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Central Bank Digital Currency: functional scope, pricing and controls

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Contents

Abstract

Even before their deployment in major economies, one of the concerns that has been voiced about central bank digital currency (CBDC) is that it might be too successful and lead to bank disintermediation, which could intensify further in the case of a banking crisis. Some also argue that CBDC might crowd out private payment solutions beyond what would be desirable from the perspective of the comparative advantages of private and public sector money. This paper discusses success factors for CBDC and how to avoid the risk of crowding out. After examining ways to prevent excessive use as a store of value, the study emphasises the importance of the functional scope of CBDC for the payment functions of money. The paper also recalls the risks that use could be too low if functional scope, convenience or reachability are unattractive for users. Finding an adequate functional scope – neither too broad to crowd out private sector solutions, nor too narrow to be of limited use – is challenging in an industry with network effects, like payments. The role of the incentives offered to private sector service providers involved in distributing, using and processing CBDC (banks, wallet providers, merchants, payment processors, acquirers, etc.) is discussed, including fees and compensation.

Keywords: central bank digital currency, store of value, means of payment, payment solution, cross-border payments, financial stability

JEL Classifications: E3, E5, G1

Non-technical summary

Central bank digital currencies (CBDCs) have been discussed with growing intensity since 2016. In October 2020 the ECB published its first report[1] on a possible Eurosystem-issued 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". In July 2021 the ECB decided to launch a two-year investigation phase into a digital euro project, starting on 1 October 2021. The expectation that CBDCs will eventually be issued reflects the benefits of maintaining central bank money in a world where more and more people and merchants prefer the convenience of electronic payment. Central bank money is the most basic, liquid and resilient form of money, and should continue to play its role. This paper examines concerns that the introduction of a CBDC, if not properly designed, could lead to undesirable bank disintermediation and crowd out private payments solutions. If CBDCs are to be successful, central banks need to establish digital currency as a means of exchange which is sufficiently widely used to achieve the necessary network effects but does not become a significant means of investment.

Because of their unique nature as risk-free institutions, central banks have a comparative advantage in the store of value function. In physical cash payments they hold a monopoly position as sole issuers of banknotes. Yet they have no experience in providing digital means of exchange directly to the public. Paradoxically, central banks must avoid being too successful in the area where it is easier for them to be so, while at the same time trying to succeed where they have fewer comparative advantages. The paradox is only apparent, however. Unlike private players, who seek to maximise profits by leveraging their competitive advantage, central banks operate in the interest of society, setting goals in the public rather than private interest. When it comes to retail payments, central banks' primary aim is to promote a competitive and efficient market for payment services that meet the needs of users.

Given that their objective is not to reach a dominant market share, central banks can instead aim at ensuring broad access to central bank money within their currency area, without displacing payments intermediated by regulated institutions at the aggregate level or in any specific segment. They might prefer a situation where a large portion of the population uses CBDC on a regular basis for a small fraction of their payments, rather than one where a minority of the population relies on it for the overwhelming bulk of their day-to-day payments.

Three key success factors of a CBDC will be: (i) merchant acceptance; (ii) the willingness of intermediaries to distribute it and interact as needed with users; (iii) an attractive value proposition for individuals and firms to use it for payments. This also raises the question of a business model for a CBDC, e.g. the incentives for front-end service providers.

1 European Central Bank (2020a)

Another important dimension in designing a CBDC to be successful without crowding out the private sector is scope. A list of functions covering all the proposals that have been made from different perspectives would be extensive. For example, it has been suggested that CBDC should: (i) be offered in the form of all major payment instruments, including cards, mobile payments and desktop access, and be as convenient as existing private solutions; (ii) allow anonymous payments, as banknotes do, to protect privacy; (iii) allow offline payments; (iv) allow instant credit transfers to any commercial bank account and direct debits; (v) be programmable and allow "smart contracts" for advanced uses in industry and commerce; (vi) promote financial inclusion (i.e. be accessible to those without bank accounts, mobile phones or internet access); (vii) be available for international uses, to strengthen the international role of the currency. Supporters of a broad functional scope for CBDC argue that a central bank is in a unique position in terms of credibility and economies of scale, such that even very significant investment in a comprehensive CBDC based on new technology can easily be justified, at least in large currency areas. It has also been suggested that excessively narrow scope could make a CBDC insufficiently attractive and lead to low demand, so the potential benefits would remain unachieved. Narrower functional scope could minimise the dangers of crowding out the private sector; a broad-scope CBDC might prove hard to manage from a project perspective and suffer delays in introduction. The payments industry offers plenty of examples of promising approaches and technologies which ultimately did not take off for reasons that could not easily have been foreseen. The paper devotes particular attention to functionality for cross-border and foreign exchange (FX) payments and how this may affect adoption. Comprehensive international payment functionality would obviously increase the attractiveness of a CBDC and its financial system footprint.

The paper concludes that while there can be little doubt about the merits of CBDC and the need for central banks to follow changes in retail payments habits and technology to continue serving individuals and firms, many questions about the design of a CBDC still need to be addressed. These include the functional scope, business model and controls required to meet demands and ensure robust use. Any CBDC project has also to be kept realistic, manageable and focused.

1 Introduction - why CBDC?

Around four years after the first publications on central bank digital currencies and the appearance of the acronym "CBDC" (Barrdear and Kumhof, 2016; Dyson and Hodgson, 2016), in October 2020 the ECB published its first report on a possible CBDC to be issued by the Eurosystem 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" (European Central Bank, 2020a)[2]. This followed similar reports from, for example, Sveriges Riksbank (2017, 2018) and the Bank of England (2020).

Central banks are considering issuing CBDC because they have a responsibility to sustain confidence in their currency by **maintaining public access to and full usability of central bank money in a world where consumers and firms are turning more and more to electronic payments.** Commercial bank monies (and other regulated forms of money such as e.g. electronic money) are liabilities of different private issuers. They are perceived by the public to be interchangeable at the same value[3]. This is because commercial bank monies are "anchored" to central bank money, i.e. the form of the currency that defines the unit of account. Convertibility at par towards the same anchor makes commercial bank monies in turn interchangeable at par with each other. This anchoring is necessary for central banks to preserve monetary and financial stability[4]. It is sustained by a series of mechanisms, one of which is the public's confidence that bank deposits can be exchanged for cash on demand.[5] If demand to use cash for payments continues to decline, this anchoring will weaken as convertibility into central bank money becomes more of a theoretical construct than a daily experience. The liquidity of cash will gradually fade if the spheres of commerce in which it can be used shrink over time (e.g. with the growth of e-commerce or after the impact of COVID-19). With CBDC, central banks are seeking to preserve the usability of central bank money in a world where more and more people and merchants prefer the convenience of electronic payments.

Broad adoption of stablecoins[6] would also undermine the anchoring to central bank money, depending on their design and nature. Stablecoins issue their own money with the promise of maintaining stable value against a currency or basket of currencies, or even commodities, by investing in the relevant assets, although they do not necessarily commit to conversion into these, assets, or into central bank money. They

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2 Retail CBDC can be regarded as a fundamental innovation, as it grants non-banks (households, non-bank firms and public sector entities) general access to digital central bank money, but wholesale CBDC already exists, since banks have accounts with central banks and these accounts are digital. The term "wholesale CBDC" is often used in a potentially misleading manner to refer to the idea of changing the way banks access digital central bank money from the current "conventional" technology to a blockchain/distributed ledger technology.

3 See "The role of central bank money in payment systems, 2003 CPMI.

4 See Panetta (2021d)

5 Other mechanisms include banking regulation and supervision or deposit insurance.

6 For a definition of stablecoins, see G7 Working Group on Stablecoins (2019).

also offer a wide network for payments, by leveraging the existing customer base of large technology firms and the corresponding incentives to establish closed loops.

Monetary strategic autonomy also plays a role in the motivation for CBDC, because (i) the ability to pay safely and efficiently is a basic necessity for any society and economy; (ii) payment services is a network industry in which relatively few firms can gain significant market power; (iii) there are funding privileges associated with being the issuer of the predominant means of exchange. The Eurosystem has put a high emphasis on strategic autonomy because payment instruments controlled and supervised from abroad have achieved a dominant position in important segments of the European retail payments market.

