 For example, in 2016, my co-authors and I published a research paper that examined how the use of a privately issued currency backed up by shares of a broad stock market index could replace publicly issued fiat currency (Andolfatto et al. 2016).

could act as anonymous cash-like payment instruments. Here, however, I will focus on account-based forms of CBDC, which the Bank for International Settlements recently described as “the most promising way of providing central bank money in the digital age” (BIS 2021).³ Any such general purpose, account-based CBDC would likely require explicit congressional authorisation.

CENTRAL BANK MONEY VERSUS COMMERCIAL BANK MONEY

It is useful to note that in our daily lives we use both central bank money and commercial bank money for transactions. Central bank money (i.e. money that is a liability of the Federal Reserve) includes physical currency held by the general public and digital account balances held by banks at the Federal Reserve. The funds banks put into these accounts are called reserve balances, which are used to clear and settle payments between banks.⁴ In contrast, chequing and savings accounts at commercial banks are liabilities of the banks, not the Federal Reserve. The bulk of transactions, by value, that US households and firms make each day use commercial bank money as the payment instrument.

FEDERAL RESERVE ACCOUNTS AND COMMERCIAL BANK ACCOUNTS

Under current law, the Federal Reserve offers accounts and payment services to commercial banks.⁵ These accounts provide a risk-free settlement asset for trillions of dollars of daily interbank payments. Importantly, the use of central bank money to settle interbank payments promotes financial stability because it eliminates credit and liquidity risk in systemically important payment systems (e.g. Committee on Payment and Settlement Systems 2003).

Congress did not establish the Federal Reserve to provide accounts directly to the general public; the Federal Reserve instead works in the background by providing accounts to commercial banks, which then provide bank accounts to the general public. Under this structure, commercial banks act as an intermediary between the Federal Reserve and the general public. The funds in commercial bank accounts are digital and can be used to make digital payments to households and businesses, but commercial banks promise to redeem a dollar in one’s bank account into \$1 of US currency. In short, banks peg the exchange rate between commercial bank money and the US dollar at one-to-one. Due to substantial regulatory and supervisory oversight and federal deposit insurance,

3 Note that any CBDC would require some kind of supporting technology. For example, many commentators have considered the possibility that a CBDC could operate using a ‘distributed ledger’. Additionally, an account-based CBDC could potentially take different forms. For example, the infrastructure for an account-based CBDC could be designed so that the Federal Reserve would interact directly with the general public, or it could be designed so that banks or other service providers would maintain all customer relationships with the general public. My comments today focus on the policy issues associated with providing a CBDC rather than on technologies or infrastructure that would be necessary to support a CBDC.

4 The Federal Reserve also provides accounts and payment services to the United States government, certain government-sponsored enterprises, designated financial market utilities, foreign central banks, and certain international organizations.

5 For this purpose, I use the term ‘commercial bank’ broadly to include banks, thrifts, credit unions, and other depository institutions.

households and firms reasonably view this fixed exchange rate as perfectly credible. Consequently, they treat commercial bank money and central bank money as perfect substitutes – they are interchangeable as a means of payment. The credibility of this fixed exchange rate between commercial and central bank money is what allows our payment system to be stable and efficient. I will return to this point later.

This division of functions between the Federal Reserve and commercial banks reflects an economic truth: that markets operate efficiently when private-sector firms compete to provide the highest-quality products to consumers and businesses at the lowest possible cost. In general, the government should compete with the private sector only to address market failures.

CONSIDERATION OF THE CASE FOR A FEDERAL RESERVE CBDC

This brings us back to my original question: What is the problem with our current payment system that only a CBDC would solve?

Could it be that physical currency will disappear? As noted before, the key to having credible commercial bank money is the promise that banks will convert a dollar of digital bank money into a dollar of US physical currency. But how can banks deliver on their promise if US currency disappears? Accordingly, many central banks are considering adoption of a CBDC as their economies become ‘cashless’. Eliminating currency is a policy choice, however, not an economic outcome, and Chair Powell has made clear that US currency is not going to be replaced by a CBDC. Thus, a fear of imminently vanishing physical currency cannot be the reason for adopting a CBDC.⁶

Could it be that the payment system is too limited in reach, and that introducing a CBDC would make the payment system bigger, broader and more efficient? It certainly doesn’t look that way to me. Our existing interbank payment services have nationwide reach, meaning that an account holder at one commercial bank can make a payment to an account holder at any other US bank. The same applies to international payments – account holders at US banks can transfer funds abroad to account holders at foreign banks. So, a lack of connectedness and geographic breadth in the US payment system is not a good reason to introduce a CBDC.

Could it be that existing payment services are too slow? A group of commercial banks has recently developed an instant payment service (the Real-Time Payment Service, or RTP), and the Federal Reserve is creating its own instant payment service, FedNowSM.⁷ These services will move funds between account holders at US commercial banks immediately after a payment is initiated. While cross-border payments are typically less efficient

6 Physical currency can effectively disappear, and everything still works. All the central bank needs to do is promise to provide the currency if requested.

7 These services will complement the existing automated clearinghouse (ACH) payment network, which now enables same-day settlement of ACH payments.

than domestic payments, efforts are underway to improve cross-border payments as well (Financial Stability Board 2020). These innovations are all moving forward in the absence of a CBDC. Consequently, facilitating speedier payments is not a compelling reason to create a CBDC.

Could it be that too few people can access the payment system? Some argue that introducing a CBDC would improve financial inclusion by allowing the unbanked to more readily access financial services. To address this argument, we need to know, first, the size of the unbanked population, and second, whether the unbanked population would use a Federal Reserve CBDC account. According to a recent Federal Deposit Insurance Corporation (FDIC) survey, approximately 5.4% of US households were unbanked in 2019.⁸ The FDIC survey also found that approximately 75% of the unbanked population were “not at all interested” or “not very interested” in having a bank account. If the same percentage of the unbanked population would not be interested in a Federal Reserve CBDC account, this means that a little more than 1% of US households are both unbanked and potentially interested in a Federal Reserve CBDC account. It is implausible to me that developing a CBDC is the simplest, least costly way to reach this 1% of households. Instead, we could promote financial inclusion more efficiently by, for example, encouraging widespread use of low-cost commercial bank accounts through the Cities for Financial Empowerment Bank On project.⁹

Could it be that a CBDC is needed because existing payment services are unreasonably expensive? In order to answer this question, we need to understand why the price charged for a payment might be considered ‘high’. In economics, the price of a service is typically composed of two parts: the marginal cost of providing the service and a markup that reflects the market power of the seller. The marginal cost of processing a payment depends on the nature of the payment (for example, paper check versus electronic transfer), the technology used (for example, batched payments versus real-time payments), and the other services provided in processing the payment (for example, risk and fraud services). Since these factors are primarily technological, and there is no reason to think that the Federal Reserve can develop cheaper technology than private firms, it seems unlikely that the Federal Reserve would be able to process CBDC payments at a materially lower marginal cost than existing private-sector payment services.¹⁰

The key question, then, is how a CBDC would affect the markup charged by banks for a variety of payment services. The markup that a firm can charge depends on its market power and thus the degree of competition it faces. Introducing a CBDC would create

8 “Key Findings from How America Banks: Household Use of Banking and Financial Services,” Federal Deposit Insurance Corporation, <https://www.economicinclusion.gov/surveys/2019household/>.

9 See <https://joinbankon.org/>.

10 Note that section 11A of the Federal Reserve Act (12 U.S.C. § 248a) directs the Federal Reserve to establish a fee schedule for its payment services. Over the long run, these fees are set “on the basis of all direct and indirect costs actually incurred in providing [a service], including interest on items credited prior to actual collection, overhead, and an allocation of imputed costs which takes into account the taxes that would have been paid and the return on capital that would have been provided had the services been furnished by a private business firm”

additional competition in the market for payment services, because the general public could use CBDC accounts to make payments directly through the Federal Reserve – that is, a CBDC would allow the general public to bypass the commercial banking system. Deposits would flow from commercial banks into CBDC accounts, which would put pressure on banks to lower their fees or raise the interest rate paid on deposits to prevent additional deposit outflows (Andolfatto 2021).

It seems to me, however, that private-sector innovations might reduce the markup charged by banks more effectively than a CBDC would.¹¹ If commercial banks are earning rents from their market power, then there is a profit opportunity for nonbanks to enter the payment business and provide the general public with cheaper payment services. And, indeed, we are currently seeing a surge of nonbanks getting into payments. For example, in recent years, ‘stablecoin’ arrangements have emerged as a particularly important type of nonbank entrant into the payments landscape. Stablecoins are digital assets whose value is tied to one or more other assets, such as a sovereign currency. A stablecoin could serve as an attractive payment instrument if it is pegged one-to-one to the dollar and is backed by a safe and liquid pool of assets.¹² If one or more stablecoin arrangements can develop a significant user base, they could become a major challenger to banks for processing payments. Importantly, payments using such stablecoins might be ‘free’ in the sense that there would be no fee required to initiate or receive a payment.¹³ Accordingly, one can easily imagine that competition from stablecoins could pressure banks to reduce their markup for payment services.

Please note that I am not endorsing any particular stablecoin – some of which are not backed by safe and liquid assets. The promise of redemption of a stablecoin into one US dollar is not perfectly credible, nor have they been tested by an actual run on the stablecoin. There are many legal, regulatory and policy issues that need to be resolved before stablecoins can safely proliferate. My point, however, is that the private sector is already developing payment alternatives to compete with the banking system. Hence, it seems unnecessary for the Federal Reserve to create a CBDC to drive down payment rents.

Returning to possible problems a CBDC could solve, it is often argued that the creation of a CBDC would spur innovation in the payment system. This leads me to ask: Do we think there is insufficient innovation going on in payments? To the contrary, it seems to me that private-sector innovation is occurring quite rapidly – in fact, faster than regulators can process. So, spurring innovation is not a compelling reason to introduce a CBDC.

11 The Federal Reserve’s longstanding policy is to offer new payment services to its accountholders only when “other providers alone cannot be expected to provide [those services] with reasonable effectiveness, scope, and equity”. See “Policies: The Federal Reserve in the Payments System” at https://www.federalreserve.gov/paymentsystems/pfs_frpaysys.htm (issued 1984; revised 1990 and 2001).

12 A well-designed stablecoin would function similarly to ‘narrow banks’, which have a long tradition in economic theory but have never existed in any serious way as a competitor for commercial banks. Narrow banks take deposits and issue liabilities on themselves much like a standard bank. However, narrow banks hold only liquid, very safe assets that back up their liabilities 100%. They do not make loans or hold risky securities.

13 However, stablecoin payments might not be free in the sense that stablecoin users would allow their financial transaction data to be harvested and monetized.

Could it be, however, that the types of innovations being pursued by the private sector are the ‘wrong’ types of payment innovations? I see some merit in this argument when I consider cryptoassets such as bitcoin that are often used to facilitate illicit activity. But a CBDC is unlikely to deter the use of cryptoassets that are designed to evade governmental oversight.

