

WORKING PAPER

# Central Bank Digital Currencies: assessing implementation possibilities and impacts

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## Abstract

Distributed ledgers are a technology that can support a digitized version of cash while potentially withholding its four major features: universality, anonymity, peer-to-peer exchangeability (P2P) and a constant nominal value. Based on that, several central banks are assessing the issuance of central bank digital currencies (CBDCs) under potentially very disruptive assumptions that would broaden their policy scope (including unbounded negative rates); but there is a range of possible schemes to be implemented depending exactly on which features of physical cash to withhold. This paper identifies and analyzes the opportunities and challenges of four key schemes, which taken as a whole offer advice on a strategy of gradual testing and implementation. Such a strategy would minimize the potentially large disruptive costs to the current financial architecture and credit markets, while ensuring efficiency gains linked to lower intermediation costs (especially in reference to the payment system), an eventual broadening of the policy scope and a reduction of informality, illicit activities and tax evasion.

Keywords: digital currencies, blockchain, distributed ledger, central bank, monetary policy, banks, interbank settlement, cash, negative interest rates, deposits

JEL classification: E42, E50, E61, G20, O33

# Executive Summary

Cash issued by central banks is a common feature of modern economies. Although the bulk of money is in the form of private banks' deposits, cash is the cornerstone of money supply and, together with the banks' deposits in the central bank, integrates "high-powered money". Despite its widespread use and convenience, cash has many drawbacks: it is the main instrument of tax evasion, money laundering and the financing of illegal activities; it deteriorates rapidly, especially in high inflation countries, posing significant logistical problems; it limits the scope for monetary policies based on negative interest rates, since it provides a zero-rate alternative that can be stored; etc.

The development of blockchain technology in recent years now provides a cash alternative in the form of central bank digital currencies (CBDCs). Recent literature explores this option, with the objective of overcoming the drawbacks of cash and also, in the view of some authors, as a means by which banking crises can be limited, by providing a central bank-based alternative to private banks' deposits. To some extent, however, the ongoing discussion about CBDCs downplays some of their potential costs.

This paper focuses on the main features of physical cash (peer-to-peer exchangeability, universality, anonymity and whether it is interest bearing or not) to explore different variants of CBDCs and consider whether an evolutionary approach is likely, with more feasible schemes being adopted before the more ambitious ones. We identify four main scenarios (A, B, C and D), from less to more disruptive:

- The most likely option in the short term is the use of blockchain technology only for wholesale payment systems (option A). Under this scheme the CBDC would be held by banks and other participants in wholesale payment systems (but not by the general public), identified (as opposed to anonymous) and non-interest bearing. This scenario would increase the efficiency of wholesale payment systems, and has few drawbacks for the public at large or for policy makers, although banks could be hit due to higher competition with non-bank payment institutions.
- Option B opens the CBDC scheme to the general public, and retains the anonymity of cash. The efficiency gains would exceed those of option A, as money transfers would no longer require intermediaries. The payment business of banks would be severely hindered and their retail funding would be lower and more volatile, which would pressure down credit levels.
- Option C introduces the possibility of CBDCs bearing non-zero interest rates. It hugely increases the room for anti-deflationary policies, through the use of negative interest rates. It would require the elimination of cash, except perhaps for very low denominations. The advantages of broader policy making should be balanced against the legitimacy issues that central banks would face as a result of potentially implementing unbounded financial repression. As in scenario B, banks would be negatively hit as people converted their bank deposits into CBDCs, with a potential cost for society in terms of credit. However, the restrictions in the usage of physical cash could drive up bancarization.

- Finally, option D centres on a non-anonymous and universal CBDC. Identification would make this CBDC equivalent to a deposit at a central bank, increasing its security while granting higher surveillance power to policy makers to fight illicit activities and tax evasion. Retail banking would face direct competition from central banks and a type of narrow banking model would likely emerge, with the resulting threat to aggregate credit.

