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CBDC – in a whirlpool of discussion

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EXECUTIVE SUMMARY

The topic of central bank digital currency (hereinafter – CBDC) has recently gained significant attention from policy makers and academics. A wide range of CBDC setups are discussed, from universally accessible central bank accounts or digital tokens to less extreme suggestions of only partially broadening central bank balance sheet access by providing CBDC to wholesale institutes or getting the private sector to mediate the process by providing synthetic CBDC.

We see CBDC as:

- 1) a means to meet the global citizen's need for a safe, trustworthy, and cost-efficient instrument for cross-border payments. As of now, there is no perfect technological solution yet; however, advancements in technology seem to be able to serve this purpose; the idea of CBDC has great potential while – crucially – joint effort is needed to arrive at the best-suited form of CBDC, the principle idea of which could be, e.g., multicurrency CBDC.
- 2) a way to address a safe medium of payments shortage. In particular, locally addressing this issue requires the least deviation from the current financial system set-up.
- 3) in no way being a universal one-size-fits-all solution. Different CBDC design types can have different outcomes. Therefore, when considering CBDC issuance at a national level, we should first of all prioritise the issue that needs to be tackled based on the country specifics and then choose the best-suited implementation method. Still, this is only true at the individual jurisdiction level. For CBDC to be a global solution, joint effort and agreement is needed.

From the monetary policy and financial stability side, no unambiguous assessment can be given yet to the balance of CBDC benefits and costs. Considerations that CBDC introduction could potentially induce higher instability of bank funding and a larger role for central banks in financial intermediation are expressed. However, there are design choices that could help mitigate such unintended side effects.

CBDC is an idea with the potential to change some of the conventional financial system realities and deserves the thorough consideration that it is currently given. Nonetheless, the focus should be on the ultimate goal – a global solution for a modern-day citizen of the world. With proper design, some of the CBDC-induced changes that are currently seen as frightening side effects would merely be a change in the status-quo – a natural part of progress.

In this context, the Bank of Lithuania is tackling the issue primarily from the practical perspective. First, experience gained via broadening access to the retail payment system to non-bank institutions provides valuable insights on a *what if* scenario in case of synthetic CBDC. Second, the application of distributed ledger technology (hereinafter – DLT) to issue a digital numismatic coin provides technological hands on experience and know-how.

1. INTRODUCTION

Central bank digital currency (CBDC) has attracted significant attention among policy makers.

While discussed and researched widely and even with the first steps taken towards its implementation in some jurisdictions, no consensus has been reached on the net balance of benefits and costs, optimal CBDC design choice, policy impact assessment. Therefore, this report aims to recall CBDC design types and discuss possible policy implications by drawing on extensive literature on the topic from academia, official institution reports, and policy maker positions. At the same time, it reminds us that there are still unanswered questions.

Literature usually recalls James Tobin's considerations from the 1980s, when he already said that "paper currency and coin are not very convenient media of exchange" (Tobin 1985, p. 23). However, at that time, the idea did not gain such wide attention as has been the case over the several recent years. What has changed over recent decades to bring this idea now to the centre of attention for academics and policymakers?

The general agreement is that there are a number of factors that have contributed to the rise of this discussion. These factors are said to be the development of technology that could make a widely accessible CBDC feasible and resilient; the emergence of digital currency issuance intentions from the private sector; the rise of payment services intermediaries and measures; and decreasing use of cash as means for payment in some countries (CPMI-MC 2018; Barrdear & Kumhof 2016).

However, these explanations seem to rather be a description of the current trends than an investigation of the underlying causes for this shift in thinking. The argument that the technology has already emerged to make a widely accessible CBDC feasible does not call for discussion; however, technology is only a means of the realisation of an idea, not a call for the birth of it. More likely, the shift in the current society's needs is mainly caused by continuing globalisation. The rise of Bitcoin and interest in the Libra idea suggests that today's society calls for a global unit of account. Indeed, with the development of global supply chains, international trade, constantly growing e-commerce, and 3.3% of the global population living outside of their country of origin (United Nations Population Fund 2015), the need for a universally acceptable and convenient unit of account seems evident. Therefore, research of CBDC and related ideas need to not lose sight of the ultimate goal while discussing technical details.

One may also ask why central banks need to address the needs of a changing society, as the private sector already shows determination to place its mark. Leaving changes with potential global impact fully in the hands of the private sector – whose primary goal in today's form of capitalism is shareholders' profit maximisation – risks structural changes that would not be in the best public interest. Therefore, the institutions whose primary goal is the good of society cannot stay at the side-lines of this change.

Finally, central banks around the world have already started individual initiatives to look into the concept deeper (with only a few joint projects taking place). Single-jurisdictional CBDC can be a solution for expensive cash logistics and financial inclusion issues and bring convenience of modern day technology. These aspects can have a high priority in some countries. However, would a single-jurisdictional CBDC be capable of meeting today's global citizen's need for a universal unit of account? The intuition suggests a single-currency CBDC in the future world will not be sufficient.

The report is organised as follows: Section 2 presents the CBDC concept, Section 3 recalls different CBDC implementation setups, Section 4 gives an overview of key literature takeaways, Sections 5 and 6 discuss policy implications from the financial stability and monetary policy sides, and Section 7 concludes.

2. THE CONCEPT OF CBDC

CBDC does not have a single universally accepted definition. Authors usually define the principle idea of CBDC as being not reliant on a specific technological choice of implementation or a pre-defined range of potential users. The Committee on Payments and Market Infrastructures (CPMI) and the Markets Committee (MC) define a CBDC as a “central bank liability, denominated in an existing unit of account, which serves both as a medium of exchange and a store of value” (CPMI-MC 2018, p. 3).

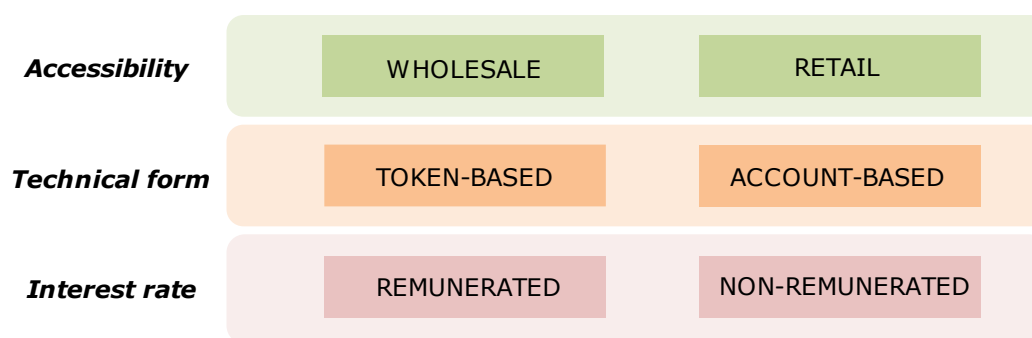
A central bank already provides other forms of digital money, such as reserves or settlement accounts, which are mainly accessible to commercial banks. However, CBDC broadens the potential user base – it can be accessible to society in general (“general purpose” or “retail” CBDC) or a less widely accessible variant of “wholesale” CBDC, which could “be used as a settlement asset in financial markets by firms that do not currently have access to central bank reserves” (Meaning, Dyson, Barker, & Clayton, 2018, p. 4).

A number of authors have already analysed the defining properties of CBDC. For example, Bech & Garratt (2017) compose a “money flower”, which maps different kinds of money based on the issuer, form, accessibility and transfer mechanism and identify the key properties of CBDC. According to them, CBDC’s defining characteristics are an electronic form of money, issued by central bank and allowing peer-to-peer transactions, and in the case of retail CBDC – also being universally accessible. Another example could be Bjerg (2017), who arrives at a set of three CBDC characteristics – central bank-issued, universally accessible, and electronic – by plotting existing forms of money on a Venn diagram. Other authors also discuss the key CBDC characteristics and broaden or narrow down the set of key ones, in such a way arriving at a particular CBDC variant. Section 3 further discusses CBDC design variants that have been discussed.

3. CBDC TYPES

As the name suggests, CBDC should be issued by a central bank and have a digital form. However, there are a number of other, “optional” characteristics that a CBDC can have and which define a particular kind of CBDC. The most widely discussed “optional” characteristics, as Fig. 1 suggests, are related to the accessibility, technical form, and applied interest rate. Section 3 further explains each form of the CBDC based on these characteristics.