Could the problem be that government authorities have insufficient information regarding the financial transactions of US citizens? In general, the government has sought to balance individuals’ right to privacy with the need to prevent illicit financial transactions, such as money laundering. For example, while the government does not receive all transaction data regarding account holders at commercial banks, the Bank Secrecy Act requires that commercial banks report suspicious activity to the government.

Depending on its design, CBDC accounts could give the Federal Reserve access to a vast amount of information regarding the financial transactions and trading patterns of CBDC account holders. The introduction of a CBDC in China, for example, likely will allow the Chinese government to more closely monitor the economic activity of its citizens. Should the Federal Reserve create a CBDC for the same reason? I, for one, do not think so.

Could the problem be that the reserve currency status of the US dollar is at risk and the creation of a Federal Reserve CBDC is needed to maintain the primacy of the dollar? Some commentators have expressed concern, for example, that the availability of a Chinese CBDC will undermine the status of the US dollar. I see no reason to expect that the world will flock to a Chinese CBDC or any other. Why would non-Chinese firms suddenly desire to have all their financial transactions monitored by the Chinese government? Why would this induce non-Chinese firms to denominate their contracts and trading activities in the Chinese currency instead of the US dollar? Additionally, I fail to see how allowing US households to, for example, pay their electric bills via a Federal Reserve CBDC account instead of a commercial bank account would help to maintain global dollar supremacy. (Of course, Federal Reserve CBDC accounts that are available to persons outside the United States might promote use of the dollar, but global availability of Federal Reserve CBDC accounts would also raise acute problems related to, among other things, money laundering.)

Finally, could it be that new forms of private money, such as stablecoins, represent a threat to the Federal Reserve for conducting monetary policy? Many commentators have suggested that new private monies will diminish the impact of the Federal Reserve’s policy actions, since they will act as competing monetary systems. It is well established in international economics that any country that pegs its exchange rate to the US dollar surrenders its domestic monetary policy to the United States and imports US monetary policy. This same logic applies to any entity that pegs its exchange rate to the US dollar.

Consequently, commercial banks and stablecoins pegged to the dollar act as conduits for US monetary policy and amplify policy actions. So, if anything, private stablecoins pegged to the dollar broaden the reach of US monetary policy rather than diminish it.

After exploring many possible problems that a CBDC could solve, I am left with the conclusion that a CBDC remains a solution in search of a problem. That leaves us only with more philosophical reasons to adopt a CBDC. One could argue, for example, that the general public has a fundamental right to hold a riskless digital payment instrument, and a CBDC would do this in a way no privately issued payment instrument can (Berentsen and Fabian Schar 2018). On the other hand, thanks to federal deposit insurance, commercial bank accounts already offer the general public a riskless digital payment instrument for the vast majority of transactions.

One could also argue that the Federal Reserve should provide a digital option as an alternative to the commercial banking system. The argument is that the government should not force its citizens to use the commercial banking system, but should instead allow access to the central bank as a public service available to all (Andolfatto 2015). As I noted earlier, however, the current congressionally mandated division of functions between the Federal Reserve and commercial banks reflects an understanding that, in general, the government should compete with the private sector only to address market failures. This bedrock principle has stood America in good stead since its founding, and I don't think that CBDCs are the case for making an exception.

While CBDCs continue to generate enormous interest in the United States and other countries, I remain sceptical that a Federal Reserve CBDC would solve any major problem confronting the US payments system. There are also potential costs and risks associated with a CBDC, some of which I have alluded to already. I have noted my belief that government interventions in the economy should come only to address significant market failures. The competition of a Fed CBDC could disintermediate commercial banks and threaten a division of labour in the financial system that works well. And, as cybersecurity concerns mount, a CBDC could become a new target for those threats.

I expect these and other potential risks from a CBDC will be addressed as the discussion over digital currencies moves forward.

REFERENCES

- Andolfatto, D (2015), "Fedcoin: On the Desirability of a Central Bank Cryptocurrency", *Macromania Blog*, 3 February.
- Andolfatto, D (2021), "Assessing the Impact of Central Bank Digital Currency on Private Banks", *The Economic Journal* 131: 525-40.
- Andolfatto, D, A Berentsen and C Waller (2016), "Monetary Policy with Asset-Backed Money", *Journal of Economic Theory* 164: 166-86.

BIS – Bank for International Settlements (2021), *Annual Economic Report 2021*.

Berentsen, A and F Schar (2018), “The Case for Central Bank Electronic Money and the Non-Case for Central Bank Cryptocurrencies”, *Federal Reserve Bank of St. Louis Review* 100(2).

Committee on Payment and Settlement Systems (2003), *The Role of Central Bank Money in Payment Systems*, Bank for International Settlements.

Financial Stability Board (2020), “FSB Delivers a Roadmap to Enhance Cross-Border Payments”, news release, 13 October.

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CHAPTER 16

On the necessity and desirability of a central bank digital currency

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The movement behind central bank digital currency (CBDC) is gaining momentum. I confess to playing a small role in promoting the idea (e.g. Andolfatto 2021a, 2021b). In this chapter, I take a step back from this work and critically re-examine the arguments I and others have made to support the CBDC initiative. I also assess some of the arguments made against CBDC. I conclude that both sides are likely overstating their respective cases. When I weigh all factors together, I conclude that, for the United States at least, a retail CBDC is not essential and may not even be desirable. A wholesale CBDC, on the other hand, is a variation on the theme that is worth considering. This latter recommendation is nothing new – it corresponds to the old idea of enacting legislation that would permit free entry into the business of narrow banking.

Let me begin by asking what makes CBDC a compelling idea. I like to think of it this way. Imagine having to design a payments system from scratch. At its core, clearing and settling payments boils down to messaging and bookkeeping. The act of debiting and crediting money accounts in a ledger does not sound like rocket science – it sounds more like Accounting 101. If we think about all the payments that are made every day between customers and merchants, merchants and suppliers, employers and employees, private and public agencies, and so on, what could be simpler than having all this bookkeeping performed on a single ledger operated by a single accounts manager? And since we are talking about money accounts, why not have these accounts consist of the nation's legal tender – digital versions of today's paper bills and metal coins? And if we are talking about legal tender money accounts, why not appoint the central bank as the trusted accounts manager? This is the main idea behind a CBDC. It is a proposal to let all Americans open chequing accounts consisting of digital fiat currency with the Federal Reserve. At present, this privilege is limited to depository institutions and a few other agencies.

THE US PAYMENTS SYSTEM TODAY

A CBDC seems like an elegant solution to the problem of managing payments compared to the system presently in place. The payments system today consists of three broad layers. On the top layer, we have the US Federal Reserve, the nation's central bank. The second layer consists of private banks – specifically, depository institutions. While the

number of banks has been falling over time, there are still almost 5,000 banks in the United States today, with the top ten banks holding about half of all deposits. Almost all (95%) American households have bank accounts in this second layer.

Note that the money in bank accounts is not fiat currency – it consists of liabilities issued by private banks. If a bank fails and if its deposit liabilities are not insured, the depositor may incur a loss. These private banks, in turn, have accounts with the Federal Reserve. The bank accounts held with the Federal Reserve are not subject to default. Traditionally, private banks have been responsible for processing retail payments. Transactions occurring between two parties not sharing the same bank are cleared through a variety of payment systems, with net interbank surplus/deficit positions ultimately settled at the central bank.

The third layer consists of several non-bank payment service providers (PSPs), like Mastercard, PayPal and very soon, Facebook-sponsored Diem, as well as a rapidly growing number of FinTechs eager to enter the business. Because this third layer is presently prohibited from having reserve accounts, firms in this category cannot use the Federal Reserve's wholesale payment rails. As a practical matter, this implies that non-bank PSPs must either partner with a bank or otherwise go through the private banks to conduct at least a part of their business. This additional layer of intermediation has been called into question by many observers. It is a layer that could be eliminated if a wholesale CBDC were to be made available.

THE CASE FOR CBDC

CBDC advocates point to several benefits. First, because CBDC is fiat currency, CBDC accounts are fully insured.¹ Second, the problem of communicating across databases speaking different languages for the purpose of clearing and settling payments is entirely circumvented; at least, to the extent that all households and businesses choose to open and use CBDC accounts. A CBDC would combine a common currency with a common language – for example, the ISO 20022 global payment messaging standard – together with real-time payments functionality. Third, a CBDC could be designed in a manner that directly addresses the concerns people and businesses have over data privacy and ownership. Fourth, the enterprise could be operated and funded in the manner of basic public infrastructure. The purpose of this would be to promote financial inclusion or otherwise level the playing field between large and small actors, say, by eliminating all user fees and minimum balance restrictions (Crawford et al. 2021). It would also promote competition and encourage innovation as FinTech firms would no longer need banks

¹ While fiat money is labelled a liability of the government, it is not 'debt' in the way money represents a contractual obligation under a gold standard or fixed exchange rate regime. For a monetary sovereign like the United States, fiat money resembles equity more than it does debt. While dilution is a possibility, default is not.

to serve as their correspondents (Usher et al. 2021). There are other purported benefits associated with a CBDC unrelated to payments, but I will touch on those arguments in a later section.

BUT IS A CBDC NECESSARY?

Granted, the US payments system is not perfect. Even if we acknowledge that the system has generally improved over time, there is little question that it has lagged its counterparts in several other jurisdictions, including a number of so-called lesser-developed economies. Whether a CBDC is the best, or even the only, way to optimise payments going forward, however, should not be assumed *a priori*. And, indeed, a number of commentators have made exactly this point (Koning 2021, Quarles 2021, Waller 2021). Much of what I have to say in this section draws on their observations.

Let me go down the list of the purported benefits of a CBDC and reflect on each point. First, it is true that CBDC accounts would be fully insured. But is the lack of deposit insurance a concern for most retail users? The Federal Deposit Insurance Corporation presently insures bank deposits up to \$250,000 per account. It seems unlikely that households and small businesses would be attracted to CBDC on the basis of relative safety. Money held in non-bank PSP accounts is not insured. The fact that people willingly hold transaction balances in such accounts further diminishes the suggestion that safety is a major concern. Whether the same holds true at the wholesale level, however, is not entirely clear. CBDC would provide universal access to a central bank deposit facility (rendering the Fed's Overnight Reverse Repo Facility, or ON RRP, redundant). The availability of an interest-bearing CBDC might encourage corporate cash managers to substitute away from repo arrangements into CBDC, avoiding the counterparty risk associated with the shadow bank sector. Or, as my analysis in Andolfatto (2021a) suggests, the effect may simply be to place a floor on money market rates without disintermediating private credit arrangements. If this latter outcome is, as I conjecture, the more likely one, then the relative safety of CBDC may not be a primary concern even at the wholesale level.