We think that the less disruptive scenarios are more likely, because of their ease of implementation and because the authorities would be reluctant to choose more disruptive schemes given their potential costs and the uncertainty about their impact. This naturally conservative bias of central banks would probably give rise to an evolutionary approach, with scenario A being likely in the short to medium run, whereas the probability of other options would depend a lot on the weighting of different objectives by both central banks and authorities in general. Since authorities across countries do not share the same goals, some are likely to move earlier than others. The possibility of cross-border competition/interaction of CBDCs is one of the extensions for further research mentioned at the end of the paper.

# 1. Introduction

Money has been traditionally defined as a financial asset (or contract) that serves three distinct roles:

1. Medium of exchange (which has removed reliance on barter economies);
2. Store value; and
3. Unit of account (or numeraire, i.e., a reference to facilitate the determination of all relative prices in a given economy).

Several types of money coexist under this broad definition -- cash, checking accounts, bank reserves in the central bank, foreign currency, money market securities, short-term repurchase agreements, and privately issued assets -- each with their own set of strengths and weaknesses when fulfilling their roles.

Looking across these different types, one observes that most moneys have already been digitized, a process made easy when money is redeemable<sup>1</sup>. The reason rests on the nature of redeemable money, which relies on the trust put on its issuer together with its non-anonymity, which is an additional safeguard that facilitates proof of ownership in front of the courts. As a result, the digitization of redeemable money has evolved quite naturally: it has proven relatively easy for already trusted issuers to gain the institutional support and additional trust needed to offer and guard solely digitized versions of the money they supply.

But the strength of cash lies somewhere else. For centuries, three distinguishing attributes have upheld cash as the world's quintessential means of payment: universality, anonymity and peer-to-peer exchangeability<sup>2</sup>. A fourth key attribute, no yield bearing, has additionally fueled the role of cash as a unit of account. Preserving all these attributes within a digitized platform had proven to be significantly more challenging until 2008, when distributed ledgers (DL), a generalization of the blockchain technology popularized by bitcoins, offered the key to digitize cash.

More specifically, DL offered a solution for the “double spending problem”: it found a decentralized way to supervise and assure that no one could ever spend twice his or her withholding of cash (Chart 1.1).<sup>3</sup>

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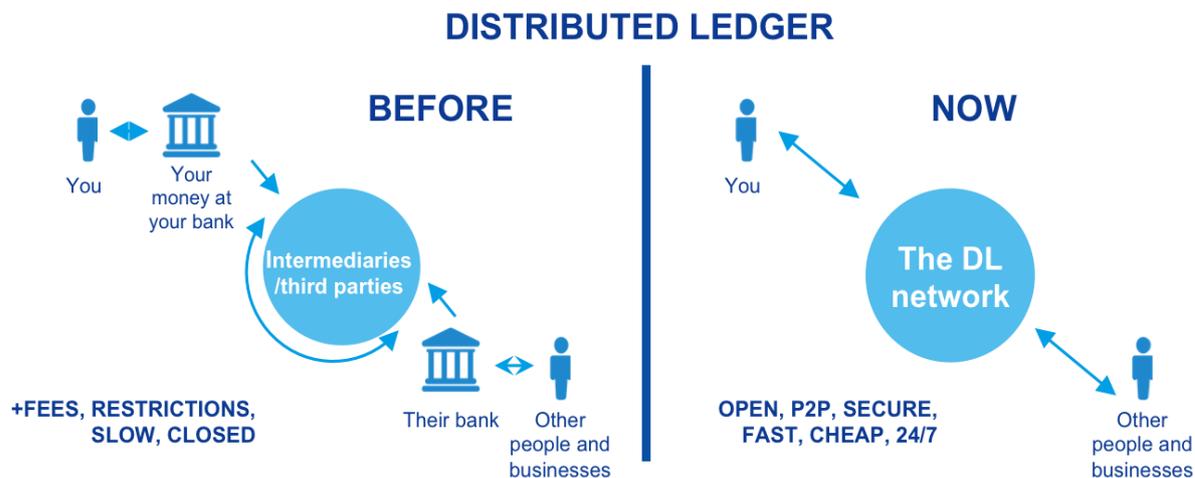
1: I.e., it is a contract that stipulates that the bearer can redeem from the issuer a given amount of a specified asset, usually cash.