These are all policy motives for central banks and legislators to consider issuing CBDC, but they do not explain why individuals and merchants might use it as a means of payment. This paper contributes to answering that question. To make CBDC successful, central banks need to establish the digital currency as a widespread means of payment while avoiding that it becomes a form of investment. To do so, it needs to have a sufficient store of value function to make and receive payments conveniently, but not beyond. The paper examines the store of value function of money in Sections 2 and 3. Section 2 revisits the concerns that a poorly designed CBDC might be too successful, in the sense of leading to undesirable bank disintermediation and excessive reliance on it as a form of investment. Section 3 analyses possible ways to mitigate the impact of CBDC on bank balance sheets and financial statements. The payment function of CBDC and the question how to make CBDC successful as a means of payment without crowding out other electronic means are analysed in Section 4. Because of their unique nature as risk-free institutions, central banks have a comparative advantage as an issuer of money in the store of value function. In physical cash payments they hold a monopoly position as sole issuers of banknotes. Yet central banks have no experience in providing digital means of exchange directly to the public. Paradoxically, central banks must avoid being too successful in the area where it is easier for them to be so, while trying to succeed where they have fewer comparative advantages. The paradox is only apparent, however. Unlike private players, who seek to maximise profits by leveraging their competitive advantage, central banks operate in the interest of society, setting goals in the public rather than private interest. When it comes to retail payments, central banks' aim to promote a competitive and efficient market for payment services that meet the needs of users. Section 5 discusses how CBDC might work for cross-border and foreign exchange payments and how this may affect their adoption. A discussion of international use of CBDC needs to address specific questions, including: (i) should a local CBDC be used to pay abroad? (ii) should a foreign CBDC be used to pay locally? (iii) should CBDC be accessible to non-residents, or should every international payment using CBDC necessarily imply conversion? (iv) should conversion be from one CBDC into another CBDC, or to commercial bank money, or should both be possible? If successful, comprehensive international payment functionality for CBDC would obviously further increase the attractiveness of CBDC and its financial system footprint. Section 6 concludes.

2 CBDC and the risk of bank balance sheet disintermediation

The CPMI Markets Committee (2018) supports the view that there could be a risk of CBDC disintermediating commercial banks, aggravating bank run dynamics in a crisis: “A general purpose CBDC could give rise to higher instability of commercial bank deposit funding. Even if designed primarily with payment purposes in mind, in periods of stress a flight towards the central bank may occur on a fast and large scale, challenging commercial banks and the central bank to manage such situations.” Recent model-based studies, like those of Andolfatto (2018) and Chiu et al. (2019), have taken a more differentiated perspective and argued that CBDC crowding out banking is only unavoidable in models where banks have no market power: in such cases, the CBDC shifts deposits away from the banking system, reducing bank lending. If instead banks have market power in the deposit market, introducing the CBDC could lead to improved economic outcomes, as it would improve competition, incentivising banks to offer better services and/or higher rates to depositors. “In this case, issuing a CBDC would not necessarily crowd out private banking. In fact, the CBDC would serve as an outside option for households, thus limiting banks’ market power, and improve the efficiency of bank intermediation” (Chiu et al., 2019).

It may however be argued that central banks have a structural advantage over commercial banks, given that they offer the settlement asset that is by definition the safest in the economy. While it is true that commercial banks can become more competitive and offer higher deposit interest rates, customers’ sensitivity to deposit remuneration may be relatively low in a crisis.[7] Moreover, higher deposit remuneration would worsen banks’ profitability and their ability to build strong capital buffers, all of which could adversely affect depositor confidence.

An important part of the potential effect of CBDC on banks can be illustrated by a stylised financial account in a two-bank system which captures the flow of funds caused by four possible forms of bank deposit outflows:

- **α** = flow into deposits with other banks, within the banking system
- **β** = flow into banknotes
- **λ** = flow into CBDC
- **μ** = flow into government/foreign central bank deposits with the central bank

To simplify, we assume that the flows β, λ and μ affect the two banks symmetrically. This should be the case for any general effects on a homogeneous banking system, or a banking confidence crisis which depositors do not attribute to specific banks. In this context we can also assume α=0. By contrast, a bank-specific crisis can be approximated by α >0; β=0, λ=0, μ=0. Below it is assumed that the banking system

[7] See Bijlsma et al. (2021).

compensates for deposit outflows by increased recourse to central bank credit, i.e. the central bank acts as the compensating party. In reality, banks do not need to rely exclusively on increased recourse to the central bank but could also tap the capital market (in this case, the central bank could match increases in its monetary liabilities by increasing outright holdings of bonds).[8]

Table 1

How bank disintermediation affects financial statements: three flows

Non-bank sectors (including households, corporates, governments, pension and investment funds, insurance companies, ROW)			
Real assets	E	Household equity	E
Sight deposits bank 1	D1 - α - β/2 - λ/2 - μ/2	Liabilities to banks	D1 + D2 + D3 + B + C
Sight deposits bank 2	D2 + α - β/2 - λ/2 - μ/2		
Banknotes	B+ β		
Non-bank deposits with CB	D3 + μ		
CBDC	C + λ		
Bank 1			
Loans to non-bank sectors	C/2 + D1 + B/2 + D3/2	Sight deposits	D1 - α -β/2 - λ/2 - μ/2
		CB credit	C/2 + B/2 + D3/2 + α + β/2 + λ/2 + μ/2
Bank 2			
Loans to non-bank sectors	C/2 + D2 + B/2 + D3/2	Sight deposits	D2 + α - β/2 - λ/2 - μ/2
		CB credit	C/2 + B/2 + D3/2 - α + β/2 + λ/2 + μ/2
Central Bank			
Credit to banks	C + B + D3 + β + λ + μ	Banknotes	B + β
		CBDC	C + λ
		Bank deposits	0
		Non-bank deposits	D3 + μ

Two issues arise when deposits with banks are substituted with bond issuance or central bank credit. First, deposits are normally the cheapest funding source, followed by central bank credit, bond issuance and equity issuance in that order (see Bindseil, 2020). Therefore, substituting deposits will make funding more expensive and reduce banks' competitiveness relative to other forms of funding for non-financial companies and households. This need not be a problem, unless (1) there are particular synergies between deposit collection and lending which CBDC would undermine, or (2) the transition to a smaller banking system would be accompanied by disruptions, for example because banks are better placed to lend to small and medium enterprises. Increased reliance on central bank credit may make collateral constraints binding and therefore eventually force the central bank to broaden its collateral framework. This is taken up further in Section 3.2.

How likely is it that CBDC will lead to material bank disintermediation? CBDC adds a further form of possible deposit outflows that is apparently identical to the case of banknotes. Like any alternative form of money, however, its impact would depend on its properties in terms of convenience, motivation, and merits in specific

8 In the current situation, where euro area banks hold large excess reserves, the first effect of deposit outflows would of course be a decrease in excess reserves. In that case, the size of the central bank's balance sheet would not increase, and commercial banks would not need additional central bank funding.

circumstances. Being a riskless and fully liquid asset with no holding costs (as it can be assumed that CBDC accounts/wallets will be made available free of charge), a CBDC would create an additional channel for deposit outflows that would likely have some impact, in particular in abnormal circumstances.

In addition to structural disintermediation, a poorly designed CBDC could facilitate deposit runs during banking crises[9]. While runs from deposits into banknotes are limited by the risks and costs of storing large amounts of banknotes, there would be no such limitations if households and institutional investors were able to hold unlimited amounts of CBDC (a riskless asset with no storage costs[10]). A crisis-related run from bank deposits into low-risk financial assets (such as gold-related holdings and highly rated government debt) is already possible in 'electronic' form and therefore does not pose the same security issues as a run into cash (except for physical gold). However, this type of run (i) is discouraged through the price mechanism (as the safe assets will become very expensive in a crisis); (ii) does not in aggregate reduce deposits with banks as such; for the investor it would reduce exposure to default risk, but increase market and liquidity risk; (iii) may not appear to be an option for all, notably not for those who have relatively limited financial wealth and no experience of financial investments. Therefore it is plausible that a CBDC supplied in unlimited quantities and without other control tools, as for banknotes, could make bank runs worse, as it would neither create physical security issues nor be subject to scarcity-related price disincentives (Bindseil and Panetta, 2020).