Second, it is true that processing payments would be made considerably easier if everyone had a CBDC account – in particular, it would avoid the need to communicate across databases when clearing and settling payments. On the other hand, this would also be true if everyone had a Bank of America account. But these are (and are likely to remain) hypothetical scenarios. In reality, American households and businesses hold bank and non-bank accounts with thousands of firms. This is not going to change anytime soon. While it is true that clearing and settling small-value payments across all these databases takes some time (typically, two or three business days), there are presently efforts underway to improve efficiency along this dimension. The automated clearinghouse (ACH) network now enables same-day settlement of ACH payments. The Clearing House has recently developed a real-time payments service that provides the owners of bank accounts immediate access to their funds. A similar technology called

FedNow is being developed by the Federal Reserve. The case for a CBDC should not be made on the assumption that the status quo is expected to persist. Rather, it needs to be made in the context of an already rapidly developing payments system. In light of what is, or what will soon be, available to most Americans through the initiatives described above, the case for a CBDC seems considerably weakened.

Third, a CBDC could adopt protocols that allocate property rights over individual transaction histories to the individuals generating those histories, as opposed to the intermediaries that record this information. Individuals would then be free to use their data to shop around to, for example, secure better terms on credit arrangements. But again, a CBDC is not the only way to achieve this outcome. The result could instead be achieved through appropriate legislation, as it is in the United Kingdom through its Open Banking initiative. That legislation forces UK banks to create open interfaces into previously locked customer accounts and payment systems.

Fourth, while the idea of basic payment services as a free public option sounds attractive, it is not immediately clear how such a facility would promote the cause of financial inclusion (which I take here to mean access to payment services, not credit). Most American households already have bank accounts. Many also have non-bank transaction accounts. The fraction of unbanked households in all other developed economies appears to be much lower than in the United States, even though CBDC does not (yet) exist in those jurisdictions. As for the charges and restrictions that are often applied to chequing accounts, banks are increasingly making free checking services available to their customers. Credit card companies often offer cards with zero fees, as long as borrowed money is repaid at the end of each month. From the consumer side of things, at least, the user cost of payment services already seems low – at least, for domestic payments. The costs of international remittances remains relatively high, but these too have been declining over time, especially through mobile payment options.² It is conceivable that a CBDC could complement the effort to reduce the costs of international money transfers. But as the Bank for International Settlements notes (BIS 2021), the effort would require international cooperation. One cannot help but wonder whether CBDCs would be needed if that cooperation were forthcoming to begin with.

Although the user cost associated with making payments is either low or declining for consumers, the same is not necessarily true for businesses. Credit card issuers (usually credit card companies) and acquirers (usually banks) recover the cost of their operations – and possibly more if they can exert market power – by charging fees to the merchants that agree to accept card payments. The contractual terms often include an ‘honour all cards’ rule that restricts the merchant from conditioning product prices on method of payment. While larger firms are often able to negotiate more favourable terms, smaller businesses have little bargaining power. They must either accept the terms or risk losing

2 See <https://www.statista.com/statistics/962701/costs-of-remittances-by-payment-type>

sales. This pricing protocol is complemented by the strategy of *paying* customers to use their cards, typically through a rewards or cash-back programme. To put it another way, card customer user costs are not only low, they are, in many cases, *negative*. The effect of these practices is to encourage consumers to select the payment option with the highest private reward – not necessarily the one with the lowest social cost. Higher costs must, of course, be absorbed along other dimensions, including – but not limited to – higher overall product prices.

Given the business model described above, how might an even zero user-cost CBDC attract users? Cardholders already have access to several low-cost payment options. A CBDC may potentially offer consumers a relatively high interest rate on their deposits, but this is a reward for saving. Card companies reward consumers for spending. While merchants would no doubt be happy if consumers were to switch *en masse* to a CBDC, there would be no point in introducing the product – at least for this purpose – if consumers are not willing to part with their beloved rewards programmes. If the success of a CBDC depends on regulating interchange fees and rewards programmes, then what is necessary is regulatory reform and not CBDC *per se*.

OTHER COSTS AND BENEFITS

CBDCs are also promoted and criticised for reasons not directly related to payments.

First, there are worries about what might happen if physical cash eventually disappears. One concern is that monetary policy may no longer be able to determine the price level in a ‘cashless’ economy. Physical currency, however, is better viewed as just one component of a broader monetary aggregate. It seems unlikely that the price level depends critically on the fraction of money balances people choose to hold in currency vis-a-vis other forms of money (Andolfatto 2021a). Another concern is that zero-interest currency places an effective lower bound on bank deposit rates. Absent this lower bound, banks may exert their monopoly power to drive deposit rates to even lower levels (Usher et al. 2021). However, it seems doubtful to me that currency is needed to avoid negative deposit rates. In the United States, all US persons can open online accounts with the US Treasury via Treasury Direct. If the yield on Treasury bills goes negative, it will be because of monetary policy and not because of monopoly banking practices. In any case, the prospect of cash disappearing seems less likely for the United States relative to other countries. If anything, the global demand for US physical currency has been growing rapidly.

Second, CBDC is sometimes promoted as a way to *encourage* the disappearance of physical currency. The concern here once again has to do with the zero lower bound. But in this case, the lower bound is seen as an impediment to monetary stabilisation policy – specifically, situations in which negative nominal interest rates are needed to stimulate aggregate demand. I am sceptical of this argument for two reasons. First, a situation that calls for negative interest rates is, in my view, better dealt with through fiscal policy.

Second, negative interest rate policy is already being applied in many countries where physical currency still exists. CBDC is not needed to implement negative interest rate policy.

Third, there is a concern that CBDC would disintermediate banks (although this is considered to be a feature and not a bug by some proponents). It seems likely that a CBDC that offers an interest rate higher than prevailing deposit rates would increase the cost of funding for banks. It is not *a priori* clear, however, how these higher costs might impact bank lending. Much will depend on monetary policy and market structure. Bank lending is not likely to be much affected if the interest rate on CBDC is kept below the monetary policy rate (Andolfatto 2021a). To the extent that banks have market power, they are likely to see their profit margins squeezed as they raise deposit rates to retain what is still a relatively cheap source of funding. But higher deposit rates may even expand the supply of deposits. Theoretically, it is possible for this latter effect to *increase* bank-financed investment (Chiu et al. 2019).

Fourth, some have suggested that a universally available central bank deposit facility is likely to promote financial instability because it would provide an extremely convenient ‘flight-to-safety’ vehicle – even more so than physical cash (which pays no interest and has a maximum denomination of \$100 in the United States). This argument fails to take into account at least three important considerations. First, if a run on banks occurred for this reason, the Federal Reserve would stand ready to lend at the discount window and standing repo facility. Second, the CBDC rate itself could be made state-contingent. In particular, it could be lowered significantly during a run event, thereby discouraging mass redemptions of bank deposits. Third, the empirical evidence we have does not support the concern. A number of commentators made similar predictions in regard to the Federal Reserve’s ON RRP facility when it was first introduced.³ Ahnert and Macchiavelli (2021) find that money market funds that had access to the ON RRP facility during the 2013 debt-ceiling crisis exhibited greater stability relative to their peers that did not.

Finally, there are those who fear that the US dollar’s status as a world reserve currency will be in jeopardy if the United States does not follow the lead of China, its main global competitor. There are a number of factors working against this outcome. First, a world reserve currency supplier must stand prepared to run potentially very large current account deficits. For better or worse, the United States is willing to do so. The Chinese economic model, however, encourages the exact opposite – something that is not likely to change anytime soon. Second, growth in the global demand for US dollars, treasury securities and dollar-denominated assets continues unabated. CBDC is not needed to encourage the global appetite for US dollars.

3 While ON RRP is not technically a deposit facility, it operates like one.

CONCLUSIONS

There is much to like about CBDC at a conceptual level. Every person in the world already has permissionless access to Federal Reserve liabilities in the form of paper currency. Why should the privilege not be extended to the digital component of Federal Reserve liabilities? This is a good question, but the example of physical currency may not be apt. First, payments made with physical currency are cleared and settled on a peer-to-peer basis. The Federal Reserve plays no role in facilitating such transactions, apart from providing the medium of exchange. Second, the technology associated with peer-to-peer currency exchange has not changed very much over time, apart from advances that have made counterfeiting more difficult.

CBDC, in contrast to physical cash, would require the services of an intermediary. It is a legitimate question to ask whether a central bank accustomed to serving a relatively small wholesale sector might possess the culture necessary to handle large-scale customer demands at the retail level. Relatedly, can one plausibly expect a public sector agency to keep pace with technological advances the way profit-seeking private enterprises can? Some recent evidence is not encouraging on this score. Compare, for example, how rapidly the Clearing House implemented its real-time payment system relative to FedNow, which is still in the works after years of consultation and deliberation. As George Selgin has pointed out,⁴ proponents of CBDC who lament how the US has fallen behind the rest of the world fail to note that the rest of the world is ahead not because other countries have CBDC, but because they have superior private-sector payments arrangements. I would only amend his observation by changing ‘superior private-sector’ to ‘superior private-public-sector’ arrangements because no money and payments system is purely private or public enterprise – and the best outcomes tend to occur through well-designed private-public collaborations.

In any case, even if the US payments system is lagging the rest of the world in some respects, it is not light-years behind. More efficient protocols are being adopted and innovation in the FinTech space is already advancing at a rapid pace. The remaining hurdles have more to do with the pricing power of large credit card companies and banks, together with inadequate legislation. If this is the case, then perhaps a wholesale CBDC is the way to go. The idea here would be to let companies like PayPal, Square, Novi and smaller FinTechs gain access to Fed Master Accounts and the Fed’s wholesale payment rails. Any non-bank with access to a Fed Master Account should be required to hold 100% of its assets either in reserves or treasury bills (and possibly longer dated treasury securities if access to the Fed’s standing repo facility is also granted). In short, these firms should be granted something akin to a ‘narrow bank’ charter. Other countries seem

4 <https://threadreaderapp.com/thread/1443904543302070272.html>

prepared to follow this route. The Bank of England (2017), for example, now permits non-bank PSPs to apply for settlement accounts in the Bank's RTGS system. Perhaps it's time for the United States to follow suit.

REFERENCES

Ahnert, T and M Macchiavelli (2021), "Safe Assets and Financial Fragility: Theory and Evidence", SSRN 3460800.

Andolfatto, D (2021a), "Assessing the Impact of Central Bank Digital Currency on Private Banks", *The Economic Journal* 131(634): 525-540.

Andolfatto, D (2021b), "Some Thoughts on Central Bank Digital Currency," *Cato Journal*, Spring/Summer.

Bank of England (2017), "Bank of England Extends Direct Access to RTGS Accounts to Non-bank Payment Service Providers", 19 July.

BIS – Bank for International Settlements (2021), "III. CBDCs: An Opportunity for the Monetary System", in *BIS Annual Economic Report 2021*.

Chiu, J, M Davoodalhosseini, J Jiang and Y Zhu (2019), "Central Bank Digital Currency and Banking", Bank of Canada Staff Working Paper 2019-20.

Crawford, J, L Menand and M Ricks (2021), "FedAccounts: Digital Dollars", *The George Washington Law Review* 89(1).