2: I.e., it does not require the intervention of a third party.

3: Through a combination of algorithms and cryptography operated in an open network, DL decentralizes the supervision of the balances in all accounts, which in the context of crypto currencies are called “wallets”. A digital wallet is actually a pair of two cryptographic keys (one public and one private) which gives access to the funds in the form of crypto currency. The word “wallet” is used as analogy to physical wallets where bills and coins are stored.

Chart 1.1

## Distributed Ledgers as peer-to-peer mechanisms



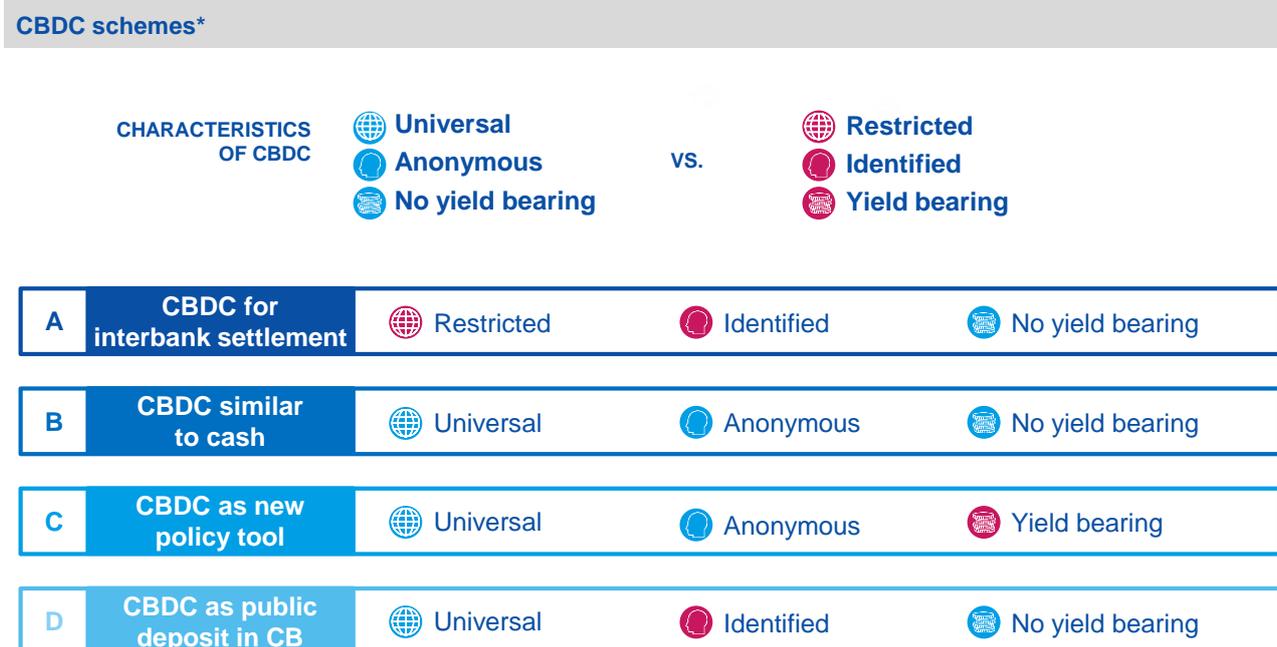
Source: BBVA Research

The Bank of England (see Ali et al. (2014)) was among the first central banks (CBs) to take notice of the feasibility of central bank digital currency (CBDC). Other monetary authorities have since followed: the Bank of International Settlements published a report late in 2015 advocating the monitoring of the technology by CBs (see Bank for International Settlements (2015)), while the monetary authorities of Canada, China, Senegal, South Africa and Sweden, among others, are currently assessing and piloting its implementation -- with both China and Senegal apparently intending to start digital issuance in 2017.