Fig. 1. "Optional" CBDC characteristics.



3.1. Wholesale CBDC and retail CBDC

Based on the user base that can access CBDC, it is distinguished into two types of currency: retail or general purpose and wholesale.

Retail or general purpose¹ CBDC refers to a variant of CBDC which, as the name suggests, can be accessible to everyone. As cash is accessible to everyone, such a variant would not be a significant deviation from the status quo. In fact, as earlier mentioned by some authors, e.g. Bjerg (2017), the attribute of universal accessibility is one of the defining characteristics of money and the variant of restricted accessibility is not considered as a form of money at all.

On the contrary, wholesale CBDC would be a restricted-access CBDC. Bech & Garratt (2017) suggest this variant would be accessible only to financial institutions. Others assume that wholesale CBDC could be offered not only to commercial banks and other financial institutions, but also corporates (Murray 2019). While opening access to the central bank balance sheet to corporates as well would be some change to the current access, the principle of wholesale CBDC does not change. It would be used to make wholesale cross-border transactions more efficient.

Distinction of CBDC into wholesale and retail does not assume any particular technological means of implementation or other CBDC features outside the distinction based on customer base. Which means that all kinds of technological implementation can be considered for both – wholesale and retail CBDC.

3.2. Synthetic CBDC

A particular variant of CBDC is the so-called synthetic CBDC, where access to a central bank liability to the general public is given with the mediation of private financial institutions; without provision of direct access to the central bank balance sheet beyond financial institutions. Synthetic CBDC falls beyond the CBDC distinction to wholesale and retail. Synthetic CBDC actually means hypothetical reserve-backed accounts or tokens, issued by private banks or payment institutions with unconditional provision of adequate bank reserves by the central bank (Adrian 2019, Šiaudinis 2019).

¹ Some authors (e.g. Bech & Garratt 2017) name the variant of CBDC accessible to the general public as a retail one, while the others (e.g. CMPI-MC 2018) choose to highlight the wide accessibility of such a CBDC variant by naming it a "general-purpose CBDC". For the purpose of CBDC analysis, retail and general-purpose CBDC concepts can be used interchangeably to refer to unrestricted access CBDC. Admittedly, intuition suggests that retail CBDC could refer to the variant used only in retail transactions, while general-purpose CBDC could be meant for all kinds of transactions.

The idea of synthetic CBDC is J. Tobin's 30-year-old proposal, which, however, did not gain the support of authorities. With the US savings and loans association crisis in the 1980s making an impression on him, Tobin (1987, p. 172) argued that central banks should "make available to the public a medium with the convenience of deposits and the safety of [central bank] currency, essentially currency on deposit". In essence, he aimed to avoid relying too heavily on deposit insurance. One may assume that the idea was rejected due to an undesirable degree of involvement of a central bank in bank funding (Šiaudinis 2019).

Whereas CBDC-related terminology has remained in flux, this particular kind of CBDC is also known as "deposited currency accounts" (Bech & Garratt 2017 with reference to Tobin 1987), "universal (central bank) reserves" (Cœuré 2018, Fegatelli 2019), and "implicit CBDC" (Šiaudinis 2019).

While not being an issuer of CBDC, the central bank of Lithuania – Lietuvos bankas – is worth mentioning in this context. Lietuvos bankas provides technical access to non-bank payment service providers to its payment system CENTROLINK.² The non-bank payment service providers are required to segregate their own and clients' accounts (thus safeguarding the funds), one of the appropriate ways being to keep them in the central bank.³ For such a scheme to be considered a synthetic CBDC, all client funds should be held only in the central bank. There is a technical challenge arising from this: while a central bank can require its payment system users to hold client funds in a central bank, it cannot ensure smooth and true realisation of this requirement from the private participant. One may argue that there is a reliance on payment service providers being supervised entities. However, as the key point of the attractiveness of synthetic CBDC is the safety provided by the central bank, an extremely high level of confidence should be required from the technical implementation of such a scheme to ensure no technical error or fraudulent action can hurt the 100% backing of private money by central bank liabilities.

The experience of Lietuvos bankas shows high interest for this facility. Such a scheme may be considered as easing access for smaller financial market players and encouraging competition in the payment services industry. This is especially important in jurisdictions with high concentration in the financial services sector, where it can contribute to decreasing payment services costs and providing payment services access to a wider range of society, thus, consequently promoting financial inclusion. Finally, Lietuvos bankas' experience could provide insights to further explore practical implementation of a synthetic CBDC.

3.2. Token- and account- based CBDC

Another distinction of CBDC is based on technological solution.

Token-based money would allow peer-to-peer transactions, while account-based CBDC requires a central counterparty for settlements – a central bank. With the current technological capabilities, token-based CBDC would probably be based on some sort of distributed ledger technology (Bordo & Levin 2017). Account-based CBDC would not necessarily require a big shift from the current technological central bank setup, as in principle for the account based CBDC a central bank needs to increase the number of user accounts in central banks. Of course, technological improvements could be needed, as the increase in the number of accounts would be rather drastic – in the case of retail account-based CBDC it could mean hundreds of millions of accounts (subject to the size of jurisdiction).

² "CENTROLINK is a payment system, developed and operated by the Bank of Lithuania, which allows customers of financial institutions to execute euro payments across SEPA." (Lietuvos bankas 2019a).

³ Today it is at the discretion of non-bank PSPs how much of the client funds to transfer to the central bank. The experience of the Bank of Lithuania shows that the amounts are nowhere near 100%.

The discussion on technology is open, with no clear evidence on either variant being the optimal one. Still, one may argue that if CBDC is used as a means to improve cross-border payments, the account-based option does not solve the current limitation of divergence among worldwide settlement systems. Therefore, either a massive improvement and convergence are needed to align settlement systems worldwide, or a distributed-ledger based solution could be used as a more suitable option. The latter one has the advantage of not having to deal with legacy issues and being capable of focusing precisely on the solution best suited for the global society today.

One angle that gets considerable attention in the discussion on token-based vs account-based money is anonymity. Cash has a benefit of guaranteeing user anonymity, and there are some proponents of preserving this. In such a case, only token-based money implementation could guarantee anonymity, while on the other hand, it is not by default a positive feature, as precisely the anonymous nature of cash enables illicit transactions. Central banks have been putting active effort to make cash less convenient for such uses (by no longer issuing banknotes with the highest nominal values) and other public institutions are in a constant battle against all sorts of illicit transactions. There needs to be a balance and an adequate level of an individual's privacy needs to be ensured. Anonymity per se is not always an asset; therefore, properly designed CBDC could be unsuitable for the illicit transactions that currently exploit the anonymous nature of cash.

3.3. Interest-bearing and non-interest bearing CBDC

A separate discussion on whether CBDC should be interest-bearing is taking place. Again, this feature of CBDC is not dependent on a particular choice of CBDC technical implementation or user base. This discussion stems from the needs of monetary policy. Bordo & Levin (2017) suggest that an interest-bearing CBDC could serve as "a secure store of value, with a rate of return in line with other risk-free assets such as short-term government securities" (p. 2). The discussion on interest-bearing CBDC stems from the needs of monetary policy since "the CBDC interest rate could serve as the main tool for conducting monetary policy" (Bordo & Levin 2017, p. 2). Therefore, more aspects of interest-bearing CBDC are discussed in Section 6.

4. OVERVIEW OF PUBLICATIONS AND PRACTICAL TESTS IN THE CBDC AREA

Recently, numerous publications have been released on this topic. The publications focus on a variety of aspects of CBDC and discuss positive and negative implications from different points of view. The discussions are so far at the theoretical level, with no cases of full practical implementation to draw experience from; therefore, opinions vary and there is no consensus on the full assessment of CBDC implications.

This section gives a brief overview of selected publications from official institutions, central banks, and academia, and presents a summary of projects that could provide insights if an institution that runs the project was to decide to take further steps towards CBDC issuance.

4.1. CBDC in the publications of official institutions

This section gives a brief overview of selected publications from official institutions and central banks on the CBDC topic.

The BIS Committee on Payments and Market Infrastructures and Markets Committee analyse the concept of CBDC and give an overview of the implications for monetary policy, financial stability, and payments. The report acknowledges that a general-purpose CBDC could provide benefits in the

environment of declining cash use. At the same time, the report advocates for analysing alternative options to reach the goals that CBDC targets (CPMI-MC 2018).