Koning, J P (2021), "To CBDC or Not to CBDC?", American Institute for Economic Research, 5 July.

Quarles, R K (2021), "Parachute Pants and Central Bank Money", speech at the 113th Annual Utah Bankers Association Convention, 28 June.

Usher, A, E Reshidi, F Rivadeneyra and S Hendry (2021), "The Positive Case for a CBDC," Bank of Canada Staff Discussion Paper 2021-11.

Waller, C J (2021), "CBDC: A Solution in Search of a Problem?", speech at the American Enterprise Institute, 5 August.

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CHAPTER 17

Building a stronger financial system: Opportunities for a digital dollar

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It would benefit the United States to develop an effective and secure digital dollar. This would be a direct obligation of the Federal Reserve, distributed to the public by regulated private-sector payment service providers. At the same time, the relevant US agencies should also make major improvements in the legacy bank-railed US payments system.

Maintaining cybersecurity and privacy while controlling illegal payments will be a challenging design problem. Without engagement of the private sector, a centralised payments system could also impair innovation. Nevertheless, it seems likely to me that a US digital dollar will ultimately be deployed. The lengthy required development work should begin now.

The project will need the innovative power of the private sector, while increasing the reach and quality of government regulation. The development process will require resources and time, perhaps more than five years, but could generate large beneficial technology spillovers to the digital economy. It may inspire both pricing and technology innovation in firms that currently provide bank-railed payment services.

In May 2021, Lael Brainard, a governor of the Federal Reserve, remarked that the United States should be involved in discussions of standards for the design and uses of central bank digital currencies (CBDCs) (Brainard 2021). This will be necessary for the country to maintain its leadership in international payment-related markets.

The Fed should also prepare a strategy for preventing undesirable cryptocurrencies from gaining traction in US payments. A digital dollar can play a role here by providing an officially supported alternative, though compliant and useful stablecoins would also help.

As a starting point, the MIT Digital Currency Initiative and the Federal Reserve Bank of Boston have made progress on Project Hamilton (Rosengren 2021). This is the 'R' in R&D. The 'D' will require more resources, and an implementation plan that balances privacy against protection from illegal payments.

¹ The author is a member of the board of directors of TNB Inc, which wishes to offer narrow bank deposits but has been unable to obtain a deposit account at the Fed. TNB's charter prevents it from offering payment-related products and services. The author is compensated by TNB with either equity or otherwise.

WHY CAN'T BANKS DO THIS?

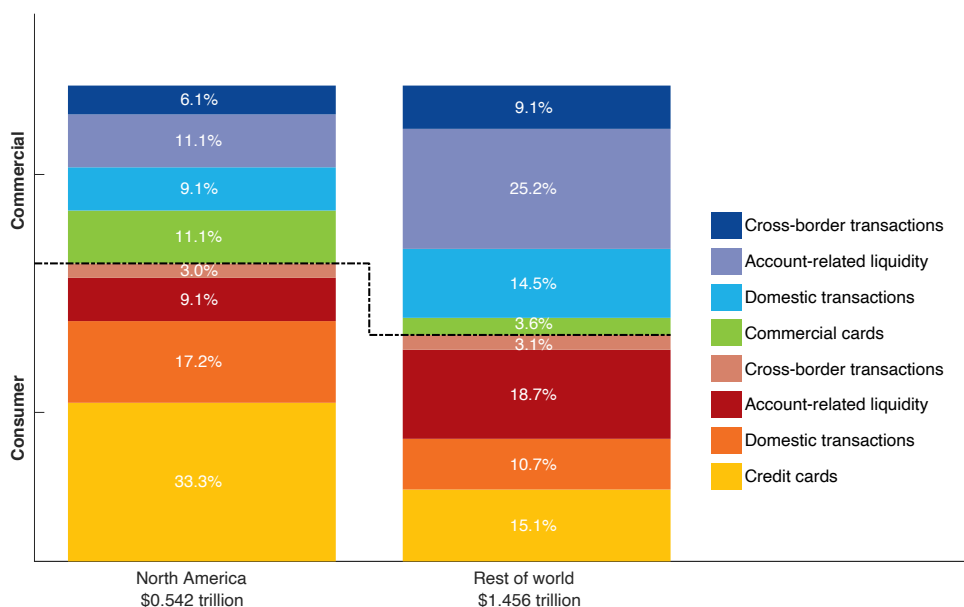
US banks could implement an effective low-cost payments system, but they have not done so due to regulation, network effects that limit entry and profit incentives.

Alice has for centuries paid Bob by asking her bank to debit her deposit account in favour of Bob's account at his bank. This is still the case today. Moreover, banks protect the privacy of their customers while monitoring payments for their legality.

Commercial bank deposits can be provided in interoperable forms suitable for smart contracting. A more advanced interoperable payments system based on bank deposits is feasible.

Currently, Americans are not getting competitive payment-related services from banks, and their primary payment instrument – their bank deposits – is compensated with extremely low interest rates. When wholesale market interest rates rise, consumer bank deposit interest rates usually stay near zero (Driscoll and Judson 2013, Drechsler et al. 2017). It often takes more than a day for US merchants to receive their payments. North Americans pay about 2.3% of GDP for payment services (McKinsey 2020), far more than Europeans, in particular due to extremely high fees for credit cards (Figure 1).

FIGURE 1 A BREAKDOWN OF PAYMENT REVENUES BY TYPE



Note: Data are from McKinsey (2020).

US banks and credit card providers operate what Rochet and Tirole (2003) called a two-sided market. On one side of the market, merchants pay high payment fees; on the other, consumers are offered low direct payment fees, and sometimes rewards. Combine this with the positive network effects of a common payments system that is convenient for consumers to use, and almost all market participants are effectively bound to the bank-railed system, making competitive entry difficult.

Ultimately, consumers bear some of the burden of merchant payment fees through higher prices for goods and services. To make their payments, many consumers borrow money at high interest rates on their card accounts or put aside cash in bank accounts that offer woefully low interest rates.

Banks have little to gain by making it simple for their customers to move their cash to the highest bidder. They maintain ‘walled gardens’ that discourage financial consumers from shopping around. Banks have also underinvested in fast, interoperable payment technologies, so the Fed has stepped in with its real-time payment system, FedNow, which will be ready in a couple of years. FedNow will improve the speed of payments and offer other efficiency gains but does not, on its own, deliver improved competition for payment services.

This has understandably led to calls for alternatives: FinTech payment firms, private stablecoins like Diem (Catalini 2021), and CBDCs. Now is the time for Congress to give the Fed the legal power to introduce a digital dollar, and to encourage (or direct) the Fed to test a digital dollar technology so that it could be deployed at short notice.

There is no need yet to make a commitment to deploy the digital dollar. Common knowledge that an effective digital dollar is under development could give banks the incentives they currently lack to offer Americans a better payments system.

Low-cost FinTech payment firms, especially if given Fed accounts, might grab bank payment franchises. This happened in China, where 94% of mobile payments are now processed by Alipay and WeChatPay, with 90% of residents of China’s largest cities using these services as their primary method of payment (Klein 2020, Business Today 2020). Or, stablecoins like Diem might disintermediate banks.

Some banks may stall investment, believing that the US government will not act aggressively to open a path by which consumers and businesses can get access to better options, such as a CBDC or other new types of FinTech payment services. If incumbent banks do not respond, then one or more of these options should be deployed.

A digital dollar might also improve financial inclusion. A 2020 study by the Federal Deposit Insurance Corporation estimated that about 7.1 million US households were unbanked, and many others underbanked. As noted by Janet Yellen, US Treasury Secretary:

“Too many Americans don’t have access to easy payments systems and banking accounts, and I think this is something that a digital dollar, a central bank digital currency, could help with” (*New York Times* 2021).

The use of paper money in US payments declined from 51% in 2010 to 28% in 2020 (McKinsey 2020). In the future, those without access to electronic payments may be isolated from parts of the economy. A CBDC could, however, actually accelerate this decline, if not properly designed, so special attention should be given to unbanked and underbanked Americans.

CBDC technology also offers options for more efficient implementation of monetary and fiscal policy – for example, faster dissemination of Covid-19 relief payments to millions of Americans (Digital Dollar Foundation and Accenture 2020). The Fed might improve the transmission of monetary policy by real-time measurement of monetary variables, and perhaps offering interest on CBDC.

CHALLENGES FOR A CBDC

The greatest challenge for CBDC designers is protecting privacy while detecting money laundering and the financing of terrorism. If there is a central regulator, data will also need to be protected from cyberattacks and surveillance. China has not hesitated to concentrate CBDC payment data in the hands of its central bank, but China is an authoritarian state. Centralised databases containing personal information may not be popular in the United States.

Along with the digital dollar, Americans could be given an option to access the payment system with standardised biometric identities – as deployed for India’s UPI interoperable payment interface, from which the United States can learn (D’Silva et al. 2019).

The United States could opt for a decentralised approach to holding data in banks and FinTech firms, although without effective regulation on standardisation and interoperability, this two-tiered market structure could become as clunky as the current bank-railed payments system. To avoid this, payment service providers should be tightly regulated to ensure open access, service levels, and – importantly – interoperability (Darko et al. 2021).

Another potential downside of a CBDC is that technology innovation could become more centralised within government – not usually a formula for success. This can be overcome with carefully designed public-private partnerships.

If the CBDC is not sufficiently resilient, an operational accident could cause millions of Americans to suffer. Congress could then feel obliged to step in. This could reduce the independence of the Fed. A Fed digital dollar should not be deployed until its technology is bulletproof (within the limits of technology), making it even more important to begin the development work now.

A heightened risk of bank runs would be a disadvantage of a digital dollar. However, banks have liquidity requirements, and can pledge assets to the Fed in exchange for loans to meet deposit redemptions. Although a CBDC would make it easier to quickly withdraw deposits from a bank, this risk can be managed satisfactorily.

The increased mobility of money associated with a well-designed and heavily used CBDC would force banks to compete more aggressively for deposits, driving up deposit interest rates. This is good for consumers, and bad for bank shareholders. But the amount of credit offered by banks would not suffer significantly. Banks do not currently offer unprofitable loans, using the irrational justification that they can recoup the associated losses by exploiting their below-market deposit rates. The set of loans that are profitable for banks to offer at any point would be about the same, on average, although some smaller banks in outlying areas might have difficulty making the transition to a more competitive payment system. In the end, the US government should not allow an inefficient payment system to persist so that depositors can subsidise banks.

The potential for disrupting banks, while real, should not be a reason for avoiding CBDCs. The banking industry is likely aware that disruption is coming, one way or another, and should prepare to offer a better payment system.

INTERNATIONAL IMPLICATIONS

Most of the world's central banks are now working on CBDCs (Boar and Wehrli, 2021). Few have specific plans to issue CBDCs, but some have moved from research to active development. Active CBDC developers include the People's Bank of China, Sweden's Riksbank (Sveriges Riksbank 2021), the Bank of Canada (2021), the ECB (2021), the Bank of Korea (Kim 2021), and the Bank of Japan (2021). But among major economies, only China has committed to deploying a CBDC.