Despite the technical feasibility to digitize cash while preserving all of its aforementioned attributes, CBs are also looking into CBDC schemes that retain only some of the four key properties of physical cash. Among all the possible combinations, Chart 1.2 shows the four basic CBDC schemes that we consider most relevant, ordered from less to more disruptive:

- A. CBDC for interbank settlement: a scheme that rejects universality and anonymity of cash;
- B. CBDC similar to cash: a scheme that retains all four key attributes of cash;
- C. CBDC as a new policy tool: a scheme that includes the possibility of bearing interest rates (even negative rates, thus eroding the historical zero-bound to financial repression); and
- D. CBDC as a deposit in the CB: a scheme that rejects anonymity in favor of transparency.

Chart 1.2



\* P2P is a feature of CBDC in each of the four schemes  
Source: BBVA Research

A clear advantage shared by all four basic CBDC schemes -or combinations thereof- is the significant reduction in the intermediation costs of the domestic-payment infrastructure. As a result, financial firms relying on the provision of intermediation services are likely to become obsolete or commoditized unless they develop alternative sources of revenue.

Also, regardless of the scheme, physical cash would retain certain advantages, such as its ease of use by the “digitally uninformed”, availability “outside the grid” and trust in an asset that is completely shielded from “singled out” confiscation. Moreover, the cost to both instruct everyone and provide access everywhere may prove insurmountable to many authorities, especially in emerging economies.

But there are other significant implications that do depend on the particular scheme being considered. For example, some CBDC schemes serve as a better alternative to checking accounts than others, and thus pose a more severe threat to today’s temporal transformation of deposits into investment. The pros and cons of bank deposits have been analyzed for decades<sup>4</sup>, yet one point is undeniable: modern economies currently count on the credit generated by the temporal transformation of deposits, and a reduction in deposits would disrupt the flow of available credit, generating significant transition costs, regardless of alternative channels from savings to credit that narrow banking may or may not foster.

Scheme D in particular would certainly disrupt retail banking, as it rejects anonymity and can thus be thought of as a public deposit in the CB. Unless the monetary authority is willing to take a new role as

4: Mainly in the context of the adoption of a narrow banking style, where the debate has been framed as a trade-off between aggregate investment vs. stability.

manager/investor of CBDC, which is hard to fathom, or outsource such responsibility to the financial sector, although it is not yet obvious how and under what criteria, CB deposits would be hoarded rather than be channeled into investment.

On the other extreme, in scheme B, which retains all the features of physical cash, CBDC would compete less with deposits. It would, at least for some agents, offer a better alternative than physical cash as it would, for example, facilitate long-distance payments and allow for fintechs to fill in for scheduled settlements. However, the CBDC would be less secure than bank deposits, which offer both additional safeguards and traceability in case of legal disputes, aside from potentially offering higher yield and complementary services.

The interaction with physical cash would also depend on the scheme being implemented. For example, the existence of cash is incompatible with scheme C, where CBDC represents a new policy tool. Negative rates would remain bounded if cash is readily exchangeable with CBDC (for a low enough rate, everyone would swap into cash) while demand for cash would dry up for a high enough positive yield.

Finally, legitimacy and overall welfare would also depend on the scheme being considered. For example, an extreme case is scheme C, where CBs can modify at will the face value of CBDC. Putting aside the dubious legitimacy of such moves in the eyes of society at large, the distinction between monetary and fiscal policy would be significantly eroded: by changing its liabilities without altering its assets, CBs would rule on the consolidated surplus/deficit of the government.

In what follows, we examine all these issues in greater detail. The paper is divided in four sections, each looking at one of the four basic CBDC schemes, followed by conclusions and recommendations for future research.

## 2. Scenario A: CBDC as a mechanism for interbank settlements

As with all the schemes under analysis, this CBDC maintains its inherent peer-to-peer feature (P2P), yet differs from alternative schemes in that its use is restricted to only a set of players. More precisely, the set of players involved would certainly include Tier1 banks, which are those that currently have settlement accounts in the CB, and potentially expand to smaller banks and non-bank players that manage high volumes of payments but that, as of today, have no access to a CB settlement account. Additionally, this CBDC would not be anonymous: the nodes of the DL system would be known and their wallets identified, and would most probably not bear interests.