International use of CBDC could increase the size and velocity of international capital flows. The flows of funds mechanics of this are shown in Bindseil (2020). Ferrari, Mehl and Stracca (2020) and IMF (2020) discuss in more detail the possible flow of funds implications of CBDC used internationally. All conclude that international use could make international capital flows more volatile and create liquidity challenges for banks in both the issuing and the recipient country. Monetary policy transmission will also be affected. Section 5 examines international use of CBDC as a means of payments.

Short-term interest rates are relevant. A number of central banks have implemented a negative interest rate policy (NIRP), notably in the euro area, Denmark, Sweden, Japan and Switzerland. Issuing unremunerated CBDC without limits on access or quantities would, however, imply the end of NIRP. It would also imply that NIRP would no longer be possible in the future and would likely lift long-term nominal yields – even those in positive territory – as NIRP scenarios would no longer be factored into expectations. Indeed, if the least risky asset in the economy (a liquid central bank liability in domestic currency, such as a CBDC) offers a return of zero, no other financial instrument can yield a negative rate, as holders would otherwise substitute it with CBDC. Therefore, effective constraints on access to and/or limits on

9 Bank runs can be triggered e.g. by a decline of banks' asset values and/or liquidity, or also by a tightening or the access to liquidity sources, such as central bank credit. Solvent banks can become subject to a bank run even if only their asset liquidity deteriorates sufficiently, providing a rationale for central bank intervention as lender of last resort (e.g. Bindseil and Lanari, 2020).

10 If CBDC could be held only as bearer instrument on a card or a phone that could break or get lost and the lost amount could not be recovered, then there would be a storage cost that may limit the amount agents want to hold, even without any formal holding limit. Such risks are however minimised if CBDC is stored on well-protected accounts.

holdings of CBDC would be necessary to preserve the ability to conduct NIRP following any future issuance of a zero-remunerated CBDC.

3 Preventing excessive holdings of CBDC

A number of measures have been proposed to prevent a permanent or temporary excessive flow of funds into CBDC[11].

Limited convertibility. This approach was proposed by Kumhof and Noone (2018), who assume that, at least in a situation of financial instability, "CBDC and reserves are distinct, and not convertible into each other," and "no guaranteed, on-demand convertibility of bank deposits into CBDC at commercial banks (and therefore by implication at the central bank)". Suspending convertibility would indeed stop the potential outflow of bank deposits into CBDC, but it obviously contradicts the sacrosanct principle of convertibility of different forms of a currency, which is at the very basis of the nature of currency. It may also create additional negative dynamics if holders anticipate convertibility suspensions (a phenomenon well known from vulnerable fixed exchange rate regimes).

Simple per capita limits. Panetta (2018) suggests addressing the structural disintermediation and bank run issues associated with CBDC by "setting a ceiling on the amount of CBDC that each individual investor can hold". ECB (2019b) provides a proof of concept for a CBDC solution based on distributed ledger technology which would also allow caps to be implemented in holders' wallets. Payments into a wallet/account leading to excess holdings would just be rejected. However, simple caps raise a number of issues. As also noted by Panetta (2018), "a ceiling on individual holdings of CBDC could limit the number or size of payments, as the recipients' holdings of CBDC would have to be known in order to finalize the payment". The risk that payments might be rejected for a reason that cannot be known to the payer in advance implies a major friction undermining the efficiency of payments.

Per capita limits with waterfall to designated account. One possible way to address this concern would be for any payment taking CBDC holdings above a certain limit to be accepted but trigger an automatic transfer of the excess from the CBDC account/wallet to a designated account with a commercial bank or other intermediary. Each registered holder of a CBDC account/wallet would have to designate a "waterfall" account, which implies that CBDC users would have to continue to hold accounts with intermediaries. For example, if the limit on an individual CBDC account was CAP and the holding of CBDC on that account at some point in time was $x<CAP$ but an incoming payment y meant that $x+y > CAP$, then an automatic transfer from the CBDC account to the associated bank account would be triggered, with the transferred amount being $x+y-CAP$.

For individuals without a bank account or who decline to designate one, the simple limit would apply. They would not, however, be prevented from opening a CBDC account, not least in view of the financial inclusion objective. One of the problems with limits is that they cannot be calibrated as easily for firms as for individuals, due to

[11] See Panetta (2021a)

variation in size and needs. They could undermine the usefulness of CBDC for industry and commerce.

Tiered remuneration, with possible reduction for the second tier in a crisis. Bindseil and Panetta (2020) argue that a two-tier remuneration system could be a solution to the risk of CBDC disintermediating the banking system in both normal times and during crises, while avoiding the drawbacks of hard limits. This had been proposed earlier by Panetta (2018), who did not however envisage negative remuneration for the second tier. In fact, tiering may only be needed when interest rates are low or negative. If short-term-market rates are 4%, then 0% remuneration on CBDC, i.e. like banknotes, provides sufficient disincentive against excessive reliance on CBDC as a form of investment. However, in the current situation in the euro area, risk-free assets have a negative yield (apart from banknotes, which are costly and risky to store in large amounts). Bindseil (2020) proposes that CBDC accounts could be remunerated at a relatively favourable rate r1 (e.g. 0% in the current negative interest rate environment) up to a certain threshold CAP, while holdings above that would earn a less favourable rate r2 (e.g. slightly below that of other risk-free assets). This tiered approach would prevent CBDC from undermining monetary policy and avoid structural bank disintermediation by enabling use of CBDC as a means of payment but discouraging it as a large-scale investment. It would also allow the central bank to act in the event of a bank run by further lowering the remuneration on second tier CBDC if necessary[12]. There would be no need to push remuneration on *all* CBDC holdings into negative territory in a crisis. Tiering could also help make the central bank less vulnerable to criticism for financial repression or expropriation. People wanting to avoid inadvertently being moved to the worse conditions of tier two (where they might earn negative interest rates, for example) could set a ceiling on their maximum CBDC holdings, above which the waterfall mechanism described above would come into effect. This could be fixed at any level, including above the tier one threshold. The central bank would need to communicate clearly at an early stage that remuneration on tier two CBDC is not meant to be attractive and may be made particularly unattractive in a crisis if needed. For tier one CBDC, the central bank could commit to never charge negative rates and never reduce the amount of tier one CBDC below a certain level.

For corporates (non-bank financial companies and non-financial companies), the tier one allowance could be calculated in proportion to some measure of size and, therefore, presumed cash needs. Simplicity and controllability of the allocations is essential. A simpler and more viable approach might be to assign a tier one ceiling of zero to all corporates. Further analysis is needed to find solutions which strike the right balance between simplicity, efficiency and fairness. Non-residents, if allowed to open accounts, might also have a tier one ceiling of zero. For some cases, such as tourists, who may want to hold limited amounts for short periods, the economic relevance of

[12] It has sometimes been remarked that lowering the remuneration of Tier 2 CBDC at the start of a bank run could signal to the general public that a bank run has started, and this could accelerate the run. However, such concerns could be raised towards any crisis measures of the central bank, both in the domain of the lender of last resort (e.g. extending collateral eligibility; offering additional facilities), and in the field of monetary policy (e.g. lowering interest rates at the risk that the public perceives this to signal that the economy is doing worse than thought before). This has not prevented central banks to act forcefully and transparently in crisis times.

imposing negative remuneration would be negligible anyway, and pragmatic and proportional solutions could be found.