It is possible that eCNY, China's new CBDC, could reduce the international dominance of the US dollar. These concerns are not a good reason to rush out a digital dollar before it is carefully designed. The international dominance of the US dollar rests on the lack of US barriers to cross-border capital flows, the depth and liquidity of markets for US Treasuries and other financial instruments, the fairness and stability of the US legal system, and the reliability of US monetary and financial policy (Gopinath and Stein 2021, Gourinchas 2019, Jiang et al. 2020, Maggiori et al. 2021). This is not easy for China to replicate.

In the (unofficially translated) words of Li Bo, Deputy Governor of the People's Bank of China:

“The internationalisation of the RMB is a natural process. Our goal is not to replace the US dollar or other currencies, but to let the market make choices to further facilitate international trade and investment” (Sun and Yan 2021).

That said, China leads the US in retail payment technology. China's mobile payment service providers have such deep market penetration that the desire to limit their dominance was one of the key government motivations for introducing eCNY.

eCNY will be part of a rich payment ecosystem. Although representatives of the People's Bank of China have emphasised that eCNY is not intended for 'yuanisation' of the economies of other countries, China is making arrangements for cross-border use of eCNY with other CBDCs, including those of Thailand, Hong Kong, and the United Arab Emirates (Hong Kong Monetary Authority 2021). There are also potentially important business-to-business cross-border applications of eCNY (Ekberg and Ho 2021).

eCNY could open up international commercial opportunities for Chinese firms and could increase the influence of China in emerging-market economies. However, the US should avoid competing with an internationally accessible US CBDC, given the impact that a digital dollar could have on small open economies through its potential for interference with local monetary policy. The United States should support the development of international agreements to protect foreign monetary systems from disruption by another country's CBDC.

Governor Brainard's remarks correctly suggest that a US CBDC technology would place the United States in a better position to influence international forums that set technical standards and make intergovernmental agreements for the cross-border use of CBDCs. Such agreements are already coming into G7 discussions (Auer et al. 2021, Associated Press 2021, US Department of the Treasury 2021).

If CBDC technology uses public-private partnerships, US firms could provide payment technologies in international markets. US banks have been ceding commercial advantage to Chinese banks in international markets, in part because of US regulations and sanctions.

CONCLUSIONS

The United States would benefit by beginning the years-long development of a digital dollar. The design should prioritise the efficiency of payments, privacy, interoperability, financial inclusion and the ability to monitor payments for compliance. The final decision to deploy the digital dollar should be delayed until more is learned about its design, costs and benefits. Delaying the start of development until the point in time that the need for a CBDC becomes obvious is a poor strategy.

The United States should also take a leadership position in international official discussions on the use – domestic and cross-border – of CBDCs.

In parallel, efforts should continue to be made to improve the competitiveness and efficiency of the legacy US payment system. Success here could relieve the United States from an eventual need to deploy a CBDC. FedNow is an important milestone, and

regulation could be used to further encourage innovation and competition for payment-related services. The Fed, for example, has recently considered offering accounts to ‘novel’ payments firms under appropriate conditions (Board of Governors of the Federal Reserve System 2021). Effective and compliant stablecoins can also play a positive role.

REFERENCES

Associated Press (2021), “Japan wants G7 finance chiefs to ‘thrash out’ digital currency policy at talks as China trials continue”, *South China Morning Post*, 9 February.

Auer, R, P Haene, and H Holden (2021), “Multi-CBDC arrangements and the future of cross-border payments”, BIS Paper 115.

Bank of Canada (2021), “Contingency Planning for a Central Bank Digital Currency”, Bank of Canada.

Bank of England (2021), “New Forms of Digital Money”, Discussion Paper, Bank of England.

Bank of Japan (2021), “Commencement of Central Bank Digital Currency Experiments”, Bank of Japan.

Bloomberg News (2021), “China Says It Has No Desire to Replace Dollar With Digital Yuan”, 18 April.

Board of Governors of the Federal Reserve System (2021), “Proposed Guidelines for Evaluating Account and Services Requests”, Federal Reserve Board.

Boar, C and A Wehrli (2021), “Ready, steady, go? – Results of the third BIS survey on central bank digital currency”, BIS Paper 114.

Brainard, L (2021), “Private Money and Central Bank Money as Payments Go Digital: An Update on CBDCs”, speech At the Consensus by CoinDesk 2021 Conference, Washington, DC, Federal Reserve Board.

Business Today (2020), “Alipay retains leadership position with 55% market share in China’s mobile payments market”, 9 July.

Catalini, C (2021), “From cryptocurrencies, stablecoins and Diem to CBDCs”, Diem, OMFIF conference.

Digital Dollar Foundation and Accenture (2020), “The Digital Dollar Project: Exploring a US CBDC”, Digital Dollar Project.

Drechsler, I, A Savov, and P Schnabl (2017), “The Deposits Channel of Monetary Policy”, *The Quarterly Journal of Economics* 132: 1819–1876.

D’Silva, D, Z Filková, F Packer, and S Tiwari (2019), “The design of digital financial infrastructure: Lessons from India”, BIS Paper 106.

Duffie, D, K Mathieson, and D Pilav (2021), “Central Bank Digital Currency: Principles for Technical Implementation”, Digital Asset white paper.

Driscoll, J, and R Judson (2013), “Sticky Deposit Rates”, Federal Reserve Board, Washington DC working paper.

Ekberg, J and M Ho (2021), *A New Dawn for Digital Currency*, Oliver Wyman.

European Central Bank (2021), *A Digital Euro*.

Federal Deposit Insurance Corporation (2020), “How America Banks: Household Use of Banking and Financial Services”, FDIC.

G7 Finance Ministers and Central Bank Governors (2021), “Communiqué”, 5 June.

Gopinath, G, and J Stein (2021), “Banking, Trade, and the Making of a Dominant Currency”, *The Quarterly Journal of Economics* 136: 783–830.

Gourinchas, P-O (2019), “The Dollar Hegemon: Evidence and Implications for Policy Makers”, presentation at the 6th Asian Monetary Policy Forum, Singapore.

Hong Kong Monetary Authority (2021), “Joint statement on Multiple Central Bank Digital Currency (m-CBDC) Bridge Project”, The Government of Hong Kong Special Administrative Region.

Jiang, Z, A Krishnamurthy, and H Lustig (2020), “Dollar Safety and the Global Financial Cycle”, NBER Working Paper 27682.

Kim, C (2021), “S. Korea’s c.bank moves to develop pilot digital currency”, Reuters, 24 May.

Klein, A (2020), “China’s Digital Payment Revolution”, Brookings Global China Discussion paper.

Maggiori, M, B Neiman, and J Schreger (2021), “International Currencies and Capital Allocation”, *Journal of Political Economy* 128: 2019–2066.

McKinsey and Company (2020), *The 2020 McKinsey Global Payments Report*.

New York Times (2021), “U.S. Treasury Secretary Janet Yellen on Covid-19 Pandemic, Economic Recovery and More”, Dealbook DC Policy Project video, 22 February.

Powell, J (2021), “Message on Developments in the U.S. Payments System”, Federal Reserve Board, 20 May.

Sveriges Riksbank (2021), “E-Krona Pilot: Phase 1”, Sveriges Riksbank.

Rochet, J-C, and J Tirole (2003), “Platform Competition in Two-sided Markets”, *Journal of the European Economic Association* 1: 990–1029.

Rosengren, E (2021), “Remarks at the Panel Discussion, ‘Central Bank Perspectives on Central Bank Digital Currencies’”, Program on International Financial Systems, Harvard Law School.

Sun, L and P Yurong (2021), “Central Bank: The current development focus of the digital RMB is to promote domestic use”, China Finance, sina.com 19 April (in Chinese).

US Department of the Treasury (2021), “G7 Finance Ministers & Central Bank Governors Communiqué,” 5 June.

Zhou, X (2021), “China’s Choices in Developing Its Digital Currency System”, Caixin, 20 February.

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CHAPTER 18

How to provide a secure and efficient settlement asset for the financial infrastructure of tomorrow

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Andréa M. Maechler and Andreas Wehrli

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EMERGING DIGITAL ASSET ECOSYSTEMS

The tokenisation of financial assets and their trading on infrastructures that employ distributed ledger technology (DLT) could transform financial markets. The innovative potential of tokenisation is visible in new ‘smart’ business processes (such as shared rules with automated execution among multiple parties), new tradable asset classes (e.g. tokenised corporate bonds, real estate and pieces of art) and enhanced operational efficiency.¹ Although its potential is yet to be fully proven, DLT-based technology could have far-reaching consequences for the functioning of financial market infrastructures.²

Should DLT-based financial infrastructures become systemically important, it will be critical to ensure the safety and integrity of payments on these novel infrastructures. These payments are generally considered ‘wholesale’ payments because they take place among regulated financial institutions (as opposed to retail payments, which involve end-users or merchants). Wholesale payments are generally considered systemic in nature, because they tend to be very large and make up for the bulk of payments in terms of value.³ Even one missed or delayed payment by one institution could create havoc for another institution, which may need to receive this payment before it can fulfil some of its own payments obligations.

Today’s traditional financial infrastructures have largely succeeded in mitigating the risks associated with settling trades in wholesale markets. They have done so partly by requiring large-value wholesale payments to be settled using central bank

1 Traditionally, all financial institutions have managed their own data silos, with separate records of transactions, securities events and other data points. In contrast, DLT would permit institutions to share an identical and continually synchronised database of immutable entries.

2 Ongoing adjustments in statutory and regulatory frameworks (e.g. the Swiss ‘DLT bill’ which enables the creation, and trading, of ledger-based securities that are represented on a blockchain) and the commercial launch of DLT-based financial infrastructures (e.g. the SIX Digital Exchange (SDX), which recently received approval from the Swiss Financial Market Supervisory Authority FINMA to operate DLT-based financial market infrastructures) indicate that DLT-based infrastructures may well play essential roles in the future.

3 Switzerland’s RTGS system is a case in point. It handles both large-value and retail payments. In 2020, large-value wholesale payments accounted for only 2.5% of the transactions, but made up 89.7% of turnover in terms of value.

money. With the emergence of novel types of infrastructures, it has become important to review the role of central bank money as a settlement asset. To date, the new tokenised infrastructures tend to use cryptocurrencies, stablecoins or tokenised commercial bank money to settle trades. While useful, these forms of money do not impart the same confidence as central bank money does – the only asset without credit or counterparty risk. These considerations, while separate from the ongoing discussions about the use of digital central bank money for retail purposes, are vital to assure the solid functioning of, and the general public's trust in, the financial system.

As new technologies continue to emerge, it is worth examining how past solutions, which ensured trust in financial infrastructures, can inform today's discussions.

We argue that a similar *economic* issue challenged central banks starting in the mid-1970s, when the failure of a medium-sized German bank nearly caused havoc on a global scale. A stable long-term solution was eventually achieved by way of introducing real-time gross settlement (RTGS) systems across the world. These RTGS systems are generally managed by central banks and require central bank money to be used as the main settlement asset.