In this scenario, the CBDC would be used as a “settlement coin” for interbank payments. In other words, the CBDC framework (coin, nodes, consensus protocol, and distributed ledger) would work as an alternative to current settlement systems, in particular, to Real Time Gross Settlement Systems (RTGS)<sup>5 6</sup>.

### 2.1 Current versus CBDC-based interbank payment systems

The current settlement of payments is costly because it needs strict monitoring to avoid any double spending or sudden default. As a result payment systems currently used by CBs are tiered: only Tier1 banks can open a settlement account in the CB (which needs to remain continuously funded) for immediate settlement purposes. Banks in other tiers have to open accounts in Tier1 banks and go through them to settle their transfers in the CB. Thus, top-tier banks intermediate other banks’ transfers while also managing their own customers’ accounts (see Chart 2.1).

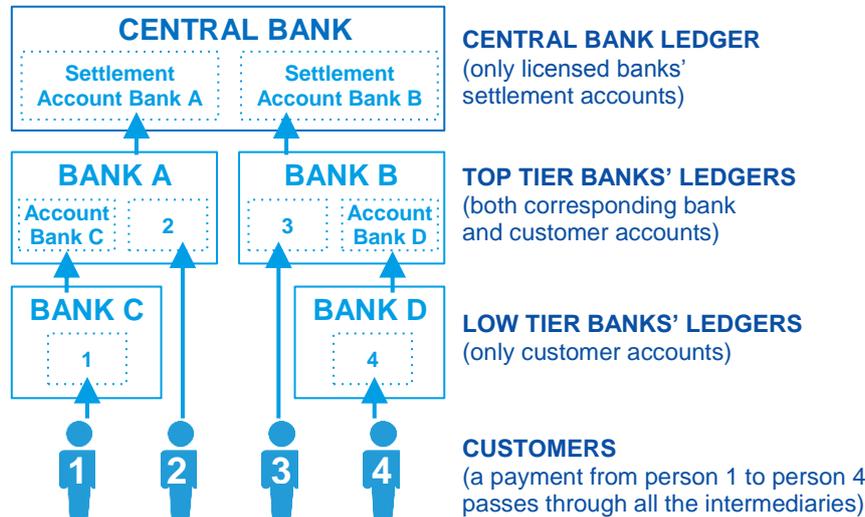
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5: An RTGS system is defined by the Bank of International Settlements as a gross settlement system in which both the processing and final settlement of funds transfer instructions can take place continuously (i.e. in real time). As it is a gross settlement system, transfers are settled individually, that is, without netting debits against credits. As it is a real-time settlement system, the system effects final settlement continuously rather than periodically at pre-specified times provided that a sending bank has sufficient covering balances or credit. Moreover, this settlement process is based on the real-time transfer of central bank money. An RTGS system can thus be characterized as a funds transfer system that is able to provide continuous intraday finality for individual transfers.

6: DNS (Deferred Net Settlement) systems, which settle transactions in batches several times per day and are used for low value retail payments, would probably continue to exist because the nature of distributed ledger does not allow the netting of multiple transactions, which are processed on an individual basis. Although a CBDC-based infrastructure could also be used for retail payments instead of DNS systems, with transactions being processed on an individual basis, the number of transactions passing through the infrastructure would dramatically increase, which could cause scalability problems and reduce efficiency.