BIS recognises that issuing a general-purpose CBDC raises a number of challenges for the issuing central bank, such as meeting anti-money laundering and counter terrorism financing requirements as well as other public policy, supervisory, and tax regulations; ensuring the appropriate degree of privacy while having in mind that a variant of anonymous CBDC would carry reputational risks as such currency could be used for illicit transactions. Cyber-security is mentioned as one the most important operational challenges and, in general, the robustness of new technologies that could possibly be used to issue CBDC remains unclear. Finally, ensuring an issuing central bank has legal authority as well as answering whether a CBDC can serve as legal tender is necessary before taking any actions (CPMI-MC 2018).

When discussing the implications of CBDC more broadly, BIS calls for further research to determine the potential implications. While BIS finds that CBDC would likely not change the basic mechanisms of monetary policy implementation, it acknowledges that CBDC has the potential to affect monetary policy transmission and financial markets and could have negative implications on financial stability. The report recognises that “the effects on movements in exchange rates and other asset prices remain largely unknown and also deserve further exploration” (CPMI-MC 2018, p. 2).

The International Monetary Fund (IMF) explores the benefits and costs of CBDC as a response to declining use of cash payments (Khiaonarong & Humphrey 2019). IMF sees “a reduction in the cost of supplying cash to the public” (Khiaonarong & Humphrey 2019, p. 24) and the chance of higher user convenience as the two main benefits of CBDC. On the other hand, the IMF admits that ultimately the “costs of digital cash depend primarily on how it is structured and implemented” (IMF 2018, p. 26)

The IMF focuses on the demand side for digital cash to determine the possible attractiveness of CBDC. The IMF admits the possibility of cash replacement by private substitutes. At the same time, the IMF sees the need for the CBDC to offer some additional incentive to use it as otherwise it would not be more convenient than private solutions. “Without an additional incentive, the upper limit to the demand for central bank digital currency is likely to be below that of the current level of physical cash” (IMF 2018, p. 29).

In 2017, the central bank of Denmark analysed the necessity for CBDC in Denmark; however, at that point it concluded that potential challenges arising from CBDC introduction would outweigh potential benefits. While acknowledging widely used arguments in favour of CBDC in general, Danmarks Nationalbank said that in the Danish context issuing CBDC “would fundamentally change Danmarks Nationalbank’s role in the financial system and make Danmarks Nationalbank a direct competitor to the commercial banks” (Danmarks Nationalbank 2017, p. 1). The analysis found additional issues arising from potential CBDC issuance in Denmark, some of which are:

- anti-money laundering and personal data protection requirements would impose additional challenges and requirements on a central bank;
- contributing to a rapid and effective payments solution is in line with Danmarks Nationalbank’s objectives. The analysis considered the Danish payment system to be secure and efficient; hence, it found no incentive to intervene with CBDC;
- the analysis argued against one of the popular arguments used to back CBDC – namely the interest rate on CBDC as a monetary policy instrument – in the Danish context as a fixed-exchange-

rate policy means that the level of Denmark's Nationalbank's interest rates is set to maintain a stable krone exchange rate; which would also be the case for interest rate on CBDC (Denmark's Nationalbank 2017).

The Riksbank, Sweden's central bank, is currently investigating the need for electronic Swedish kronor issuance. However, no final decision has yet been taken on issuing e-krona (Sveriges Riksbank 2019). The interest of the Riksbank in CBDC arises from the continuing decline of use of cash in Sweden (Sveriges Riksbank 2018). BIS notes that Sweden is an exception in the CPMI jurisdictions context in terms of trends of cash in circulation: while in the CPMI jurisdictions the cash in circulation has grown (typically used as store of value), in Sweden cash in circulation is decreasing (Bech & Boar, n.d.). If such a trend continues, the Riksbank sees that e-krona could address the following potential issues:

- e-krona could help avoid losing society's access to central bank money, which has lower liquidity and credit risk than private bank money;
- e-krona could serve as a contingency measure in case of payments function disruptions in crisis situations;
- e-krona could facilitate maintaining financial inclusion of socially more vulnerable society groups;
- issuing e-krona could increase competition by providing a competitively neutral infrastructure solution for payment service providers (Sveriges Riksbank 2018).

The central bank of Iceland researched issuance of rafkrona. It discussed two ways in which rafkrona could be issued: as base money and "as a registered, traceable deposit to a payment account with the Central Bank" (Central Bank of Iceland 2018, p. 36). The report acknowledges that the issuance of rafkrona could have a broad range of effects on the current financial system, some of which may still be unknown. At the same time, the central bank calls for more research to determine possible effects before it can take a position on rafkrona issuance (Central Bank of Iceland 2018).

Lietuvos bankas, as a member of the Eurosystem, is not in a position to issue CBDC but is taking a proactive role in gaining practical hands-on experience in this area. The approach is borrowed from the regulatory sandbox concept of the supervisory unit of Lietuvos bankas. In this case, a niche area of numismatics has been identified as a "playground" with controlled risk for the central bank and potential retail users. A digital numismatic coin under the working name LBCOIN is under production and is set to be released in the first half of 2020 (Lietuvos bankas 2019b). Multiple valuable legal, technological, cybersecurity, and other issues have been encountered and resolved, providing an invaluable steep learning curve. The can be considered as *in vitro* test of multiple aspects relevant to the CBDC discussion.

4.2. Academic literature overview

4.2.1. General remarks

Academic society researches CBDC and possible implications to monetary policy, financial stability and discusses operational aspects outside of the official institutions' capacity. The following are some of the considerations outlined in the academia.

Barontini & Holden (2019) survey central banks to determine the level of their interest in the topic and intentions to launch their own CBDC. They find that while a majority of central banks are researching the implications of CBDC, the number of those intending to issue a CBDC in the short to medium term is low.

The authors also survey central banks to rank the most significant factors to consider in issuing CBDC and find that payment safety and payment efficiency are regarded as most important by central banks.

Berentsen & Schär (2018) distinguish central bank cryptocurrency. The authors define currencies based on the tri-dimensional (transaction handling, money creation, and representation) control structure. They distinguish cryptocurrencies as having a distinction of a decentralised nature which allows for user anonymity and permissionless handling. While they say CBDC could bring a number of benefits, they argue that a true central bank cryptocurrency would raise too-high reputational risks namely due to the anonymous nature of cryptocurrency.

Barrdear & Kumhoff (2016) analyse the macroeconomic implications of CBDC adoption. One of the conclusions they arrive at is that a CBDC could “contribute to the stabilisation of the business cycle, by giving policymakers access to a second policy instrument that controls either the quantity or the price of CBDC in a countercyclical fashion” (Barrdear & Kumhoff 2016, p. 3).

Bordo & Levin (2017) fear central banks risk a number of negative consequences if they view CBDC adoption too passively. These include macroeconomic instability in case cash is no longer used and there is no alternative legal tender provided; loss of monetary control as if the monetary base is held only in private institutions – this may encourage a drift of market interest rate from central bank targeted interest rate; with no CBDC competition, payment systems could become quasi-monopolistic; and vulnerability to severe downturns without interest-bearing CBDC providing for a policy alternative.

Dyson & Hodgson (2016) argue for digital cash carrying a number of benefits and investigate the ways central bank digital cash could be implemented and managed. They suggest that the indirect-access way of implementation would be the most market-driven and acceptable form of CBDC.

4.2.2. Discussion on monetary policy effects

Research on CBDC implications for monetary policy and financial stability is particularly extensive. Nonetheless, authors demonstrate a varying degree of enthusiasm for CBDC adoption. Based on the amount of merit the authors give to CBDC’s effect on monetary policy, they could be split into three strands: idealistic, moderately enthusiastic, and sceptical.⁴ Below is an overview of some of the representatives of each strand and their principle ideas.

Such authors as Bordo & Levin (2019), Brunnermeier & Niepelt (2019), and Rogoff (2016) could be considered as representing an idealistic view. Their main motivations argue for CBDC adoption, as they could bring the following benefits from the monetary policy and financial stability side:

- CBDC can be an efficient way to replace outdated banknotes, ensuring central bank involvement in the modern retail payment framework;
- CBDC is an inevitable response by the central banks to the digitalisation trend and challenge of global stablecoins (e.g. Libra);
- if combined with the abolishment of banknotes, CBDC could overcome the effective lower bound problem;

⁴ The idea is borrowed from Bindseil (2019a), who calls these views a bit differently: idealistic views; fearful/conservative views; pragmatic views.