Today's challenges regarding DLT-based financial infrastructures are both practical (e.g. in what sense are they more efficient?) and conceptual (e.g. how can they ensure the same level of trust in the financial system?). It is vital to combine applied technical experimentation and high-level policy research in order to come up with useful answers. This chapter therefore also touches on some of the lessons learned from recent projects that explore the role of central bank money in wholesale financial infrastructures for digital assets.

THE IMPORTANCE OF SECURE CASH SETTLEMENT

While the innovative potential of tokenised assets is the focus of many industry efforts, it represents only half the story. Sellers must also transfer the tokenised assets to the buyers, and buyers must pay the sellers. The settlement of a securities trade thus involves two types of transfers, or 'legs'. In the *delivery* leg, ownership of a security is transferred from the seller to the buyer, while the *payment* leg consists of the transfer of money from the buyer to the seller. A crucial question is: what types of 'money' are acceptable as settlement assets?

If the new infrastructures are to become large, a sustained and secure solution for the payment leg is needed. Today, cryptocurrencies, stablecoins and tokenised commercial bank money are used to settle trades on many tokenised asset platforms. important. As the importance of these platforms grows, it will be vital to assure that their payment leg cannot be affected unduly by settlement and counterparty risks.

One of the essential tasks of modern central banks is the provision of a safe, efficient and liquid ‘settlement asset’, in particular for systemically important financial market infrastructures. The secure settlement of large-value transactions is a prerequisite for the overall stability of the financial system. Financial market transactions, as a rule, involve substantial amounts and are time-critical, and they are therefore of great significance for the non-financial, or real, economy as well. This is why it is essential to place the execution of large-value transactions on a reliable foundation (Maechler 2018).

We contend that private agents alone will not deliver solutions that meet the requirements of security and efficiency for systemically important infrastructures. The commercial logic of innovation, speed and scale needs to be balanced with security and trust in order to achieve a sustained solution. To achieve this, both the public and the private sector have important roles to play.

LESSONS FROM THE PAST

In recent decades, central bankers have faced challenges similar to the ones they contemplate today. For instance, technological progress and rising trading volumes in the 1970s led to some substantial mishaps in financial markets. A famous example is the collapse of Germany’s Herstatt Bank in 1974, when the bank’s failure to meet its payment obligations caused a near-meltdown of international FX settlement in large global banks operating in New York. We have since learned that problems in cash settlement can have systemic implications. If left unaddressed, these problems can trigger a domino-like chain reaction of unfulfilled payment obligations.

Even though the technological context is very different today, the fundamental economic question is the same: how to design a secure and efficient settlement solution that protects buyers and sellers from settlement and counterparty risk? In the aftermath of the Herstatt incident, RTGS systems were created, in which electronic central bank money is used to settle large-value or wholesale transactions. Payments executed on an RTGS system are final and irrevocable. In combination with robust settlement mechanisms, this solution succeeded in taking the issue of settlement risk ‘off the table’ in financial markets for more than 30 years, and it has thus stood the test of time.

THE ROLE OF CENTRAL BANK MONEY IN ROBUST SETTLEMENT MECHANISMS

A major challenge in securities trading is settlement risk, i.e. the risk that the parties to the transaction may fail to honour their obligations. History shows that the severity of this risk must not be underestimated. As anyone who has been to garage sales and flea markets knows, cash is still king in many transactions among strangers –

one person hands over the merchandise, the other simultaneously hands over the cash. This is a quintessential example of a *delivery-versus-payment* (DVP) mechanism. Any mechanism that is less direct – for instance, with a time delay between the two legs – and any settlement asset not issued by central banks exposes the trading parties to various forms of settlement and credit risk.

Efficient and secure asset trading requires robust settlement mechanisms. Starting in the 1980s, the need to minimise settlement risk led to a gradual move from deferred net settlement to RTGS systems. These payment systems were also increasingly linked with securities settlement systems to permit an efficient and secure association of both legs of a securities transaction. The resulting DVP mechanism ensures that delivery of the security occurs if, and only if, the delivery of the payment leg occurs. This concept and its associated technology were as revolutionary in the 1980s as DLT is today.

Securities trading also requires a trustworthy *settlement asset*. Central bank money is the most secure such asset. Its security derives from the twin facts that it is risk free (as it represents account holders' claims on the central bank itself) and that the exchange of the cash balances is performed entirely on the books of the central bank. These features permit the payments to be final and irrevocable. Should central bank money not be available for the settlement of wholesale financial transactions of tokenised assets, then stablecoins would be plausible alternatives. However, while they could be tailored to meet efficiency needs, they cannot robustly satisfy the safety needs.

The use of central bank money fosters trust, not only in the dependability of the payment system but in money itself (CPSS 2003). For instance, it establishes a solid protection against the domino effect described above. In addition, the use of central bank money has facilitated, over the years, several waves of innovation in securities trading and settlement systems.⁴

EXPLORING SOLUTIONS FOR THE FUTURE

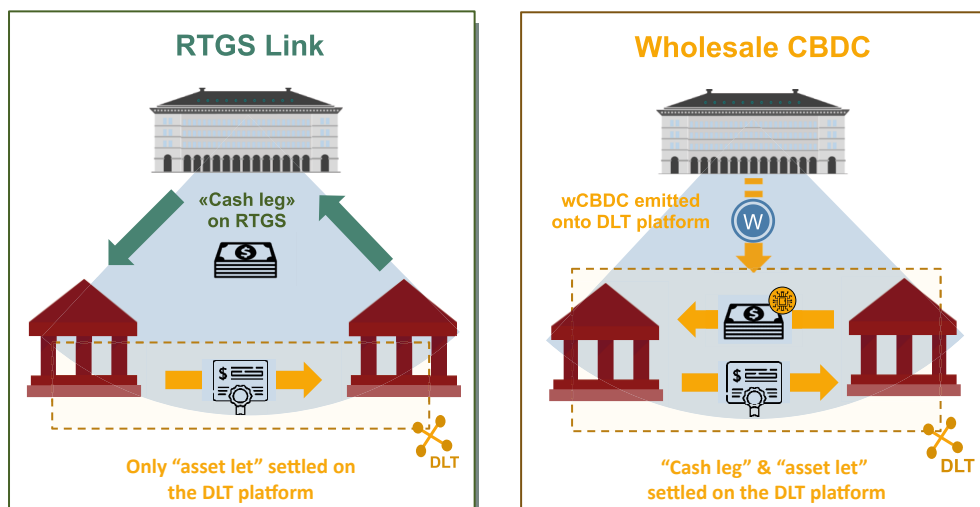
Central banks need to think ahead and ensure that they remain able to fulfil their mandates in a rapidly changing digital landscape. With new ecosystems emerging, central banks once more face the fundamental task of providing a secure settlement asset for tomorrow's financial infrastructure. Given the global nature of the ongoing changes in the financial system landscape, the Swiss National Bank (SNB) works closely with other central banks and favours pursuing an interdisciplinary approach.

Over the past year and a half, the SNB, in collaboration with the BIS Innovation Hub and the financial infrastructure operator SIX, has tested two options for introducing central bank money into DLT-based financial infrastructures (BIS et

4 The forthcoming ability to provide instant payments at retail level is also facilitated by the integral use of central bank money.

al. 2020). Specifically, we have leveraged the SDX initiative of a regulated, DLT-based trading, settlement and custody infrastructure to test the viability of (1) interoperability between a DLT platform and the existing Swiss RTGS system (Figure 1, left-hand side); and (2) issuing a wholesale CBDC (wCBDC) on the DLT platform (Figure 1, right-hand side).

FIGURE 1 TWO OPTIONS FOR CASH SETTLEMENT WITH DLT-BASED FINANCIAL MARKET INFRASTRUCTURES



We have learned that both the RTGS link and a wCBDC can be used to settle the payment leg for transactions of tokenised assets. Both options are technically feasible and legally robust under Swiss law. The RTGS link is operationally simpler for a central bank, while wCBDC has more upside potential in terms of innovation and efficiency gains vis-à-vis the settlement process.

The scope of the experiments was recently expanded to explore end-to-end transactions among several commercial banks that employ their own core banking systems. One key factor that will determine the future success of novel infrastructures is whether they can provide robust bridges to existing infrastructures. We therefore strive to conduct these experiments under very realistic operational, legal and policy conditions.

We are also expanding the scope of the experiments to explore the use of wCBDC in settling cross-border transactions. Until now, we have experimented exclusively within a single-currency framework. For an international financial centre such as Switzerland, it is natural to expand the scope of the investigation to examine cross-border transactions and to contribute to ongoing work aimed at overcoming challenges in cross-border settlements (CPMI et al. 2021). In close collaboration with the Banque de France, the BIS

Innovation Hub and a private sector consortium led by Accenture, the recently launched Project Jura will explore the conduct of cross-border settlement with two wCBDCs and a French digital financial instrument on a DLT platform (BIS et al. 2021).

CONCLUSION

The ease of use and the safety associated with money as a means of payment influence the degree of trust the population is willing to place in a currency. In order to establish and maintain this trust, sustainable solutions are needed where they matter most. Given the huge volume and value settled on a daily basis in the wholesale segment of the financial system, robust mechanisms for containing settlement and counterparty risk are essential. The historical lesson of unsettled payments by a relatively small bank, which did not involve exchange of central bank money and which jeopardised trust in the then-existing financial system, illustrates this point. In reaction to this experience, a new type of payment standard was introduced – RTGS systems – along with a requirement that systemically important financial market infrastructures settle obligations in central bank money whenever practical and available (CPMI and IOSCO 2012).

If novel types of financial infrastructures become systemically important, it will be essential for central banks to understand how they can operate with the same level of safety, efficiency and trust as the existing ones do.⁵ Their emergence also points to a critical need to understand and address a host of additional challenges, such as a tendency for increased market fragmentation, and to better understand how these developments could affect central banks' ability to implement monetary policy effectively.

If, where, when and how central bank money will be offered for settling tokenised asset trades depends on many factors. Policy objectives, legal constraints and practical operational requirements for scalability, speed and security will guide central banks' next steps. As there will be no 'one size fits all' solution, central banks will continue to investigate various options of how they may continue to fulfil their mandates as financial markets evolve.

REFERENCES

BIS, Swiss National Bank and SIX (2020), "Project Helvetia: Settling tokenised assets in central bank money", December.

BIS, Banque de France and SNB (2021), "Bank for International Settlements Innovation Hub, Swiss National Bank and Bank of France collaborate for experiment in cross-border wCBDC", June.

5 See also recent guidance from CPMI and IOSCO confirming and clarifying that stablecoin arrangements should observe international standards for payment, clearing and settlement systems (<https://www.bis.org/cpmi/publ/d198.htm>).

CPMI and IOSCO – Committee on Payments and Market Infrastructures and International Organization of Securities Commissions (2012), *Principles for Financial Market Infrastructures*, April.