Chart 2.1

**Payments: Tiered Model**



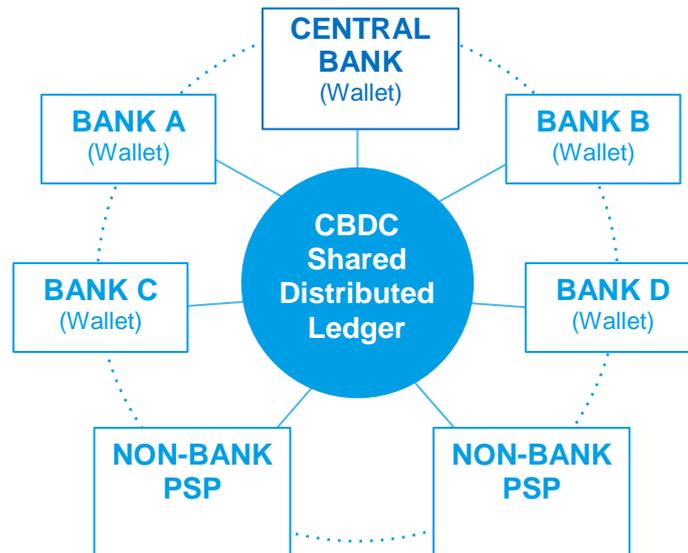
Source: BBVA Research

By implementing a CBDC-based settlement system, the centralized CB ledger would be substituted by a distributed ledger (DL) and settlement accounts by CBDC wallets. Such an infrastructure could without any relevant cost be easily shared by an indefinite number of participants in the financial system. The CB would be another node in the network and all players would be able to validate transactions, facilitating instant settlement.<sup>7</sup>

Once permission to participate has been granted, connecting and operating with the DL infrastructure does not involve additional costs for the CB. Thus, non-bank Payment Services Providers (PSPs) and other players could be invited to directly access the CBDC ledger, directly settling transfers with “central bank money”.

7: It is important to note that bilateral relationships could remain confidential, even when performed through the shared ledger. The DL-based system would be used for interbank settlement purposes, but the information of bilateral transactions between banks or between a bank and the CB could remain private to the parties involved. The only exception would be the CB, which would have access to all the information. Bilateral arrangements would still be performed outside the shared ledger when there are no payments involved. We assume that off-ledger payment transactions would be allowed but the ledger would be more efficient and would ensure enough privacy.

Chart 2.2

**Payments: Distributed Model**

Source: BBVA Research

Scenario A is highly probable not only because of its benefits but also because it could serve as an intermediate step to start testing the more disruptive schemes of scenarios B, C and D. CBs such as the Bank of England are currently working on modernizing their RTGS systems, and a DL-based infrastructure is being seriously considered.

## 2.2 Advantages and disadvantages for major stakeholders

This CBDC scheme fulfills the objectives sought by modern payment infrastructures, granting peer-to-peer exchangeability and faster payments as well as facilitating the integration of non-bank fintechs into the financial system. As such, it would accelerate the divergence between the two major strands of business in the financial sector: credit and payments, with the latter being at risk of commoditization and thus subject to significant innovation, in order to derive value-added services.

In this scenario all players would benefit from the efficiency gains springing from higher speed and lower costs in the overall system.

For CBs, the utilization of a DL-based infrastructure allows for the full availability (365 days a year, 24 hours a day, 7 days a week) of the system, which can operate without interruption, unlike current RTGS systems, such as TARGET2 in Europe, which have predetermined operating schedules. In addition, a decentralized system is more resilient to cyber-attacks because there is not a single point of failure to go against.

Moreover, the existence of a shared DL allows CBs real-time, transparent transactional information about capital flows. Transparency about capital flows and real-time access to information is a step towards the dynamic monitoring and better management of systemic risk. Additionally, such a system also allows a CB to compete with private digital currencies/ledgers<sup>8</sup> in order to keep full-control (supervision) of the settlement system.

A DL-based system would also expand accessibility and therefore foster competition: the marginal cost of adding a new participant would be significantly reduced: adding a new node to the network is technologically and operationally simpler than with a traditional payment infrastructure. As a result, more players would have direct access to the wholesale payments business, increasing competition.

All these benefits would come at a high initial cost of implementation<sup>9</sup> and subsequent infrastructure maintenance costs (although the latter could be lower than for the current system).

For banks, the main benefits would be concurrent with the ones of the CB: full availability and resilience under cyber threats. Additional benefits would be speed and cost efficiency in the whole settlement process, including infrastructure costs. Also, higher competition would reduce transaction fees to more accurately reflect the marginal cost of verification. The effect on the aggregate financial industry would be a reduction in the transactional costs associated with payments.