- CBDC enriches the monetary policy toolkit with an additional instrument – namely interest in CBDC;
- CBDC has the potential to increase financial stability by providing a widely-accessible, digital, safe means of payment;
- the most extreme view comes from proponents of “sovereign money” and “helicopter money”. They argue that CBDC is an appropriate technical tool to nationalise money issuance (sovereign money concept) or “drop” money to the general public “from a helicopter”.

The views of Carney (2018; 2019), Kumhof & Noone (2018), Bindseil (2019), and Fegatelli (2019), could be attributed to the group of moderately enthusiastic ones. These authors take CBDC caveats very seriously and acknowledge that CBDC cannot be issued without the appropriate solutions. However, at the same time, they regard the CBDC idea in general as promising and make big efforts to devise CBDC schemes with a positive net balance of benefits and costs. They work with real data of financial accounts to prepare for CBDC launch in reality. They also argue that the Libra initiative facilitated central bank cooperation in investigating CBDC feasibility.

Some central bank projects are also characteristic of the moderately enthusiastic views. These examples could be the e-peso project of the Central Bank of Uruguay (2017–2018) and the e-krona project of the Riksbank (2018).

Representatives of the sceptical views argue that CBDC costs could eventually outweigh any potential benefit. The following arguments are given by Constâncio (2017; 2018), Danmarks Nationalbank (2017), Joint Report by the BIS Committee on Payments and Market Infrastructures and the Markets Committee (CPMI-MC 2018) to warn of potential risks from CBDC:

- Issuing CBDC would lead to an excessive expansion of the central bank balance sheet at the expense of banks and self-regulation of financial markets and risk premiums due to heavy participation of a central bank;
- CBDC would reduce the volume and/or quality of eligible collateral that, if needed, is available for expansionary monetary policy;
- CBDC could undermine financial stability, as it provides bank run assets and facilitates bank runs in a crisis;
- CBDC could undermine efficient credit allocation by increasing bank funding costs and reliance on wholesale funding and reducing maturity transformation;
- it is difficult to see what CBDC would be able to contribute that is not already covered by the payment solutions that exist today;
- each declared benefit of CBDC could be provided at a lower cost and risk by alternative solutions;
- since the traditional approach of money supply served the public and the financial system well, the potential barrier for changing the current monetary and financial structure is high;
- CBDC would open the door to extreme ideas of sovereign money, disruptive for a market-based economy and democracy.

4.3. Overview of central bank projects on CBDC

A number of central banks have already taken a step further in CBDC research and attempted the first technical experiments, pilot projects, cross-jurisdictional research projects. Table 1 gives a brief

overview of some of the projects implemented and stresses the main takeaway messages from these projects.

Table 1. An overview of projects on CBDC or underlying innovation in technical solutions undertaken by central banks globally.

Jurisdiction	Project name	Project website or main information source	Key takeaways/highlights
Canada	Project Jasper	Part of Bank of Canada website designated to Fintech experiments and projects: https://www.bankofcanada.ca/research/digital-currencies-and-fintech/fintech-experiments-and-projects/	<ul style="list-style-type: none"> • “The goal of the project is to better understand how the technology could transform the future of payments in Canada” (Payments Canada 2017, p. 3). • “Project Jasper is a proof of concept of a DLT-based wholesale payment system” (Chapman, Garratt, Hendry, McCormack, & McMahon 2017, p. 1). • “One of the main lessons from this experiment is that the versions of distributed ledger currently available may not provide an overall net benefit when compared with existing centralized systems for interbank payments” (Chapman, Garratt, Hendry, McCormack, & McMahon 2017, p. 4).
China	Project “DC/EP”: Digital Currency/Electronic Payments.	Secondary sources, primarily news sites	<ul style="list-style-type: none"> • Very limited amount of details available. • The goal of the project was to digitise cash. • The new digital currency could provide a way for bank settlement. • There is no timetable for the launch. • No official statement on the technology to be used. • Existing financial institutions are expected to be used for distribution. • There are some speculations about privacy issues, but bank representatives say they will seek a balance between anonymity and identifying illicit transactions (Financial Times 2019).
Ecuador	Dinero electrónico	Secondary sources, e.g. Bech & Garratt 2017, BIS Quarterly Review September 2017 https://www.bis.org/publ/qtrpdf/r_qt1709f.pdf	<ul style="list-style-type: none"> • Introduced in 2015 (Prasad 2019). • “Dinero electrónico is a mobile payment service in Ecuador where the central bank provides the underlying accounts to the public” (Bech & Garratt 2017, p. 62). • Accessible via app with national identity number (Bech & Garratt 2017). • Transaction centers were designated for money depositing or withdrawal (Bech & Garratt 2017). • “[...] it is a (rare) example of a deposited currency account scheme” (Bech & Garratt 2017, p. 62). • Denominated in US dollars (official Ecuador currency) (Bech & Garratt 2017). • “[...] since the system failed to attract a significant number of users or volume of payments, [central bank of Ecuador] deactivated the system in April 2018” (Prasad 2019, p. 14).
Lithuania	LBCOIN	LBCOIN section on Bank of Lithuania website: https://www.lb.lt/en/digital-collector-coin-lbcoin#ex-1-1	<ul style="list-style-type: none"> • LBCoin is a blockchain-based digital collector coin. • The project serves as a playground with controlled risk for the central bank and potential retail users. • LBCoin is currently under production and is expected in the first half of 2020. • The project is viewed as <i>in vitro</i> test of multiple aspects relevant to CBDC discussion (Lietuvos bankas 2019b).

Jurisdiction	Project name	Project website or main information source	Key takeaways/highlights
Singapore	Project Ubin	Project Ubin section on the Monetary Authority of Singapore website: https://www.mas.gov.sg/schemes-and-initiatives/Project-Ubin	<ul style="list-style-type: none"> • "Project Ubin is a collaborative project with the industry to explore the use of Blockchain and Distributed Ledger Technology (DLT) for clearing and settlement of payments and securities" (Monetary Authority of Singapore 2019). • "The project aims to help MAS and the industry better understand the technology and the potential benefits it may bring through practical experimentation. This is with the eventual goal of developing simpler to use and more efficient alternatives to today's systems based on central bank issued digital tokens" (Monetary Authority of Singapore 2019). • "Project Ubin is a multi-year multi-phase project, with each phase aimed at solving the pressing challenges faced by the financial industry and the blockchain ecosystem. The project is now in its fifth phase [...]" (Monetary Authority of Singapore 2019).
Sweden	E-krona	Section on the Riksbank's website for e-krona: https://www.riksbank.se/en-gb/payments--cash/e-krona/	<ul style="list-style-type: none"> • In 2017, the Riksbank started a project "to examine the scope for the Riksbank to issue a central bank digital currency (CBDC), a so-called "e-krona" (Sveriges Riksbank 2019). • "An e-krona would give the general public access to a digital complement to cash, where the state would guarantee the value of the money" (Sveriges Riksbank 2019). • As of autumn 2019, the Swedish central bank is procuring a technical supplier for test solutions; looking into the impact of e-krona on Swedish legislation and the tasks of the Riksbank; and continues analysis on the need for e-krona and the potential impact on the economy (Sveriges Riksbank 2019).
Ukraine	E-hryvnia	National Bank of Ukraine analytical report on e-hryvnia pilot project: https://old.bank.gov.ua/news/all/e-hryvnia	<ul style="list-style-type: none"> • "In essence, the e-hryvnia is digital fiat currency, which can be exchanged for cash or cashless money on a one-to-one ratio" (National Bank of Ukraine 2019a). • The National Bank of Ukraine (NBU) launched its pilot e-hryvnia in May 2016. They chose to test it using blockchain technology (National Bank of Ukraine 2019a). • "In 2018, the NBU implemented a pilot project that envisaged creation of the Electronic Hryvnia platform [...], issuance of a limited amount of the e-hryvnia and testing of e-hryvnia transactions made by the NBU personnel and companies participating in this project" (National Bank of Ukraine 2019b, p. 6). • "E-hryvnia may be considered as the disruptive technology, since it has the potential to change the ecosystem of Ukraine's payment market and reassign the current roles of market participants" (National Bank of Ukraine 2019b, p. 33). • "Implementation of e-hryvnia is impossible without major investment and time needed to upgrade the payment infrastructure for this instrument" (National Bank of Ukraine 2019b, p. 33). • "[...] there are no fundamental advantages in using specifically the DLT technology to build a