In normal times, i.e. periods of financial stability, Bindseil and Panetta (2020) consider the following illustrative example for the remuneration on the two tiers (where i_{DFR} is the rate of remuneration on the ECB deposit facility)[13]: **r1 = max(0, i_{DFR} – 2%); r2 = min(0, i_{DFR} – 0.5%)**. In words, this means that remuneration on tier one CBDC will be either 2% below the ECB deposit facility or zero, whichever is higher. The remuneration on tier two CBDC will be 0.5% below the ECB deposit facility or zero, whichever is lower. Of course, other formulas could be designed. In times of crisis, i.e. when there is a risk of a run into CBDC, r2 could be reduced further. This might raise a number of issues related to the signalling effects of such an action,[14] which need to be considered carefully. Needless to say, all of the options above require an adequate legal basis in the relevant monetary area. If this does not exist under current law, it may need to be specifically established as part of the issuance of CBDC. For example, tiered remuneration or limits require holders of CBDC to be identifiable, in the sense of having an account relationship, which is not compatible with a pure bearer instrument (also called often a "token-based" CBDC). This may be relevant if CBDC were issued only on the basis of a provision in the respective central bank law that entitles the central bank to issue banknotes.

13 The rate on the deposit facility is the floor of the corridor represented by the monetary policy rates, i.e. the rate paid on excess reserves of commercial banks deposited at the ECB.

14 The decision to lower remuneration on tier two could in theory be interpreted by investors as an indication that the central bank thinks a crisis is imminent, leading to self-fulfilling instability. However, this applies to all actions taken by central banks in a crisis, without being considered a reason to question the credibility of such measures.

4 CBDC as a means of payment: factors affecting use

This section turns to the payment function of CBDC and to the factors that may determine its use. It starts, in paragraph 4.1, by reflecting on why people pay with the currently available form of central bank money – banknotes – as a basis to consider which of these elements may affect use if central bank money takes also a digital form. Section 4.2 discusses in which segment of the payment market the use of CBDC would be most likely. Section 4.3 considers what could be a definition of "success" for central banks in offering a CBDC as a means of payment. We then turn to the conditions for success: Section 4.4 reflects on a first condition: merchant acceptance and how this may be influenced by legal tender status; Section 4.5 reflects on a second condition: what could motivate supervised intermediaries to distribute CBDC considering that they are themselves distributing their own payment products? Section 4.6 sets out the condition that citizens/consumers see a value in using CBDC as means of payments within a wide array of payment products.

4.1 Why do people pay with banknotes?

With increased digitalisation, many countries are experiencing a decline in the use of cash for payments, despite the increase in the actual stock of cash issued. In the euro area only about 20% of the cash stock is used for payment transactions (compared with 35% fifteen years ago), with the remainder used as a store of value, in the euro area or abroad.[15] Before considering why people may pay with CBDC in the future, it is appropriate to examine why people pay with the currently available form of central bank money: banknotes. Literature and surveys indicate people pay with banknotes[16] as a result of:

- Habit;[17]
- Better perception of the value of money in material form;[18]
- Barriers limiting access to digital means of payments (children, elderly people who may not be able or willing to pay digitally);
- Anonymity;
- No explicit cost;
- Instant finality of payment;

15 See Zamora-Pérez (2021).

16 See European Central Bank (2020b) for more information, including the impact of demographics.

17 See van der Cruijsen et al. (2017).

18 See Hernandez et al. (2014).

- Insufficient financial services in rural areas;
- Above all, *for their very high reachability* in face-to-face payments.[19] Paying with cash in a store is always an option, provided (a) most physical stores continue to accept cash, either because it is legal tender or sufficient clients demand to pay in cash, and (b) people regularly hold cash in their wallets in case of need,[20] even if they use it infrequently. The two conditions are interdependent: if one falters, the other is likely to falter as well.

Legal tender status is closely associated with the nature of central bank money. It enables banknotes to leverage network effects, although this depends on its concrete application in different jurisdictions. People may not be consciously paying with banknotes because they are central bank money,[21] but they may well do so as an indirect result of the network effects legal tender confers on banknotes. This privilege can only be granted to instruments which have central bank money "inside" them. Central bank money is established as the ultimate settlement asset, the anchor to which other legally recognised forms of money need to be convertible at par.

When it comes to the costs of banknotes, the universal approach taken by central banks has been to issue and distribute them free of charge. This approach may have been based on the presumption that issuing banknotes is highly profitable, as long as central banks can match the interest-free liabilities with interest bearing assets. Seignorage generates regular profits that can be transferred to government. Even with interest rates negative, as they have been in the euro area for some years now, this approach has not been questioned. Cash handling has a cost for all parties in any case. With CBDC the central bank moves closer to the habitat of private issuers of digital means of payment and invites them to collaborate in its distribution. Costs and cost recovery aspects may be re-examined in this context.

4.2 Types of payment for which CBDC could be used

Payment segments are defined by the business need they serve. For each segment, the payment instruments most commonly used in the EU are described in Table 2.

19 This does not apply to e-commerce, where cash has only a very limited presence.

20 In turn, one of the key factors in paying with cards is not having to worry about "carrying enough cash". See Esselink and Hernandez (2017).

21 Some people are aware that in banknotes the intrinsic nature of the payment asset (i.e. central bank money) is safer. This will not normally affect their payment decisions, only in times of crisis (Gresham's law suggests consumers will use the least safe payment asset). Beyond the safer nature of the payment asset, as a bearer instrument banknotes are still subject to theft or destruction and thus not necessarily a safer way to hold money.

Table 2

Payment instruments frequently used in the EU for different payment segments.

Segment	Payment instruments frequently used in the EU (varies by country)
Person to person (P2P)	Cash, mobile applications supporting various payment instruments, instant credit transfers
Physical point of interaction (POI)	Cash, cards, mobile applications supporting various payment instruments
E-commerce	E-commerce solutions supporting various payment instruments (including web-based wallets), cards
Recurrent payments	Direct debits, standing orders
Corporate/business to business (B2B)	Specific applications generating instant transfers or wholesale payments

Source: European Central Bank (2020b), Laboure and Reid (2021).

If a cross-currency dimension is added to the segments above, new categories emerge, such as remittances (P2P, cross-border/cross-currency), or the use of local currency when buying abroad (POI, cross-border/cross-currency).

Once the payment segments have been defined, possible criteria can be identified to determine whether central banks should aim to introduce or discourage CBDC. These include the following:

1. **Legacy/use currently covered by banknotes:** It may be easier to argue for CBDC in segments where use of banknotes has traditionally been strong but the trend is declining as a result of increased digitalisation. If use of banknotes is high and stable in a segment, there may be less pressure to introduce CBDC. This suggests covering P2P and physical POI payments.

2. **Adapting to and facilitating innovations in commerce:** Commerce has changed substantially since banknotes were introduced, and e-commerce accounts for a growing share. A forward-looking approach is required. CBDC does not face the same physical restrictions as banknotes for use in e-commerce. When it comes to innovations at an early stage in the private sector (e.g. smart contracts), central banks may wish to weigh carefully the added value these provide against the investment required to make CBDC available in that segment.

3. **Strategic autonomy:** Related considerations may advocate deploying CBDC to a segment if (i) a large share of payments in the segment is in the hands of providers over which the state has limited influence (e.g. foreign intermediaries or technology companies), or (ii) disruptions in the segment would be particularly damaging for the domestic economy and individuals. Depending on the specific country and currency, this could apply in the P2P, physical POI or e-commerce POI segments.

4. **Market power and abuse:** A segment which is more prone to abuse of market power is also a natural candidate for CBDC. This situation favours an alternative, public provider with no aim to exploit market power. Depending on the specific country and currency, this could apply in the P2P, physical POI or e-commerce POI segments.

5. **Limited access to financial services:** Public policy considerations suggest considering how CBDC might facilitate access to financial services. This could be the case in rural areas (because of insufficient bank branches or ATM networks) or for people on low incomes (who cannot afford the cost of using existing digital means of payment).

6. **Compatibility with limited CBDC holdings:** To avoid adverse effects on the functioning of the financial system, central banks will need to set restrictions on the amount of CBDC persons or businesses may hold. Depending on how these restrictions are configured, this may impact the feasibility or convenience of making high-value payments. For example, setting limits at the same level for citizens and businesses may impact the practicality of using CBDC for corporate activity.