However, some players would lose a current source of revenue. Tier1 banks would lose their privileged role as ultimate settlers in CB accounts, and would lose part of the payment business in favor of Tier2 banks, and all of them in favor of non-banks. Moreover, direct access to the wholesale payments settlement system would allow non-banks to provide end-to-end payment services and, as a consequence, increase their market share. Such new entrants might negatively impact the revenues of banks. However, the benefits in terms of efficiency, infrastructure costs savings, resilience, transparency and innovation could well outweigh such loss of revenue.

This scenario would further push banks to focus on the credit business, where they would maintain a competitive advantage -- mostly due to both their expertise in risk management and the resources needed to enter into the business.

On the payment front, competition would shift from the transaction itself to the offering of additional services. The transactional part of payments would be easily covered by any kind of player since they could have direct access to the CB settlement system. Therefore, the value creation in the payment business would have to be based on a seamless, appealing user experience and a broad range of value-added services, mainly built upon the knowledge extracted from transactional data.

Anyway, given the important role that non-banks will have in the new competitive landscape, potential partnerships between banks and non-banks could naturally arise, with the aim of complementing knowledge, skills and processes to build a win-win value proposition in payments and credit services.

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8: We refer in this paper to digital currencies not issued by the CB as "private" digital currencies even though some of them, such as bitcoin, are public and do not have a private owner.

9: Implementation costs include the development of new skills needed in CBs in order to be able to exploit data stored in the ledger.

From an operational point of view, this scenario would force banks to excel in wallet funding calculation. A good management of their CBDC wallets will be essential because prefunding of wallets is mandatory in a DL-based system, meaning that banks cannot operate in overdraft. This is not completely different from what happens with CB settlement accounts in RTGS today, which are periodically pre-funded with accurate calculated funds enough to cover the payment needs without tying up too much money<sup>10</sup>. However, in this scenario the complexity grows because banks can have CB money both in its traditional form and in CBDC, and they have to balance the amount they want to have in each form at all times.

End-customers do not have access to the CBDC in this scenario. However, they would benefit from cheaper and faster money transfers.

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10: Some literature points at a potential freeing up of collateral as one of the advantages of using DL-based interbank settlement systems. However, RTGS systems settlement accounts are usually pre-funded, meaning that no collateral is involved. Therefore, in general, collateral management does not constitute a significant advantage.

## 3. Scenario B: CBDC similar to cash

This CBDC scheme retains all four attributes of cash: P2P, universality, anonymity and no yield bearing. Banks would continue to be money creators and preserve their exclusivity at maintaining reserves at the CB. In a recent speech, Yves Mersch, a member of the executive board of the ECB (Mersch (2017)), defined this CBDC as “value-based” in juxtaposition to an “account based” CBDC (analyzed later in scenario D).

More specifically, P2P grants the ability to exchange CBDC without the need for intermediaries. In addition, universality means that anyone would be allowed to operate it, hold it and store it. Anonymity<sup>11</sup> would raise issues of security and safety in the same way cash does today: it would be difficult to recover it once it is stolen or lost, although CBDC would likely be less prone to being stolen or lost than cash. Finally, and exactly like cash, this CBDC would bear no yield.

Moreover, we assume that the CBDC is maintained at a 1:1 parity with cash. We make this assumption for all schemes under analysis as lifting parity would create a set of inconveniences and generate no -or limited- gains.

### 3.1 How does the CBDC compare to other moneys?

By focusing on the three defining roles of money- unit of account, medium of exchange and store of value - we assess the performance of the CBDC relative to the three most relevant types of money: cash, bank deposits and other private/foreign currencies.

Its performance as a unit of account would be similar as that of physical cash, as long as they remained pegged to each other<sup>12</sup>. As such, it should serve as a better price reference than private and foreign currencies, both of which would remain vulnerable to exchange rate instability under current standard monetary practices, not to mention the risk of capital controls.