Jurisdiction	Project name	Project website or main information source	Key takeaways/highlights
			centralized e-hryvnia issuance system” (National Bank of Ukraine 2019b, p. 6).
Uruguay	E-peso	<p>Secondary sources, e.g. IMF staff report for the 2018 Article IV Consultation on Uruguay, Box 4: https://www.imf.org/en/Publications/CR/Issues/2019/02/22/Uruguay-2018-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-46624</p>	<ul style="list-style-type: none"> “E-peso is a legal tender digital currency issued by the central bank. It is an electronic money and does not use distributed ledger technology. The pilot program was used to test the technical aspects and run for 6 months (November 2017-April 2018), with limited bill issuance (\$20 million for 10000 mobile users) and size per person (\$30,000 per wallet and \$200,000 for registered businesses). E-peso was mainly used for payment transactions in registered stores and businesses, and peer-to-peer transfers. The system used instantaneous settlement and run through mobile line (no internet connection was needed). E-peso was anonymous but traceable, with unique bills preventing double spending and falsification” (IMF 2019, p. 16).
Joint Projects			
Bank of Canada, Bank of England, and Monetary Authority of Singapore	Research Project on cross-border interbank payments and settlements	<p>Project report: https://www.bankofengland.co.uk/-/media/boe/files/report/2018/cross-border-interbank-payments-and-settlements.pdf?la=en&hash=48AADDE3973FCB451E725CB70634A3AAFE7A45A3</p>	<ul style="list-style-type: none"> The project aimed to “examine the existing challenges and frictions that arise when undertaking crossborder payments” and explored “proposals for new and more efficient models for processing cross-border transactions” (Bank of Canada, Bank of England, Monetary Authority of Singapore 2018, p. 5). It was concluded that the ongoing industry initiatives partly address the challenges that were identified. Nonetheless, these changes were not considered incremental and it was considered that “in the longer term there may need to be a more fundamental paradigm shift to address these challenges in a more holistic way, enabled by new technology platforms” (Bank of Canada, Bank of England, Monetary Authority of Singapore 2018, p. 5).
European Central Bank and Bank of Japan	Project Stella	<p>ECB and BoJ joint reports: https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews190604.en.html; https://www.boj.or.jp/en/announcements/rel2019/rel190604a.htm/</p>	<ul style="list-style-type: none"> The third phase of the Stella project was completed in June 2019. “The 3rd phase investigated innovative solutions to improve cross-border payments, particularly in terms of safety” (ECB and Bank of Japan 2019). It was concluded that “from a technical perspective, the safety of today’s cross-border payments could potentially be improved by using payment methods that synchronise payments and lock funds along the payment chain” (ECB and Bank of Japan 2019, p. 7). There was still a number of issues found that needed to be solved before implementation can be considered. These issues included legal and compliance aspects, maturity of the technology, and a need for cost-benefit analysis (ECB and Bank of Japan 2019). The first phase of the Stella project in researched liquidity saving mechanisms in payment systems in a distributed ledger environment (ECB and Bank of Japan 2017). The second phase of Stella focused on securities settlement systems and researched delivery versus payment in a distributed ledger environment (ECB

Jurisdiction	Project name	Project website or main information source	Key takeaways/highlights
			and Bank of Japan 2018).
Hong Kong Monetary Authority and Bank of Thailand	Project LionRock-Inthanon	HKMA-BOT Cross-Border Payments Proof-of-Concept Project Leaflet https://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/BOT-Cross-Border-Payments-Proof-of-Concept-Project-Leaflet.pdf	<ul style="list-style-type: none"> • Joint project of Bank of Thailand and Hong Kong Monetary Authority, both of which have projects to address domestic transfers (Hong Kong Monetary Authority and Bank of Thailand n.d.). • “Project LionRock-Inthanon explores real-time cross-border transfers and FX payments via a corridor network to achieve atomic PvP with reduced settlement layers” (Hong Kong Monetary Authority and Bank of Thailand n.d., p. 2). • A report with the project findings is planned to be released in the Q1 2020 (Hong Kong Monetary Authority and Bank of Thailand n.d.).

4.4. Takeaways from literature overview

Several conclusions can be drawn from the literature overview:

1. Literature on CBDC has become abundant over recent years and various aspects and implications of CBDC adoption are discussed.
2. While different models are applied to measure potential CBDC impact, since there is no practical CBDC experience and consequently no data, it is hard to assess the real CBDC impact. Thus, the majority of research is theoretical and there is no consensus on the possible CBDC implications for the financial system, with the enthusiasm and caution varying greatly among central banks and academics.
3. Academic literature review gives the impression that the amount of consideration devoted to researching CBDC policy implications and possible technological solutions at this point exceeds the focus on finding the key issues that need to be addressed. In every jurisdiction's case, the highest priority may be different, with some first of all needing to improve financial inclusion or provide a safe asset. At the same time, for those focused on CBDC primarily as a means to improve cross-border payments efficiency, the best way forward appears to be a joint effort in search of a common solution (some central banks have joint projects already taking place).
4. CBDC can be implemented in a variety of different setups. While there seems to be no optimal CBDC design choice to be applicable for all cases, an individual central bank can choose the most suitable setup for it by assessing country specifics. The design of CBDC and – first of all – the assessment on whether potential benefits of CBDC can outweigh the threats of its implementation will depend on different individual country's features, such as payment system efficiency, monetary policy regime, level of financial inclusion, credit quality, existence of credible deposit insurance mechanism, and others.
5. The majority of work seems to focus on the assessment of the CBDC need and implications for a single jurisdiction. However, the assessment is much more limited for such ideas as a CBDC for several jurisdictions or multicurrency CBDC. In fact, one might argue such a currency could be a perfect solution to address in particular the issue of cross-border payment efficiency and would therefore deserve a more thorough discussion among academics and policy makers.

6. The literature on the cross-jurisdictional effects of CBDC is limited. If a credible, convenient, and available-outside-the-jurisdiction CBDC will be issued, it would get the benefits of being the first. There are some discussions in the literature that CBDC could facilitate “digital dollarization” (e.g. Adrian 2019, Brunnermeier, James, & Landau 2019). However, when assessing CBDC implications for a particular jurisdiction, the majority of research assumes the abolishment of cash or a rise of private sector stablecoins. Cross-jurisdictional effects are not given significant consideration. The barely researched idea of a multi-currency CBDC deserves more consideration in this aspect. A multi-currency CBDC would help avoid the danger of “digital dollarization” and a race among central banks.

5. CBDC IMPLICATIONS FOR FINANCIAL STABILITY

There are very different views on how CBDC may influence financial stability. Two main financial stability concerns are raised by many authors (Bryant 2005, Stevens 2017, CPMI-MC 2018, Cecchetti & Schoenholtz 2017, Šiaudinis 2019):

- Introduction of CBDC could lead to higher instability of bank funding and increased risk of systemic digital bank runs.
- CBDC would mean the larger role of central banks in financial intermediation (its higher exposure credit risk, etc.).

Section 5 discusses these concerns in more detail.

5.1. Increased risk of bank runs

Some authors (see Constâncio 2017, 2018; Danmarks Nationalbank 2017; Joint Report by the BIS Committee on Payments and Market Infrastructures and the Markets Committee CPMI-MC 2018) state the concern that a widely available CBDC provides investors with a flight-to-safety instrument, the mere availability of which could be destabilising. At their core, many financial crises were a systemic bank run. But the basic economic structure of most financial crises was the same as that of panics and runs on demand deposits. A frequently made argument against the introduction of a CBDC points to the danger of increased run risk. According to this argument, a CBDC would not foster *traditional* bank runs where non-banks try to withdraw deposits and convert them into cash. Instead, it would give rise to a *novel* form with volatile deposit withdrawals in response to swings in sentiment and shifts into a safe-haven CBDC, since such swaps would be very easy to conduct and nearly costless (Brunnermeier & Niepelt 2019).

During a hypothetical systemic digital run, dramatic changes in the two-tiered banking sector balance sheet could occur. If commercial banks suffer a significant deposit outflow into CBDC, the central bank would be obligated to provide adequate liquidity support to maintain the functioning of the banking sector and prevent the targeted market interest rate from an uncontrolled jump.