7. **Digital central bank money is already present in the payment value chain:** In some segments, central bank money settlement is already part of the payment value chain, even if this is not visible to payer or payee. This might reduce the need for CBDC in this segment in the short run. For example, credit transfers and direct debits often imply a net settlement in central bank money. Instant payments sometimes settle directly in central bank money[22] and sometimes not.

4.3 A possible objective for CBDC use: width vs. depth

In the mid-20th century banknotes were used for almost all daily transactions. This is no longer the case today; wages and salaries are no longer paid in banknotes and they are less popular for point-of-sale payments because of the convenience and speed of modern contactless technology. Paying in cash has become impossible or impractical in growing areas, e.g. e-commerce, or where speed of payment or automation are key, such as bus rides and highway tolls.

Central banks have never set an objective for the use of banknotes as a means of exchange, yet they have become concerned at the steep decline in recent years. Arguably, not setting an objective was an implicit consequence of (i) the fact that cash has traditionally been dominant in certain segments, (ii) the difficulty of measuring use of banknotes as a means of payment (from surveys or merchant data), and (iii) the difficulty of influencing use of banknotes as a means of payment once they are in circulation.

These factors do not apply in a CBDC context, at least not to the same extent. In fact, there is no expectation that CBDC will be the dominant digital means of payment. Moreover, central banks could easily monitor their use. Finally, CBDC payments would continue to be intermediated by regulated institutions: any objective of higher use would therefore still require the involvement of supervised intermediaries.

Central banks might therefore be less reluctant to set objectives for the use of CBDC in the future. Given that they will not be seeking to reach dominant market share,

[22] In the EU, instant payments settle directly in central bank money when TIPS is used.

central banks may aim instead at ensuring broad access to central bank money within their currency area, without displacing payments relying on private instruments at the aggregate level or in any specific segment. Central banks might prefer a situation where a large portion of the population uses CBDC on a regular basis for a small fraction of their payments rather than a situation in which a minority of the population relies on CBDC for the overwhelming majority of their day-to-day transactions.

This is in line with the idea that paying with central bank money should be a credible option in as many circumstances and for as many payers as possible, so as to profit from the benefits of CBDC in terms of (i) enhancing competition and lowering the cost of payments, (ii) guaranteeing co-existence and interchangeability between public and private forms of money, and (iii) ensuring the strategic autonomy of payments.

Central banks may identify reasons to set different objectives for different segments. For example, the use of cash in one segment could be a reason to set or to alter the objective for CBDC penetration in that segment. In a digital context, it would probably be possible to measure whether this objective is met or not.

4.4 First condition for success: widespread merchant acceptance

The ability to pay digitally anywhere is one of the basic elements of success for a CBDC. Just like for banknotes, a public network needs to be set up, based on two features of central bank money: (a) it is the safest/most stable payment asset in the economy, and (b) only central bank money can be legal tender.

These are two crucial and inseparable features. In normal times, neither payer nor payee will put excessive emphasis on the quality of the payment asset being used. In a financial crisis however, a lack of confidence or awareness of the low quality of private payment assets can bring commerce to a halt, contaminating the real economy. To prevent this risk a public institution, the central bank, is granted the exclusive right to issue sovereign money, *in the form of banknotes*, and the use of cash is always an option available for individuals to discharge debts. The enforceability of legal tender to impose acceptability of cash by merchants has varied over time and across different countries.[23]

When it comes to the exclusive right to issue banknotes, most central bank statutes refer to the visible form (i.e. the payment instrument: banknotes[24]) rather than the internal content (i.e. the payment asset: central bank money). The institutional and legislative changes that gave central banks the role of issuing banknotes took place when paper was the only form central bank money could take to process payments between individuals with immediate finality. This suggests that legislation may be required for central bank money to be legal tender if it takes a digital form (i.e. CBDC).

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[23] The EU Commission Recommendation of 2010 sets mandatory acceptance as a rule, apart from possible exceptions subject to the good faith principle.

[24] In the euro area, in accordance with Article 128(1) of the Treaty on the Functioning of the European Union, the Governing Council of the ECB has the exclusive right to authorise the issue of euro banknotes within the Union. The ECB and the national central banks may issue such notes.

Making CBDC legal tender raises a number of questions. The obvious guide is that of banknotes:

- With cash, merchants do not face any per-transaction fee. Nor do they require any acceptance device. This may not be the case for CBDC. By contrast, banknotes involve processing costs, both internal and external. Moreover, merchants must take the risk of holding cash or pay theft insurance. They also face charges from suppliers of cash/coins for making change or depositing cash at their banks.

- Who is obliged to accept legal tender may differ for cash and CBDC. Cash is impractical in e-commerce, while making CBDC legal tender may require exceptions for merchants who do not have the device needed to accept non-cash payments.[25] One option is to construe the legal tender status of CBDC as enforcing non-discrimination on merchants who already accept electronic payments.

- In practice today the vast majority of merchants cannot afford the luxury of accepting cash only. They are therefore subject to the market power of providers of digital payment services, which at times in the recent past has been exercised to the point of inducing competition authorities to cap prices. The choice of business model for a CBDC has the potential to modify the balance of bargaining power being merchants and payment providers.

The key variable determining whether the current equilibrium would be preserved or not is likely to be the ability to apply a merchant service charge (MSC). In the context of CBDC, an MSC would raise a number of considerations, such as: is it compatible with legal tender status? Would the absence of an MSC (and the implied cost recovery) put private payment solutions at a competitive disadvantage? What would the optimal level of the MSC be?

Another crucial issue when granting a CBDC legal tender status is the impact technical standards could have on competition. Developing CBDC on the basis of existing standards would limit the overall investment required. It would also help secure widespread adoption. For example, since payment by scanning a QR code is scarcely used in Europe, basing the legal tender requirement only on provision of a QR code could limit penetration. From a competition perspective, if a standard is made mandatory, it needs to be an open standard enabling easy adoption by any provider of payment terminals. For example, if a particular near-field communication standard is set as legal tender but this is the proprietary technology of one company, that company would be given an undue competitive advantage. Understanding intellectual property rights in the payment terminal market is essential when specifying how legal tender status may be applied.

A further question is whether the acceptance standard applied for legal tender can be re-used for payment instruments based on commercial bank money. This need not

[25] For example, elderly semi-professional merchants in traditional street markets may be only able to accept cash, as they lack an electronic device. If there is no exception to CBDC as legal tender, the state may have to provide the necessary devices. See Bossu et al. (2020).

imply that a merchant is under an obligation to accept such payment. To draw a parallel in the physical world, public roads reduce the cost of reaching merchants' stores, but they do not give rise to any form of obligation to buy from them. Collaborative mechanisms are not new to central banks and commercial banks (e.g. the Single Euro Payments Area (SEPA) standard in the euro area). Ensuring that the standard chosen for CBDC is made available to regulated PSPs as a public good would also facilitate the interoperability of CBDC with private payment solutions, so any payment can be made from a CBDC account or wallet to a commercial bank money account and vice versa.

4.5 Second condition for success: efficient distribution of CBDC

The Eurosystem report expresses the view that a digital euro should preferably be distributed by supervised intermediaries. Banks and other regulated payment providers could fall under this category. This would have a number of advantages, including leveraging the expertise and resources of the financial sector in the provision of end-user services, easing the conversion from commercial bank money to central bank money and vice-versa, and facilitating reliance on the customer authentication and compliance checks done by financial institutions.

Commercial banks have an interest in the continued use of central bank money, as it impacts their long-term strategic positioning[26]. Cash distribution already represents a cost rather than a source of revenue for banks, but they do it because it is inherent to their business model to provide conversion of sight deposits into cash at par on demand or within a very short notice period. Convertibility of their core liabilities (sight deposits) at par into central bank money is an essential element of the special nature of banks. If there were no demand from individuals for central bank money, either in physical or digital form, bank deposits would not be inherently different from other forms of debt. What would count as money in this scenario? The long-term equilibrium may depend more on which payment assets large global payment platforms agree to offer or which instruments large e-commerce platforms accept, because this would become the characteristic that effectively confers liquidity. The stability of the value of that payment asset would be less significant. This scenario of loss of monetary sovereignty would be incompatible with monetary and financial stability,[27] and be undesirable for public authorities, above all central banks. But it would be undesirable for commercial banks too, as they would lose their central role in financial intermediation.