CPMI, BIS Innovation Hub, International Monetary Fund and World Bank (2021), *Central bank digital currencies for cross-border payments*, July.

CPSS – Committee on Payment and Settlement (2003), August, “The role of central bank money in payment systems”, CPMI Papers No.55, Bank for International Settlements.

Maechler, A M (2018), “The financial markets in changing times. Changes today and tomorrow: the digital future”, speech at the SNB Money Market Event, 5 April.

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CHAPTER 19

Central bank digital currencies: Taking stock of architectures and technologies

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Raphael Auer, Giulio Cornelli and Jon Frost¹

Bank for International Settlements

A NEW FORM OF CENTRAL BANK MONEY

Around the world, central banks are researching a new form of money: central bank digital currency (CBDC). While the concept of broadening access to central bank money was proposed decades ago (e.g. Tobin 1987), central banks were initially slow to embrace it. This has changed with the declining use of cash – more so during the Covid-19 pandemic, the emergence of cryptocurrencies and the possible entry of private ‘stablecoins’ (G7 Working Group on Stablecoins 2019, FSB 2020).² CBDCs, if issued, could become a new, third form of central bank money – alongside physical cash accessible to the public, and central bank reserves accessible to many financial institutions.

National interest in the topic differs, as do the policy approaches and technologies being considered. Some central banks are experimenting with CBDCs, while others have decided that they see no need. And even where CBDCs are being studied, technological and economic designs differ, with very different implications for the monetary and financial system (Auer and Böhme 2021).

In recent research (Auer et al. 2020c), we analyse the economic and institutional drivers of CBDC projects, thus shedding light on their motivations. We then assess the policy approaches and technical design of projects, and commonalities and differences across countries.

A NEW CBDC DATABASE

We assemble a comprehensive, publicly available database from three sources of information.³ First, to measure the stance on issuance, we use the database of central bank speeches maintained by the Bank for International Settlements (BIS). We search

1 This chapter draws on Auer et al. (2020c), with data updated to 1 October 2021. The views expressed are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

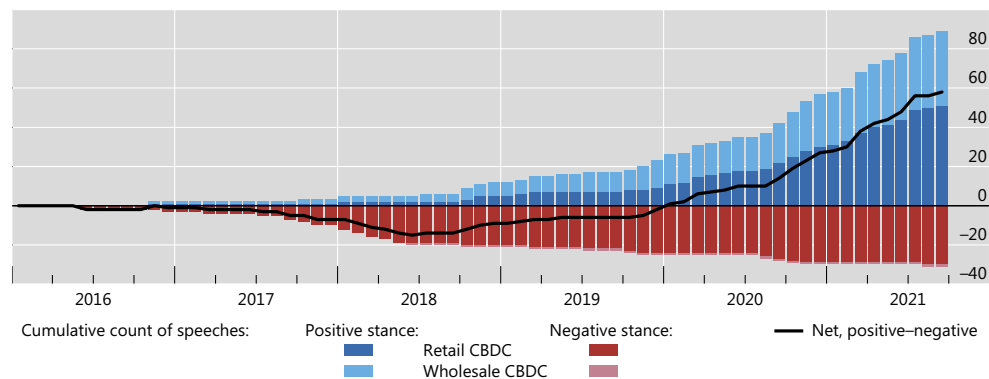
2 In the Covid-19 pandemic, attention to CBDCs has been enhanced due to concerns about viral transmission through cash (Auer et al. 2020a) and the need for remote payments and pandemic-related government-to-person payments that reach the whole population (Auer et al. 2020b).

3 The database is available online at <https://www.bis.org/publ/work880.htm>

the universe of over 16,000 speeches for terms such as “CBDC” or “digital money”. We then classify the stance as either negative, neutral, or positive.⁴ We differentiate the stance by wholesale and retail CBDC.⁵ The results are presented in Figure 1.

FIGURE 1 SPEECHES ON CBDCS HAVE TURNED MORE POSITIVE SINCE LATE 2018

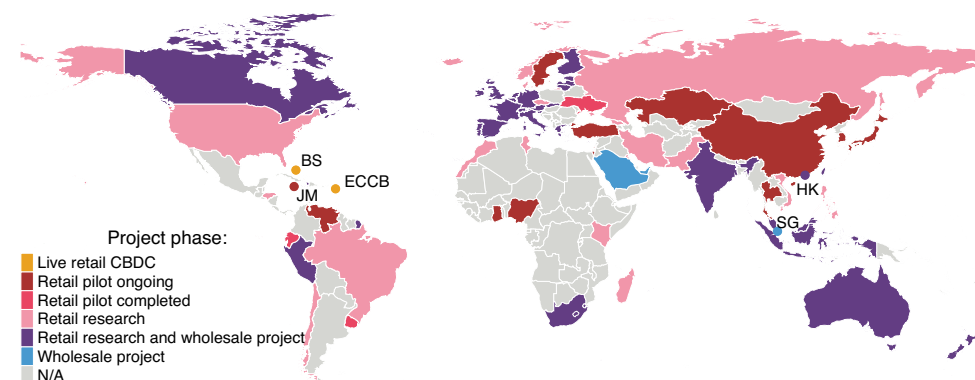
Number of speeches



Notes: Search on keywords “CBDC”, “digital currency” and “digital money”. The classification is based on the authors’ judgement. The score takes a value of -1 if the speech stance was clearly negative or in case it was explicitly said that there was no specific plan at present to issue digital currencies. It takes a value of +1 if the speech stance was clearly positive or a project/pilot was launched or was in the pipeline. Other speeches (not displayed) have been classified as neutral.

Source: Auer et al. (2020c).

FIGURE 2 CBDC PROJECTS STATUS



Notes: BS = The Bahamas; ECCB = Eastern Caribbean Central Bank; HK = Hong Kong SAR; JM = Jamaica; SG = Singapore. The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

Source: Auer et al. (2020c).

4 This is based on authors’ judgement. A negative stance is when the speech was clearly negative towards CBDCs or explicitly said there was no plan to issue a CBDC. A positive stance is when speeches are clearly positive or said that a pilot or project was in the pipeline.

5 So-called wholesale CBDCs could become a new instrument for settlement between financial institutions. Retail (or general purpose) CBDCs would be cash-like central bank currency accessible to all. The issuance of CBDCs would be a far-reaching step, and many open questions remain.

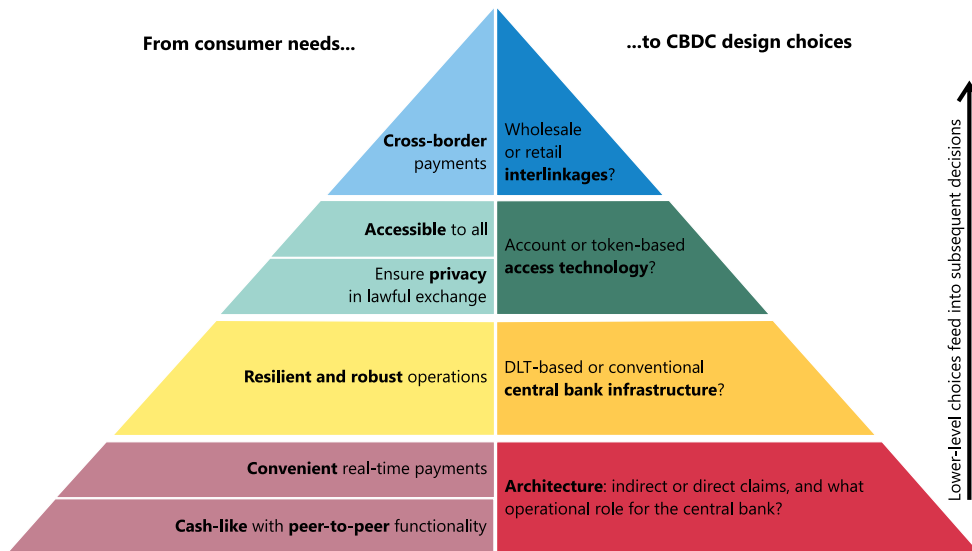
The second source is published CBDC project reports and in-depth interviews we conducted with the respective authors. Starting from central bank webpages, we consult all published reports by central banks on wholesale and retail CBDC projects. We only use official reports, not rumours and unconfirmed press articles. We have classified these into four ‘buckets’: no project, research, a pilot, or a live CBDC. A growing number of central banks has communicated on their CBDC work, and several are actively piloting a retail or wholesale CBDC (Figure 2). The Central Bank of the Bahamas and the Eastern Caribbean Central Bank have now launched live retail CBDCs.

The third source is internet search interest. In our paper, we use Google Trends and Baidu trends to gauge the search intensity of keywords like “CBDC” for the period 2013–20.

STOCK TAKING DRIVERS AND TECHNICAL DESIGNS OF CBDCS

The technical designs of CBDC also vary. This requires us to distil the main attributes of different CBDC projects. One way to do so is the ‘CBDC pyramid’ of Auer and Böhme (2020).⁶ Figure 3 classifies four attributes of ongoing retail CBDC projects: architecture, infrastructure, access and cross-border (retail or wholesale) interlinkages. Among the retail CBDC projects in our sample, we find a wide variety of approaches to these four attributes across jurisdictions.