However, there are mitigating aspects to these concerns which could mean that the extent of their effect would be much lower than some might think. The mitigating aspects are as follow:

1. **Money market funds or treasury bills or cash possess similar risk to CBDC during a crisis,** as people can (try to) run to those assets too.⁵

⁵ See Cochrane (2019) discussing the potential impact of narrow banking on financial stability. Cochrane’s (2019) arguments directly translate to the case of the introduction of CBDC. Moreover, if you are introducing an additional financial asset into the financial system, you should analyse the marginal effect of this asset (CBDC) on the probability of bank runs. Systemic bank runs had happened in the past and probably

2. **Investors who already hold CBDC would not need to run anywhere.** Therefore, by introducing CBDC we would trade a financial system based on a small amount of run-free central bank money (cash) and a large amount of run-prone private money for a system with a large amount of run-free central bank money (CBDC) and a small amount of run-prone private money. Thus, there is a lot less run-prone shadow banking to run from in a crisis (Cochrane 2019).
3. **Run on banks would lead to an automatic substitution of one type of bank funding.** It is frequently argued that CBDC could increase run risk, due to the low cost of withdrawing deposits and transferring them to CBDC accounts, and thereby undermine financial stability. But this neglects the fact that the very act of transferring funds from a bank to central bank accounts would amount to an automatic substitution of one type of bank funding (deposits held by households and firms) by another one (central bank funding for banks). By construction, a depositor run for CBDC, therefore, would not reduce bank funding and undermine financial stability – it would only change the composition of bank funding (Brunnermeier & Niepelt 2019).
4. **It is not clear why the credible commitment of central bank intervention would not be sufficient to discourage bank runs in the first place.** The run-inducing incentives put in place by CBDC would, by their reckoning, require a heroic expansion of lending by a central bank in a financial crisis (Andolfatto, Berentsen, & Martin, 2017).
5. **According to Brunnermeier & Niepelt (2019), it is plausible that the introduction of CBDC could reduce run risk rather than increasing it.** After a large swap, coupled with pass-through funding, the central bank could become a large, possibly the largest, depositor at private banks. As a consequence, incentives for small depositors to run might also vanish. In addition, CBDC and pass-through funding would bestow the central bank with an informational advantage relative to conventional runs into cash, which the central bank only learns about with a delay.

5.2. Increased role of central banks in financial intermediation

If CBDC were to be introduced, banks could lose a portion of their funding, and it would have to be replaced. This could change the future development of the banking sector. One could argue that it would lead to development of alternative bank funding markets (e.g. a covered bond or ABS markets, which could replace the part of deposit funding). If this was not the case, a central bank would be forced to replace the funding gap and accept higher and less-known credit risk.⁶ This by some is perceived as an unintended consequence of CBDC. Nevertheless, it is not straightforward that such a development would become a significant issue.

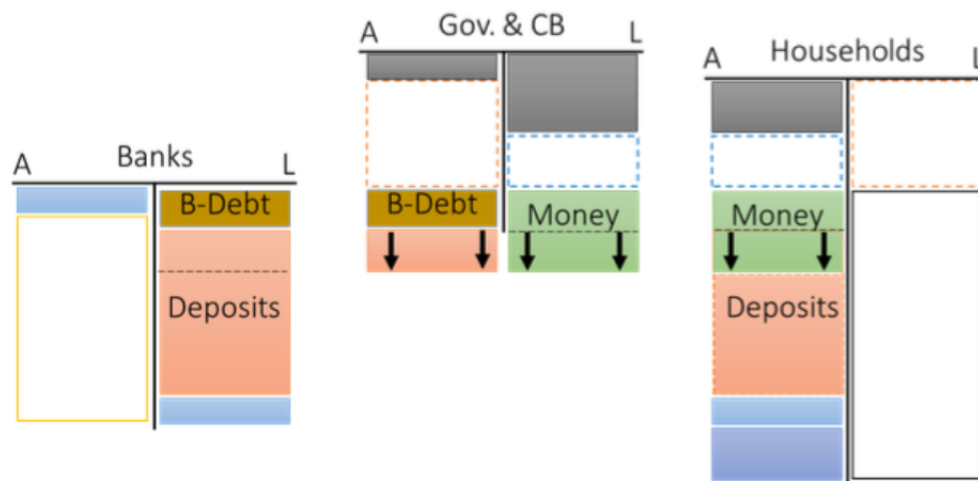
The introduction of CBDC could lead to significant changes in bank financing. If people were to swap some of their bank deposits into a CBDC, the banks would lose a source of funding, but a central bank would gain funds which it would have to invest. A central bank could pass the funds through to commercial banks,

will happen in the future independent of CBDC; therefore, the cost of CBDC is an additional bank runs (or additional severeness of bank runs, which would not have happened if CBDC would not have been introduced. It should be noted that introduction of CBDC in the Diamond & Dybvig (1983) type of bank run model would not have a significant effect as it is not very different in nature from government bonds or cash. In addition, there are many ways to limit the incentives of a bank run in Diamond & Dybvig (1983) type bank run models: liquidity requirement, capital requirement etc. Thus, the additional cost of CBDC could be reduced by various resilience increasing measures.

⁶ Even under the current financial system, central banks do not try to fight runs (financial crisis) by forcing investors to hold risky assets. In a crisis, central banks are on the frontlines, buying assets and issuing reserves as fast as they can. The Fed itself makes the supply of reserves elastic in a crisis. See Cochrane, J. (2019)

effectively leaving the environment for banks completely unchanged. The important point to note is that a substitution of monies (a CBDC for deposits) only requires new sources of bank funding, not new ownership and control over real assets (Brunnermeier & Niepelt 2019).

Fig. 2. Illustration of the effects of the pass-through operation on balance sheets of banks, a central bank, and households.



Notes: The arrows in the green rectangles indicate that households hold fewer deposits but more central bank-issued money, for example in the form of a CBDC. The central bank passes the funds through to banks by holding more deposits, as depicted by the arrows in the red rectangle on the asset side of the central bank's balance sheet.

Source: Brunnermeier & Niepelt (2019).

Fig. 2 illustrates this “pass-through” mechanism: when households expand their CBDC (“money”) holdings and lower their deposit holdings (as indicated by the arrows on the asset side of the household sector’s balance sheet), then the central bank’s liabilities expand correspondingly (indicated by the arrows on the liabilities side of the central bank’s balance sheet). In exchange for the CBDC, the central bank acquires claims vis-à-vis the banking sector (indicated by the arrows on the asset side of its balance sheet). That is, the central bank automatically provides substitute funding for banks, effectively intermediating between non-banks and banks (Brunnermeier & Niepelt 2019).

Many fear a large flow of deposits from uninsured bank accounts to insured CBDC accounts. This fear, however, according to Andolfatto (2018) seems to be based on the questionable assumption that banks would not raise the deposit rates they offer to retain deposits. Banks may witness deposit outflows, but they can choose to stem those outflows by offering depositors better terms. The capacity to do so seems evident, at least in the US, judging by the current spread between bank lending and deposit rates. But even in the event of a large deposit outflow, an interest-targeting central bank should be willing to let banks borrow reserves.

Andolfatto (2018) argues that if today deposits are perfectly liquid and risk-free because of unconditional deposit insurance backed by government guarantees and a lender of last resort, then a CBDC combined with pass-through funding would simply make implicit government guarantees explicit. If deposits are risky, in contrast, then the newly introduced CBDC would have to be accompanied by transfers or taxes in order to exactly replicate outcomes under the contemporaneous regime.

In either case, the net wealth and liquidity positions of agents would remain unchanged even if their gross positions reflected in balance sheets might change (for further discussion see Andolfatto 2018).

A related question is whether a central bank would lose control over its balance sheet once the CBDC is introduced. A central bank that passes through funds from non-banks to banks increases its balance sheet, and if the volume of funds varies over time, so does the size of the balance sheet. There is no reason, however, to be concerned with the size of a central bank's balance sheet per se (especially if some items on the asset and liability side net out) except for the implications on credit risk exposure. This exposure can be minimised with the appropriate collateral policy (Brunnermeier & Niepelt 2019).

5.3. CBDC as a risk free asset

According to Caballero (2010), the fundamental problem in the current global macroeconomic and financial equilibrium is the shortage of a risk free asset. Caballero & Farhi (2014a) argue that a steady rise in the demand for safe assets from the end of the 1990s was behind a wide variety of macroeconomic phenomena, such as the global savings glut and raising global imbalances. The demand for these assets has expanded also as a result of the fear triggered by various crises.