Having said that, one cannot rule out the possibility of encouraging the distribution of CBDC. Incentives could take the form of premia paid to supervised intermediaries. In any case, central banks need to define a business model which preserves a competitive payments landscape.

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26 See Bindseil, U. and Terol, I (2020)

27 See Panetta (2020).

Below we distinguish two types of services (provided by different actors) that are needed to distribute CBDC: (a) onboarding and funding services; this includes the operations required to open, manage and close a CBDC account, as well as for its funding and de-funding through an associated commercial bank account or via cash; (b) payment services in the segments where use is intended. A few related design issues are briefly reviewed below in (c).

(a) CBDC onboarding and funding services

A key factor sustaining the accessibility of cash is the fact that people in general hold banknotes in their wallets in case of need, even if they use them infrequently. The equivalent network effect in CBDC would be to facilitate as much as possible a process by which citizens own a CBDC account/wallet, although different individuals would fund it (and use it to pay) to differing extents. A CBDC account/wallet would probably need to be associated with (a) a liquidity source, most often a bank account, and (b) a unique identity and identifier code (e.g. an IBAN in the EU), to which a mobile phone number and/or e-mail address can be linked.

End-users should be able to set floors, which would trigger automated funding requests, and caps, which would trigger automated defunding orders. The ability to define a floor would be particularly relevant for consumers/payers not wishing to worry about having sufficient CBDC funds to make payments. Surveys on payment preference show this is a critical factor for success in a digital payment instrument. Merchants may defund the CBDC from all sales received to a commercial bank money account prior to the time of the day at which remuneration is calculated.

Deposit-taking institutions already run a know your customer (KYC) process when opening accounts for their clients. They are thus well positioned to take care of opening a CBDC account. Incentives for deposit-taking institutions to actively encourage their clients to open a CBDC account or wallet could be driven by competition between banks to link the funding/defunding of the CBDC account/wallet to the commercial bank account held with them. Possible compensation by the central bank for the service provided would also matter.

To access people who are unbanked, a central bank would need to go beyond this and, for example, widen the range of entities permitted to do KYC/onboarding or incentivise banks to perform it for people who are not their clients. Funding services for the unbanked need also to be considered, for example by facilitating convertibility between banknotes and CBDC when paying in a supermarket.

(b) Payment services

Incentives for PSPs to offer CBDC payment services will depend on the impact on (i) costs (does the distribution represent an additional cost for PSPs or does it allow them to save?); (ii) revenues (does it generate new revenues or does it undermine existing

ones?); (iii) exclusivity (should the ability to offer CBDC payment services be available to any PSP at any time, or is it something they should compete for?).

(i) Cost impact. The costs that will have to be borne by front-end providers of CBDC payment services and central banks need to be defined precisely. The more cost items that fall upon by PSPs, the more central banks will need to consider whether there needs to be an equivalent source of revenue or additional business to encourage provision of the service. PSPs may find themselves covering some of the following additional costs. They entail synergies with those costs already incurred when processing commercial bank money payments:

- End-user support and servicing (e.g. questions related to service outages or individual payments).
- Processing and network costs to connect to CBDC back-end infrastructure.
- Maintaining and upgrading terminal infrastructure and solutions (no additional marginal cost if the same terminals are also used for non-CBDC payments; see 4.4.).
- Responsibility for fraudulent payments made using a CBDC payment instrument and the costs related to resolving individual cases.

(ii) Revenue impact. The revenue impact for PSPs will depend on:

- Their ability to reach a wider range of merchants to offer their services, both for CBDC and for payment instruments based on commercial bank money (if a CBDC legal tender status facilitates this; see Section 4.4).
- Their ability to obtain revenue for basic CBDC payments at the POI. Possible sources might be an MSC and/or compensation paid by the Eurosystem to intermediaries as a fraction of the additional seigniorage revenues generated by issuing a CBDC. While the introduction of CBDC would be designed to have only a limited impact on bank deposits (see Section 3), this could be quantified and temporarily returned to the payment industry as an incentive for offering CBDC payments. The impact of CBDC would be neutral for the industry as a whole, while the participants who are most efficient in the provision of CBDC payment services would benefit.

(iii) Exclusivity (certification or licensing). A further consideration is whether the ability to offer CBDC payment services should be available to any PSP meeting the technical requirements set by the central bank (i.e. through a certification process). An alternative would be to grant licenses to a limited number of PSPs to offer CBDC payment services for a defined period. PSPs winning a tender would then be sure of enjoying the perceived advantages of offering CBDC payment services for a set length of time, giving them an incentive to invest in promoting CBDC. The duration of the licence could be made conditional on reaching particular objectives; this would protect the central bank if results are suboptimal.

(c) Further design issues

Three further relevant considerations will need to be addressed.

First, from the perspective of monetary sovereignty, the question arises as to what extent it would be acceptable for non-domestic firms or subsidiaries thereof to play a major role in distributing the digital euro. This outcome would not be ideal if reducing external dependencies were one of the objectives of introducing a CBDC. Central bank measures to avoid an undesired outcome also need to be consistent with financial regulation and trade agreements.

Second, should a CBDC have its own mobile app, or should it be integrated into PSPs' apps? A central bank may wish to facilitate the visibility and branding of its CBDC payment and liquidity management services through a separate mobile app available to citizens and merchants. It may also prefer the higher degree of control and independence that comes with a separate app, and the ability to control the privacy of payments data, for example. As soon as the deposit-taking institution has onboarded a citizen or merchant, this app would be available to them for making payments. Alternatively, CBDC wallets could be integrated into existing payment apps, e.g. of PSPs. Depending on the choice made, either the PSPs or third parties would need to support the relevant app.

Third, should CBDC be integrated, or allowed to be integrated, into e-commerce payment solutions as one of the possible wallets from which to pay? If so, what conditions might apply to the payment solution provider? For instance, would it condition the level of the merchant service charge applied?

4.6 Third condition for success: demand from consumers to pay with CBDC

"Pay anywhere, pay safely, pay privately" summarises the case for consumers choosing to pay with CBDC. Beyond wide merchant acceptance (see section 4.4) and an active distribution by supervised intermediaries (see section 4.5), the following could motivate citizens to make payments with CBDC:

- In currency zones like the euro area where no single P2P solution covers a broad section of the population, CBDC could provide fertile ground for P2P payments beyond the reach of existing private solutions. Where a P2P solution already exists (e.g. Swish in Sweden, Tikkie in The Netherlands, Bizum in Spain), CBDC may require additional features to attain adequate take-up.
- If merchants encourage the use of CBDC at the POI and in e-commerce.
- If CBDC is as convenient to use as existing private payment solutions at the POI and in e-commerce.

- Where privacy is important for the consumer, provided users understand the privacy level configurations the CBDC allows[28]. As public and independent institutions, central banks have no interest in monetising users' payment data. They would only process such data to the extent necessary for performing their functions and in full compliance with public interest objectives and legislation. Central banks could use privacy-enhancing techniques while still complying with regulations on anti-money laundering and combating the financing of terrorism.

- As a way of facilitating access to digital payments to those who would otherwise only make use of cash, boosting financial inclusion.

- As a way of combining use of digital identity and CBDC. Most people hold an ID card and cash in their physical wallets, since they sometimes need either one or the other. In a digital situation where a person is asked to register and pay for a service, both e-identity and CBDC could be combined to do this with maximum convenience. Explicit consent would be required both to share the e-identity and to make the payment.

- For international payments between two currency areas, subject to the two central banks agreeing on the mechanism for offering cross-border and cross-currency P2P/POI payments in such a way that each citizen always holds CBDC in their own currency (see Section 5).

Of course, applications are complementary, and consumers may expect a CBDC with a sufficient range of uses before they embrace it as one of their regular means of payment.