FIGURE 3 THE CBDC PYRAMID



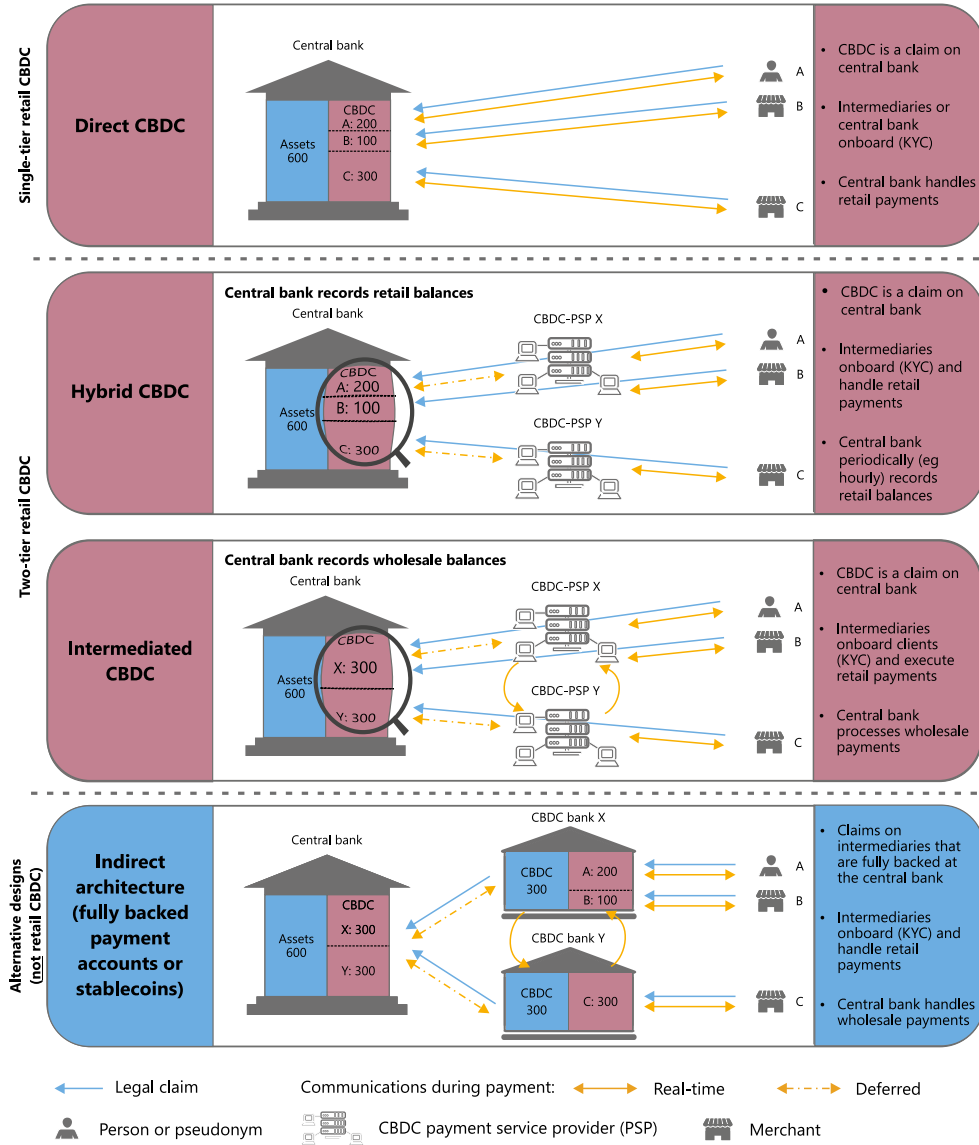
Notes: The CBDC pyramid maps consumer needs (left-hand side) onto the associated design choices for the central bank (right-hand side). The four layers of the right-hand side form a hierarchy in which the lower layers represent design choices that feed into subsequent, higher-level decisions.

Source: Auer and Boehme (2020).

6 The pyramid gives a taxonomy of technical designs, starting from consumer needs. The scheme of design choices forms a hierarchy in which the lower, initial layers represent design decisions that feed into subsequent, higher-level decisions.

Central banks must first decide on the **architecture** – or the operational role that the central bank and private intermediaries will play in a CBDC system (see Figure 4).

FIGURE 4 RETAIL CBDC ARCHITECTURES AND FULLY BACKED ALTERNATIVES



Notes: In the 'direct CBDC' model (top panel), the CBDC is a direct claim on the central bank, which also handles all payments in real time and thus keeps a record of all retail holdings. Hybrid CBDC architectures incorporate a two-tier structure with direct claims on the central bank while real-time payments are handled by intermediaries. Several variants of the hybrid architecture can be envisioned. The central bank could either retain a copy of all retail CBDC holdings (second panel), or only run a wholesale ledger (third panel). In the indirect architecture (bottom panel), a CBDC is issued and redeemed only by the central bank, but this is done indirectly to intermediaries. Intermediaries, in turn, issue a claim to consumers. The intermediary is required to fully back each claim with a CBDC holding at the central bank. The central bank operates the wholesale payment system only.

Source: Auer and Böhme (2021).

Auer and Böhme distinguish four architectures:

- In a ‘direct CBDC’ architecture, the central bank directly operates the payment system, offers retail services directly and maintains the ledger of all transactions.
- In a ‘hybrid CBDC’, the payment system runs on two engines: private intermediaries handle retail payments, but the CBDC is a direct claim on the central bank.⁷
- ‘Intermediated CBDC’ is similar to hybrid CBDC, but the central bank maintains only a wholesale ledger rather than a central ledger of all retail transactions. Again, the CBDC is a claim on the central bank and private intermediaries execute payments.
- An alternative to CBDC design is the indirect provision of retail digital money via financial intermediaries. We note that, as this does not allow the consumer to directly access central bank money, it is not a retail CBDC (Bank of Canada et al. 2020). Consumers have claims on intermediaries, which operate all retail payments. These intermediaries fully back all liabilities to retail clients with claims on the central bank.

In our stocktake (see Figure 5, left-most panel), we find that only two central banks are considering a direct model (as part of research); a full 27 central banks are considering the hybrid, intermediated or multiple options; and a larger group has not yet specified the architecture.⁸

Second, central banks must decide on the **infrastructure**. Specifically, a CBDC can be based on a conventional centralised database or on DLT. These technologies differ in their efficiency and degree of protection from single points of failure. DLT often aims to replace trust in intermediaries with trust in an underlying technology. Yet no central bank we examined aims to rely on permissionless DLT, as used for Bitcoin and many other private cryptocurrencies. We find 5 central banks running prototypes on DLT, 6 with conventional technology and 11 considering both. Yet these infrastructure choices are often for first proofs-of-concept and pilots. Only time will tell if the same choices are made for large-scale designs.

Third, central banks must decide how consumers can **access** the CBDC. Account-based CBDCs are tied to an identity scheme, which can serve as the basis for well-functioning payments with good law enforcement. Yet, access is likely to be difficult for one core target group: the unbanked and individuals who rely on cash. This allows for token-based payment options, for example pre-paid CBDC ‘banknotes’ that can be exchanged both physically and digitally. However, this also brings new risks of illicit activity and

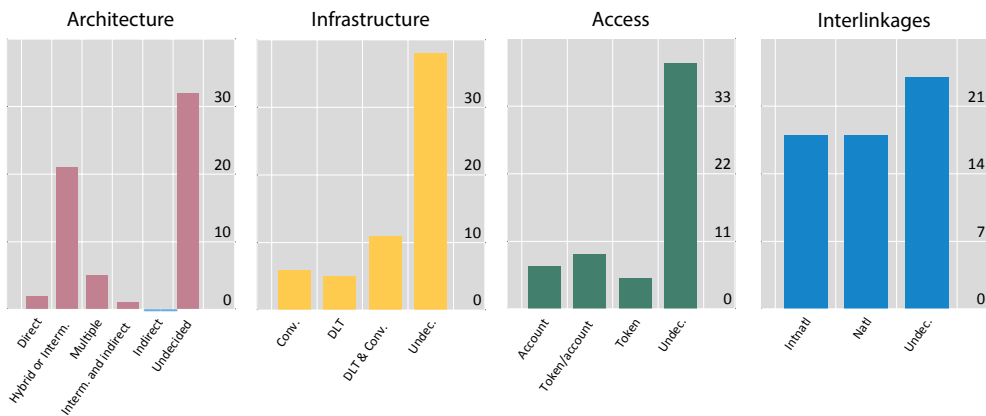
⁷ The hybrid CBDC comes in two variants: the central bank can either keep a central ledger of all transactions, which allows it to restart payments, or it can maintain only a wholesale ledger (the ‘intermediated’ variant).

⁸ We also examine whether central banks pursue the so-called synthetic or indirect CBDC model. The latter involves claims on private sector intermediaries that are fully backed by central bank reserves. However, at current, no public report indicates that a central bank is pursuing this indirect/synthetic architecture.

counterfeiting. In our stocktake, tiering of account- and token-based access is more common, with nine central banks clearly leaning toward this feature, seven towards account-based and a further five looking at token-based access.

Fourth, central banks face a design choice in retail and wholesale **interlinkages**, including accessibility for cross-border payments. Some designs may allow for use by non-residents. Most of the projects in our sample are for domestic use. Yet several – by the European Central Bank, the French, Spanish and Dutch central banks, and the Eastern Caribbean Central Bank – are by construction focused on use among the members of a multi-country currency area.

FIGURE 5 ATTRIBUTES OF RETAIL CBDC PROJECTS



Notes: Intern. = intermediated; Multiple = two or more options among direct, hybrid and intermediated under consideration; Undecided = undecided/unspecified or multiple options under consideration; DLT = distributed ledger technology; Conv. = Conventional; Token/account = tiering of token- and account-based access; Natl = national use; Intnatl = international use.

Source: Auer et al. (2020c).

A NEW MULTITUDE OF PAYMENTS

The diversity of approaches and designs reflects that each central bank is considering a CBDC that fits the unique needs of its own jurisdiction. Yet our overview has also revealed some key common features. In particular, none of the designs we survey intends to replace cash; all aim to complement it. And most projects would allow for an important role of the private sector in the payment system. To encourage greater learning and allow for future interoperability, ongoing dialogue and peer learning among central banks remains important (e.g. CPMI and Markets Committee 2018, Bank of Canada et al. 2020).

REFERENCES

- Auer, R and R Böhme (2020), “The technology of retail central bank digital currency”, *BIS Quarterly Review*, March: 85–100.
- Auer R and R Böhme (2021), “Central bank digital currency: the quest for minimally invasive technology”, BIS Working Paper No. 948.
- Auer, R, G Cornelli and J Frost (2020a), “Covid-19, cash and the future of payments”, BIS Bulletin No. 3, April.
- Auer, R, J Frost, T Lammer, T Rice and A Wadsworth (2020b), “Inclusive payments for the post-pandemic world”, SUERF Policy Note No. 193.
- Auer, R, G Cornelli and J Frost (2020c), “Rise of the central bank digital currencies: drivers, approaches and technologies”, CEPR Discussion Paper 15363, October.
- Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements (2020), *Central bank digital currencies: foundational principles and core features*, Report No 1, Bank for International Settlements.
- CPMI – Committee on Payments and Market Infrastructures and Markets Committee (2018), “Central bank digital currencies”, CPMI, Markets Committee Papers No. 174, March.
- FSB - Financial Stability Board (2020), *Regulation, Supervision and Oversight of ‘Global Stablecoin’ Arrangements*, October.
- G7 Working Group on Stablecoins (2019), *Investigating the impact of global stablecoins*, October.
- Tobin, J (1987), “The case for preserving regulatory distinctions”, *Proceedings of the Economic Policy Symposium, Jackson Hole*, Federal Reserve Bank of Kansas City, pp. 167–83.

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CENTRE FOR ECONOMIC POLICY RESEARCH

Within a few years, retail central bank digital currency (CBDC) has morphed from an obscure fascination of technophiles and monetary theorists into a major preoccupation of central bankers. Pilot projects abound and research on the topic has exploded as private sector initiatives such as Libra/Diem have focused policymakers' minds and taken the status quo option off the table.

In this eBook, academics and policymakers review the economic, legal and political implications of CBDC; they discuss current projects; and they look ahead. While consensus on the 'right' CBDC choices remains elusive, common perspectives begin to emerge. First, money, banking and payments are ripe for upheaval, with or without CBDC. Second, the key risk of CBDC is unlikely to be bank disintermediation – privacy, information more generally, and politics may be more critical. Third, the use case for CBDC must be clarified, country by country. It may not exist, because of alternative, better solutions to the existing problems. And fourth, as the implications of CBDC go far beyond the remit of central banks, parliaments and voters should have the final say.

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