Caballero & Farhi (2014b) argue that the shortage of safe assets will remain a structural drag on the economy, undermining financial stability and straining monetary policy during contractions.

Caballero & Farhi (2014a) show that a safe asset is such that is expected to preserve its economic value following bad macroeconomic shocks. They provide a model which illustrates how a chronic shortage of safe assets can push the economy up against the zero lower bound and weaken the effectiveness of some of the standard market mechanisms. They refer to this situation as a *safety trap*, which has some similarity to the conventional liquidity trap.

It could be argued that issuance of on-demand CBDC could expand the real supply of safe assets, thus, solving the problem of their shortage. This way, a central bank could convert the private sector's assets to risk free assets (CBDC). It would mean that a central bank would need to take more credit risk; however, ultimately CBDC could be a solution for risk-free asset shortage.

6. CBDC IMPLICATIONS FOR MONETARY POLICY

The potential impact of CBDC adoption on monetary policy and its implementation are a significant part of the discussion on CBDC. Not surprisingly, one of the main obstacles to determine the actual implications of CBDC adoption on monetary policy and its implementation is the lack of practical experience to draw conclusions from. Nonetheless, at the theoretical level, the discussion on CBDC implications for monetary policy is broad and there are a number of aspects that can and should be considered before any steps towards CBDC adoption are taken.

This section discusses the main arguments for issuing CBDC from the monetary policy perspective as well as the limitations that need to be addressed and describe the possible ways to tackle some of the potential problems.

6.1. Main monetary policy arguments for issuing general-purpose CBDC and caveats

There are a number of arguments that support CBDC adoption. However, the majority of them also have some limitations that need to be solved to reap the potential benefits of CBDC adoption from the monetary policy perspective. Table 2 outlines these arguments as well as the corresponding limitations. Only

the general-purpose CBDC is discussed here, as wholesale CBDC is of a much more limited scope and, therefore, its implications for monetary policy and financial stability would also be limited.

Table 2. Monetary policy arguments for issuing general-purpose CBDC and related requirements or other factors.

Main arguments	Related requirements or caveats
Overcoming the zero (or effective) lower bound constraint.	Requires discontinuation of banknotes (or at least of larger denominations). Questions of side effects on financial stability and the politically acceptable level of the effective lower bound would be still in place. There is no consensus if negative policy rates should be applied and to what extent. Can be delivered by alternative non-standard measures at likely lower costs.
Potential strengthening of the pass-through of the policy rate to the markets: - interest rates on CBDC with direct impact on deposit rates; - hard floor for money market rates due to CBDC accessibility by the non-financial sector; - higher demand for the central bank liquidity-providing operations.	CBDC should be interest-bearing. CBDC would likely reduce bank lending capacities: less stable deposit base and higher reliance on wholesale funding; reduced maturity transformation; increased funding costs and lending rates. Asset price channel and exchange rate channel could become less certain. CBDC could lead to large cross-border and domestic capital movements and related exchange rate and other asset price effects.
Permanent expansion of the central bank balance sheet by bond purchases would permanently lower bond yields.	Risk of central bank excessive participation in bond markets and the distortion of risk premiums. May require an expansion of the eligible collateral universe by including lower-quality assets. Risk of political pressure on the central bank to continue high participation in the government bond market beyond monetary policy considerations.
Monetary transmission could strengthen if CBDC spurs greater financial inclusion.	At most, relevant to emerging markets.

6.2. Two key caveats and counter-arguments against CBDC

The key arguments against CBDC have significant implications for monetary policy. If the structural disintermediation of banks were to materialise, monetary policy could be affected via: firstly, impacting bank funding costs and, secondly, reducing the volume and quality of eligible collateral available if monetary policy is needed (Bindseil 2019; Kumhof & Noone 2018; Šiaudinis 2019).

It is argued that CBDC would facilitate bank runs in crisis situations by providing a digital bank run asset. From the monetary policy perspective, this would mean that bank runs and emergency liquidity assistance would shake the money market and, therefore, distort monetary policy transmission, at least for a while.

Annex 1 elaborates further on the possible effects of CBDC adoption to monetary policy by illustrating CBDC-induced hypothetical changes in balance sheets of the central bank and commercial bank.

6.3. CBDC schemes to deal with the two key caveats of CBDC

While the potential side effects of monetary policy are a cause for worry, CBDC design can be adjusted to mitigate the potential negative implications. Research attempts are focused on control of CBDC quantity both in normal and crisis times. Although the distribution of restricted CBDC amounts is a

common practice in the pilot tests, the market-based CBDC concept is widely assumed to be out of direct administrative control.

Bindseil (2019), Kumhof & Noone (2018), and Juks (2018) suggest a central bank could take proactive measures to mitigate the risks from CBDC to monetary policy. These could include 1) quantity limits; 2) active pricing; 3) issuing of CBDC against eligible bonds. Although the proposed schemes may reduce CBDC-related risks, the authors acknowledge significant residual risks still remain.

The quantity limits of CBDC under unstable demand would lead to a volatile deviation from parity in the exchange rate or differential in interest rates between CBDC and other types of money. This would negate one of the crucial achievements of central banking – a high homogeneity of money supply – with likely negative implications for financial stability and monetary policy.

Under active pricing, the central bank would apply time-varying interest rates on CBDC, cooling demand if necessary. One could assume, however, that sooner or later it would not be able to avoid a divergence from the main conventional monetary policy instrument, i.e. steering of interest rates. It might be politically unacceptable to impose the technically unjustified costs of owing CBDC on the general public, even if central banks communicate the necessity to link CBDC costs to those of physical cash, to preserve financial stability, or to eliminate effective lower bound constraint. Moreover, Kumhof & Noone (2018, p. 34) pointed out that the public may want “to convert deposits to CBDC at (almost) any price, perhaps because it is concerned about the solvency of banks”. During a period of stress, an intentional hike of CBDC costs by the central bank to prevent a bank run would definitely provoke a negative reaction from the public, coupled with disappointment with the economic and financial development.

Bindseil’s (2019b) attempt to improve the pricing scheme, as proposed by Kumhof & Noone (2019), led to a disappointing conclusion: in order to contain CBDC risks, quote-based CBDC volume should prevail. Bindseil (2019b) proposes two-tier CBDC remuneration, applying principles already used by the ECB for monetary policy purposes in remuneration of bank required and excess reserve as well as Government balance at a central bank. Here, CBDC Tier 1 is quote-based to provide basic payment service, substituting banknotes; CBDC Tier 2 is issued on demand and contained by active and less attractive pricing. Hypothetical fluctuations of CBDC remuneration rates, proposed by Bindseil (Ibid.), seem to be too synchronised and narrow to be true, at least during the banking crisis of 2008. Bindseil finally acknowledges that the aim is “to be confident that CBDC volumes will not significantly exceed the total tier one CBDC allowance” (p. 27). Therefore, CBDC Tier 1 appears to be an illusory option for the public, and the bulk of CBDC issuance should be based on predetermined quotes-per-capita, eliminating the possibility to use CBDC as a monetary policy tool to provide a policy rate and a flexible demand-driven channel of a safe means of payment.

Issuing CBDC directly to the public against eligible assets may have some advantages, but the overall effect appears to be disappointing. There is a prevailing assumption that CBDC can be issued only in exchange for already-issued banknotes and deposits. Researchers have suggested an alternative supply mechanism to issue CBDC directly to the broad public against good collateral, such as Treasury bonds (Kumhof & Noone 2018; Juks 2018). Advantage of this scheme should not affect the total amount of deposits in commercial banks, the level of reserves, and the availability of collateral held by banks. Initially, potential investors of CBDC would buy eligible assets in the market, paying with their deposits remaining in banks. Next, investors would sell these assets to the central bank in exchange for newly created CBDC. One can

assume, however, that typical bond traders are the wholesale financial institutions, while many CBDC investors would be retail depositors, implying a shift in the deposit structure towards less stability. Digital runs would consequently still be possible and would create extreme pressure, bubble pricing, and even a physical shortage in asset markets, compromising the whole CBDC scheme. As pointed out by Kumhof & Noon (2018, p. 36) – considered the originators of CBDC issuance against eligible assets – “the risk is that the market could run out of eligible assets to convert into CBDC, even with the current high levels of government debt and other potentially eligible debt securities in many developed economies.”