[28] See Panetta (2021b)

5 The international dimension

The literature on the international dimension of CBDC has highlighted that using a CBDC for cross-border payments could have substantial benefits but would also come with potential risks. A number of studies focus on the **financial stability risks of large-scale international use of CBDC**. For example, Bindseil (2020) explores the flow of funds implications and related financial stability risks of asymmetric cross-border holdings of CBDC, suggesting that it will be in the interests of both jurisdictions and their central banks if CBDC is not held in unlimited amounts across borders (e.g. by paying a rate of interest which makes it less attractive as store of value relative to other cross-border investments). In the event of unconstrained international usability of CBDC, Ferrari et al. (2020) note that "the presence of a CBDC amplifies the international spill-overs of shocks, thereby increasing international linkages. […] CBDC creates a new international arbitrage condition that links together interest rates, the exchange rate and the remuneration of the CBDC. [….] This leads to stronger exchange rate movements in response to shocks in the presence of a CBDC – foreign agents rebalance much more into CBDC than they would into bonds, if the latter were the only internationally traded asset, because of the CBDC's hybrid nature."

In view of such potential risks, one alternative would be the extreme approach where no cross-border use or holdings of CBDC are allowed at all, so international payments have to continue to rely on solutions provided by the private sector only. However, publications by central banks – such as European Central Bank (2020a) and FSB (2020) – have emphasised the **potential benefits of using CBDC** for improving cross-border payments. Building block 19 of the FSB/G20 work on cross-border payments (CPMI, 2020) focuses on the potential benefits: "CBDCs can enable cross-border payments either through the availability of domestic CBDC to users from other currency areas or through the domestically issued CBDC, in conjunction with the CBDC arrangement on the side of the receiving jurisdiction. This building block is aimed at providing prospective domestic CBDC implementations with the necessary guidance on interoperability and interfacing with international infrastructures to enable cross-border transactions." There is a literature stressing the **importance of interoperability of CBDCs** for future cross-border payments, suggesting that early considerations of this issue will maximise the benefits of CBDC for international payments. A group of central banks and the BIS published a report (Bank of Canada et al., 2020) concluding that *"CBDC systems could be designed to interoperate to facilitate cross-border and cross-currency payments."* Auer et al. (2021) develop this argument in detail and argue that: "Cross-border payments are inefficient, and technology could play a role in making them better. One means could be through interoperating central bank digital currencies (CBDCs), forming multi-CBDC (mCBDC) arrangements. […] These benefits are especially relevant for emerging market economies poorly served by the existing correspondent banking arrangements. Yet competing priorities and history show that these benefits will be difficult to achieve unless central banks incorporate cross-border considerations in their CBDC

development from the start and coordinate internationally to avoid the mistakes of the past."

Another perspective supporting the cross-border use of CBDC is **promoting the international use of a currency** by issuing a digital version of it. In a communication of January 2021[29], the European Commission discusses the digital euro in the context of strengthening the international role of the euro. The Eurosystem **digital euro report** discussed the matter in a scenario where issuing a digital euro could become beneficial (European Central Bank, 2020a): "Euro area leaders recently stressed that a strong international role of the euro is an important factor in reinforcing European economic autonomy. The issuance of CBDCs by major foreign central banks could enhance the status of other international currencies at the expense of the euro. In such a situation, the Eurosystem might consider issuing a digital euro in part to support the international role of the euro, stimulating demand for the euro among foreign investors. A cooperative approach to interoperable designs of CBDCs across currencies could contribute to strengthening the international role of the euro and to improving cross-currency payments also without having to grant non-euro area residents' access to the digital euro[30]. Moreover, a digital euro could help to fill gaps or correct inefficiencies in existing cross-currency payment infrastructures, notably those for transfers of remittances, through improved interoperability among payment systems dealing in different currencies." The report therefore concludes that the "digital euro should be potentially accessible outside the euro area in a way that is consistent with the objectives of the Eurosystem and convenient to non-euro area residents."

In its recent report on the international role of the euro the ECB examines how issuing a CBDC could impact the international role of a currency (proxied by its share in global export payments).[31] The analysis suggests that this would have a positive impact on global use of the currency, as it would reduce frictions and costs of cross-border payments. The impact could also benefit from a wholesale dimension, as large transactions between financial intermediaries (e.g. invoicing in global trade, use as a reserve currency and/or investment vehicle) are important in determining the international role of a currency.[32] However, the international role of a currency mainly depends on other factors such as the stability of economic fundamentals, the size of the economy and the size and efficiency of capital markets.

One might argue that all major currency areas issuing digital currency and making them available for international use is a zero-sum game in the sense that any one currency can only expand its role at the expense of the others. This could create the risk of global competition to promote international use of own currencies. However, competition is useful and can improve the quality and availability of international

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29 Press release19 January 2021, "Commission takes further steps to foster the openness, strength and resilience of Europe's economic and financial system"

30 See Panetta (2021c)

31 For the 2021 report see: https://www.ecb.europa.eu/pub/ire/html/ecb.ire202106~a058f84c61.en.html; see in particular the special feature B: Central bank digital currency and global currencies.

32 For example, the ECB report on the international role of the euro uses a composite index to assess the evolution of the international role of the euro comprising FX reserves, international debt, international loans, FX turnover and SWIFT volumes.

means of payments for the benefit of the international economy, i.e. it is more than a zero-sum game. In view of the strategic importance of the matter for every major monetary authority, however, common rules can and should be agreed to govern this competition and prevent CBDCs destabilising the international monetary system (e.g. by increasing the volatility of international capital flows).

Consider the following international user/use categories for CBDC. We distinguish between uses including currency conversion and those without.

1. **Use of domestic CBDC to purchase goods and services abroad with currency conversion**. CBDC could in principle be used internationally for e-commerce in the same way as international credit card schemes (ICSs). How ambitious and realistic is it for a CBDC to be competitive in this regard, and would it depend on international interoperability issues between CBDCs? Co-branding with an ICS would probably not be considered desirable by public authorities, in view of the limitations this would imply for strategic autonomy and level-playing field considerations. However, the major card schemes combine decades of experience and investments in global usability with large economies of scale through their massive customer base. Establishing a competitive independent alternative would require significant investment, and probably also co-ordination between central banks (as discussed in the literature quoted above).[33] Central banks moving more or less simultaneously towards developing CBDCs could share technical standards at an early stage and think about possible interoperability. An alternative view would be that co-ordination with domestic stakeholders (individuals, firms, the payments industry, public authorities, legislators) is already overwhelmingly complex, and it would be challenging to add a global dimension as well. Under this scenario, CBDCs would be developed with a view to domestic POI payments first, and interoperability and cross-border use only be considered for future releases once several CBDCs have appeared. Ideally, of course, cross-border functionality and interoperability would be considered right from the start under an open architecture.

2. **Foreigners entering the currency area to pay with domestic CBDC, with currency conversion when obtaining it.** Solutions allowing foreigners coming into a currency area that issues a CBDC to pay with that CBDC appear less challenging. Uploading CBDC holdings to a card or app should be as efficient as withdrawing cash from an ATM. However, travellers typically rely on ICSs, which can be used immediately without any set-up costs. Before using CBDC, the traveller would need to register or at least, for low values, obtain a card and upload funds. It may be more efficient for short-term travellers to simply rely on this latter solution. Onboarding travellers to CBDC may become more attractive for longer stays if registration and uploading can be handled efficiently. Solutions for temporary visitors would ideally be included in CBDC projects, even if a

[33] From a front-end perspective, developing and implementing dynamic currency conversion services at merchant level for consumers is an innovation that can used for multiple payment products, not just CBDC and credit cards. From a back-end perspective, technical conversion and settlement need to be addressed. If these issues can be resolved in the international/SEPA (non-cards) infrastructure, it could be deployed for all non-card payment products, including CBDC.

solution is not strictly necessary immediately on first release because of the continued existence of ICSs and banknotes.