6.4. CBDC and the effective lower bound

CBDC proponents suppose that, in a cashless society, a negative policy rate on CBDC would promote banks to transmit negative interest rates to remaining deposits and lending rates (IMF 2018). However, there is no consensus on whether negative policy rates should be applied at all to provide an additional monetary accommodation.

There are significant considerations that argue against transmitting negative interest rates to the non-financial sector. The legal restrictions that some countries have on the application of negative rates to depositors are among the obstacles currently in place to apply such a policy. However, more broadly, the experience of negative policy rates in the 2010s suggests that central banks primarily target investment activity (including bank lending and borrowing by non-financial corporations) rather than stimulating demand by penalising retail savings. In fact, the potential outcome of targeting retail savings by a negative interest rate policy is unclear and could have a negative effect on consumption. In a crisis situation, such a policy could be even more harmful – a cashless society’s disappointment in economic development, coupled with negative (penalised) rates on CBDC and deposits would likely be considered as unfair wealth tax, with destructive consequences for the credibility of the banking sector and authorities.

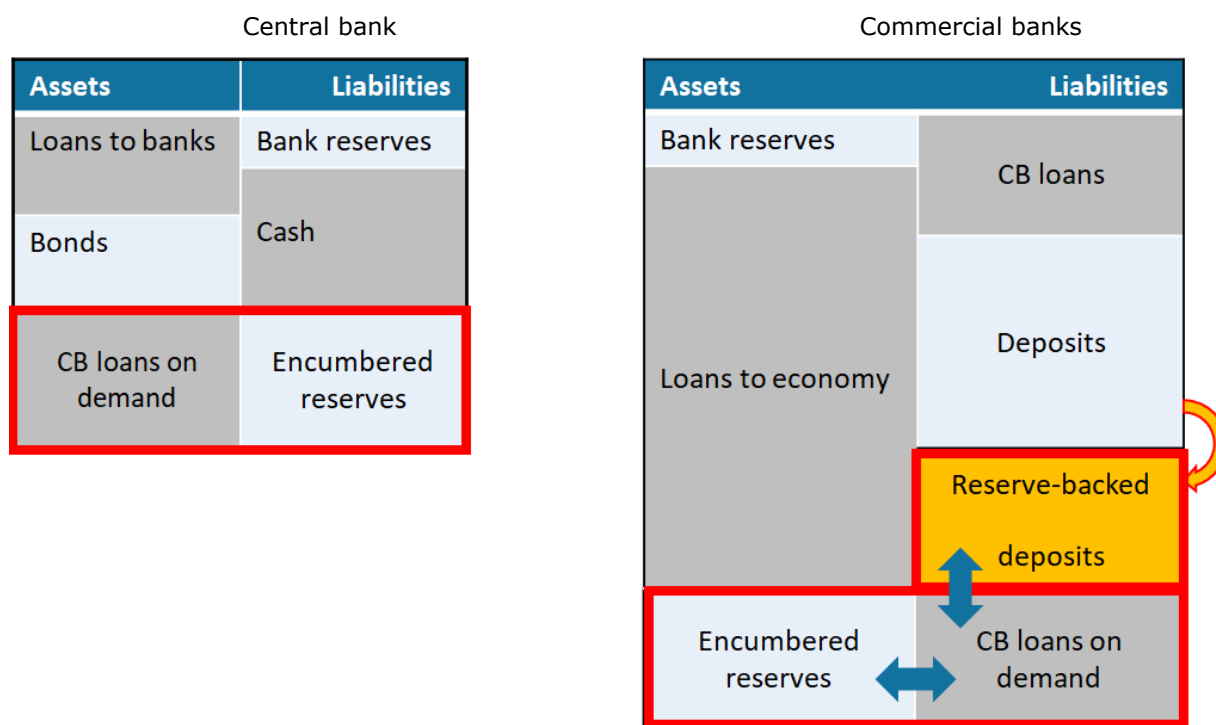
6.5. Synthetic CBDC

Synthetic CBDC has some advantages, but it does not prevent the central bank from massive unconditional liquidity provision to banks on demand. The option to exchange conventional deposits into reserve-backed deposits is expected to reduce the risk of bank run related to bank liquidity concerns. On the other hand, demand for synthetic CBDC could suddenly spike during periods of financial tensions, and the central bank would be forced to provide an equivalent amount of bank to affected banks (Fegatelli 2019; Šiaudinis 2019).

It has some other notable advantages relative to the fully-fledged version of explicit CBDC (Adrian 2019). This kind of CBDC outsources several steps to the private sector: technology choices, customer management, customer screening and monitoring including for “Know Your Customer” and AML/CFT (Anti-Money Laundering and Combating the Financing of Terrorism) purposes, regulatory compliance, and data management – all sources of substantial costs and risks. The central bank merely remains responsible for unrestricted provision of bank reserves, regulation and close supervision.

Fig. 3 further explains the mechanics of synthetic CBDC by illustrating the effects of a hypothetical case of synthetic CBDC adoption on the balance sheets of a central bank and commercial banks.

Fig. 3. Synthetic CBDC-induced hypothetical changes in the balance sheets of a central bank and commercial banks.



7. CONCLUSIONS

A wide range of CBDC variants are being considered – from universally accessible central bank accounts or digital tokens to less extreme suggestions of only partly broadening central bank access by providing CBDC for wholesale consumers or getting the private sector to mediate the process by providing synthetic CBDC.

There are benefits that CBDC introduction could bring. While hopes that CBDC could be a perfect solution to some of the hard-to-solve monetary policy issues – like tackling the effective lower bound constraint or strengthening the monetary policy transmission – seem to be overly optimistic, the benefits of having a widely accessible risk-free medium of payment are more straightforward.

CBDC design choices can contain negative policy implications. Key negative implications for policy from CBDC introduction are thought to be that an introduction of CBDC could lead to higher instability of bank funding and increased risk of systemic digital bank runs. Also, CBDC could mean a larger role for central banks in financial intermediation. However, design choices can help contain these risks. For example, a central bank could limit the risk of deposit runs by setting limits on individual CBDC holdings. During episodes of runs, a central bank could lend the funds it collects from depositors back to banks.

So far there is no empirical data from which to draw conclusions on the possible CBDC cost and benefit balance. Such an assessment may be easier on an individual jurisdiction level, as the possible value from CBDC introduction depends on country specifics, such as payment system efficiency, monetary policy regime, level of financial inclusion, credit quality, existence of credible deposit insurance mechanism, etc.

In our current world, single-jurisdictional level initiatives are not capable of meeting a global citizen's need for a safe, trustworthy, and cost-efficient instrument for cross-border payments.

Therefore, joint effort is needed to find a global solution. Modern day technology seems to be able to address this need. Although political aspects are at the core to solving interoperability among CBDCs, the issue, including the idea of multicurrency CBDC, deserves deep joint analysis.

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ANNEX 1. CBDC-INDUCED HYPOTHETICAL CHANGES IN BALANCE SHEETS OF CENTRAL BANK AND COMMERCIAL BANKS

Panel A. Before CBDC

Central bank		Commercial banks	
Assets	Liabilities	Assets	Liabilities
Loans to banks	Bank reserves	Bank reserves	CB loans
Bonds	Cash	Loans to economy	Deposits

Panel B. Launch of CBDC: some parts of cash and deposits are exchanged to CBDC

Central bank		Commercial banks	
Assets	Liabilities	Assets	Liabilities
Loans to banks	Bank reserves	Bank reserves	CB loans
Bonds	Cash	Loans to economy	Deposits
	Cash → CBDC		Deposits → CBDC
	Deposits → CBDC		

Panel C. Exchange of deposits to CBDC creates a necessity of CB extra-lending to banks

Central bank		Commercial banks	
Assets	Liabilities	Assets	Liabilities
Loans to banks	Bank reserves	Bank reserves	CB loans
	Cash		
Bonds	Cash → CBDC		
	Deposits → CBDC	Loans to economy	Deposits

Panel D. CB extra-lending to banks due to CBDC

Central bank		Commercial banks	
Assets	Liabilities	Assets	Liabilities
Loans to banks	Bank reserves	Bank reserves	CB loans
	Cash		
Bonds	Cash → CBDC		
+ loans to banks	Deposits → CBDC		+CB loans
		Loans to economy	Deposits