3. **Remittance-like cross-currency payments in CBDC with FX conversion:** in the more distant future central banks might consider having a global CBDC-based payment system, creating a single payments area in CBDC like the current SEPA in commercial bank money, for everyone. This could have addressable accounts (possibly using proxies, like phone numbers) and an automated FX conversion layer (assuming the money laundering and terrorism financing issues can be solved). Cross-border holdings of CBDC would then not be necessary, as each CBDC could stay domestic and every cross-border payment in CBDC would be converted at the border. The FX conversion layer could be organised by asking competing market makers with accounts in both currencies to provide quotes up to a certain value; whenever a cross-currency CBDC transfer is initiated, the best quote offered would be executed instantaneously. An all-encompassing solution of this sort would also cover the uses discussed in the previous points, and would not require any cross-border holdings, thereby avoiding the problem of capital flows in CBDC, as discussed in Ferrari et al. (2020).

4. **Cross-border payments without FX conversion** would normally require a foreign resident to be able to hold and use CBDC, even if not travelling to the issuing jurisdiction. As a work-around allowing foreign importers to pay a domestic exporter who asks to receive CBDC, the importer could initiate a payment in its domestic currency but instruct a correspondent bank to convert it into CBDB in the issuing country (possibly involving another correspondent). If a foreign importer were able to hold domestic CBDC and use it to pay the domestic exporter directly without any further bank involvement, this could go a long way towards substituting the international payment services offered by banks.

5. **Foreign residents using CBDC for payments between them (within one jurisdiction or between two), without FX conversion.** This involves a foreign means of payment being used entirely outside its issuing jurisdiction, making it a truly international use of a currency. It would of course require cross-border holdings of CBDC, and would probably only emerge when there is a small number of internationally dominant contenders, e.g. a USD-CBDC, maybe co-existing with few others such as a EUR-CBDC. This use raises the most issues from the perspective of international currency competition, strategic autonomy of foreign countries and cross-border capital flows. Ideally, such use would take place within a mutually agreed framework, taking into account the flow of funds implications and risks to international financial stability.

In sum, there are various possible uses for CBDC in international payments, but immediate implementation also faces several challenges. First, cross-border holdings should only be allowed when there is an international consensus and a set of rules, and probably also safeguards against facilitating large and fast capital flows. Second, the same reasons that make cross-border payments (especially remittances) inefficient would also apply to the use of CBDC across borders: money laundering/terrorism financing compliance, varying and ambiguous global

implementation of rules, and the associated legal uncertainty and risk. Progress on these would benefit private and CBDC-based international payments alike. Third, international card payments schemes are relatively efficient for small-value payments and may seem to reduce the immediate need to deploy CBDC for international travellers and retail e-commerce, although in the medium term such uses should be in-scope. A fully effective cross-border CBDC network with automatic currency conversion (supported by competing private market makers) is conceivable in the medium- to longer-term future, especially once CBDCs have been effectively rolled out for domestic use and compliance with the money laundering/terrorism financing rules in international payments has been made more efficient. It is important to keep this scenario in mind and ensure that design decisions taken on CBDC with a view to their domestic use also facilitate cross-border use in future.

6 Conclusions

Central banks will want to predict, and to some extent control, the role that CBDCs will eventually play as a store of value and means of payments. Their use must not be so minor that the related investments made are not recovered, but nor should they take on excessive importance and crowd out private innovation, or even undermine stability by damaging the viability of the financial sector. Navigating between these scenarios is therefore a key challenge. This paper started by drawing a clear distinction between the flow of fund effects of introducing CBDCs, which mainly relate to their store of value function and the risk of disintermediation of bank balance sheets, and their role as a means of payment. Overall, controlling the former by means of limits and/or interest rate incentives looks feasible. Steering the latter is more complex, in view of the need to understand and secure the network effect for a new payment option. The balance sheet effects from the store of value function and the market share in payments gained by CBDC are of course linked. If a CBDC is very attractive as a means of payment it will attract many individuals to open accounts, which could potentially trigger large flows of funds. Similarly, if they are attracted to the store of value function and most individuals rapidly open an account, use as a means of payment will benefit because the incremental step to using it for that purpose will be low. The same applies to the level of holdings and the level of payment activity: if individuals use CBDC every day as a standard means of payments, the stock needed as a liquidity reserve for these payments will depend on the efficiency of funding mechanisms. There is nevertheless a considerable disconnect between the two functions. The paper has also considered whether the central bank should set a target for CBDC use, and if so, how this should be achieved. A number of parameters are available to central banks that will determine the take-up of CBDC, and to a degree also help to make it relatively predictable: (i) merchant acceptance as also determined by legal tender status; (ii) functional scope and convenience of use, along with data protection; (iii) the scope of free payment services; (iv) the incentives for private sector financial firms and merchants to support use, including the charges levied and/or compensation paid to service providers to support distribution; (v) the built-in controls to prevent an excessive stock, i.e. over-reliance on CBDC as a store of value.

When designing a CBDC from scratch there is obviously a temptation to give it comprehensive, state-of-the art functionality and base it on the most innovative technology. It has been suggested that CBDC should: (i) be offered in the form of all major payment instruments, including cards, mobile payments and desktop access, and be as convenient as existing private solutions; (ii) allow fully anonymous payments to protect privacy; (iii) allow offline payments; (iv) allow instant credit transfers to any commercial bank account and direct debits; (v) be programmable and allow “smart contracts” for advanced uses in industry and commerce; (vi) promote financial inclusion (i.e. be usable by those without bank accounts or mobile phones); (vii) be available for international use, to strengthen the international role of the currency. Supporters of **broad functional scope** for CBDC argue that a central bank is in a unique position in terms of credibility and economies of scale, such that even very significant investments in a comprehensive CBDC based on new technology can

easily be justified, at least in large currency areas. These proponents also claim that excessively narrow scope may make CBDC insufficiently attractive, leading to low demand, so the potential benefits remain unachieved. On the other hand, supporters of **narrower functional scope** aim to minimise the possibility of crowding out the private sector. They maintain that a broad-scope CBDC could prove to be a project that is very hard to manage and launches late, and that broad scope may go beyond user and policy needs, making it inefficient. The payments industry provides numerous examples of promising functionality and technologies which ultimately did not take off. This dichotomy between narrow and broad scope suggests there may be benefits to using open architecture, so additional functionalities can be added as they become sufficiently clear. Needless to say, what exactly should be included in the functionality of CBDC also depends on identifying where there may be gaps in the availability and practicality of central bank money, and/or where CBDC could plausibly offer better value and efficiency for society. This paper proposes some criteria to help central banks decide which payment segments a CBDC is best (or worst) suited for.

Central banks need to define the CBDC business model in collaboration with the three key stakeholders who may draw advantages from it: consumers, merchants and supervised intermediaries. Their ability to improve the existing situation depends on actions taken by others and reconciling initially conflicting interests will be important. This paper identifies three conditions for success: (1) legal tender status, to support effective merchant adoption; this requires defining what exactly legal tender implies in a digital context and whether and how other payment solutions may benefit from the standard it generates; (2) incentives for supervised intermediaries; this requires an understanding of how their cost and revenue structure may be impacted by various fee/compensation structures; (3) demand from consumers to pay with CBDC and a way to identify the transactions for which CBDC is likely to be used, without becoming invasive.

Finally, the design of cost recovery and fee/compensation structures should be based on a comprehensive analysis, and consider alternative (and only partially compatible) principles such as e.g. (i) allow costs to be recovered while possibly also identifying a public-good factor; (ii) be aligned with compensation structures of existing private sector solutions; (iii) be aligned with the cost recovery and fee approach taken by central banks for banknotes; (iv) be based on comprehensive microeconomic analysis that takes welfare into account; (v) aim to achieve a market share that is considered desirable and therefore adequately incentivises the various parties to use CBDC.

While there can be little doubt about the merits of CBDC and the need for central banks to follow the change in retail payments habits and technology to continue servicing individuals and firms, this paper has illustrated the complexity of the technical challenges ahead. Designing CBDC to achieve its objectives in a controlled manner will require giving deep consideration to both the economic nature of money as a means of payment and a store of value, and to the rich ecosystems of digital retail payments.

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