As a medium of exchange, this scheme would compete with/complement both cash and bank deposits, but it would remain an imperfect/uncertain substitute for both. Its usage would surely increase as people grew comfortable with online transactions, but it would remain a poor substitute for cash for those who are less technologically inclined or who reside in places with poor internet access. It is worth noting that this scheme would not curb illicit transactions, as it would retain anonymity<sup>13</sup>. Compared to bank deposits, this scheme would facilitate long-distance and/or large-quantity payments, but it would not necessarily offer additional services<sup>14</sup>. That said, it would facilitate the offering of such services by firms other than banks -fintechs and

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11: It is technologically feasible to make CBDC anonymous and untraceable, although this would likely require an ongoing technological investment.

12: The implementation of this CBDC scheme would be akin to the issuance of a new “coin” or “note”, albeit a note that would be infinitely divisible and easily traded online.

13: This scheme could even facilitate illegal activities, as transaction/transportation/storage costs are lower than those of cash. On the flip side, it remains to be seen how much the public would trust the anonymity granted by a digital asset in which the CB plays a key role.

14: To be more precise, we regard as unlikely the possibility that CBs purposely decide to provide financial services, but acknowledge the fact that some types of services can be intrinsically attached to a CBDC.

small players- thus further commoditizing the payment infrastructure and reducing the comparative advantage of deposits.

As a store of value, in this scheme CBDC would remain riskier than bank deposits, at least those deposits up to the amount guaranteed by authorities: anonymity implies that it would be untraceable if it were stolen or the password to the wallet forgotten. As argued by Broadbent (2016), if “all a CBDC did was to substitute for cash (...) people would probably still want to keep most of their money in commercial banks”.

In conclusion, the introduction of this scheme would further reduce the usage of cash and potentially dent but not slash bank deposits. Cash would still reign in less digitized economies but CBDC would more readily substitute cash in economies where cash usage has been falling regardless.

## 3.2 Advantages and disadvantages for major stakeholders

For end users, the overall benefits of this scheme would outweigh its costs. CBDC would be a digital representation of cash without the volatility, price instability and lack of liquidity of current non-government digital currencies, such as bitcoin. However, in this case CBDC holders would also benefit from the advantages of currencies like bitcoin: mainly cheaper and faster money transfers. These advantages would likely translate into output gains<sup>15</sup>. It would also promote financial inclusion, namely where banks have had difficulties in establishing a geographical presence or where governments have had problems in making physical cash available. For example, the Central Bank of Senegal announced recently that it is considering the issuance of a CBDC to promote access to financial services.

Potential costs for end users include the lingering threat of losing anonymity as a result of either policy decisions or hacking. To counter hacking, CBDC implementation would require continuous investment to update the system. Other costs that some end users may face can be grouped under “access barriers”, which go from sub-optimal infrastructure to technological illiteracy. Finally, the partial substitution of CBDC for bank deposits would result in a fall in credit *ceteris paribus* - a fall which monetary authorities might or might not offset through, for example, an increase in the monetary base. But even in an optimistic scenario, this offsetting would require time, with the ensuing transition costs.

Also for monetary authorities the benefits would likely outweigh the costs. Efficiency gains would be higher in emerging markets, especially in countries with high inflation, where maintenance and issuance of physical cash are especially costly. Moreover, CBDC would also allow CBs to compete and potentially limit the end user incentives for using private or foreign digital currencies with the lack of control that the latter generally entail. On the side of costs, monetary authorities would need to finance the implementation and maintenance of a completely new infrastructure that demands first hand equipment and a novel set of skills.

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15: See Barrdear and Kumhof (2016) for more on this issue.

But for banks, the costs would likely outweigh the benefits. More specifically, this scheme would make most intermediation for payment transactions redundant, bringing to an end banks' payment business<sup>16</sup>. Banks would probably continue to offer payment services as part of an all-embracing service of financial management.

Banks' credit business would also suffer because of the partial substitution of CDBD for deposits. It is worth noting that the scheme would not only reduce the volume of deposits, but would also increase their volatility (due to customers' greater ease of wealth reallocation away from deposits into a broader range of alternatives). As a result of increased volatility, asset and liability management by banks would be more difficult.

On top of that, incumbents in the banking sector would face the entrance of new and potentially less-regulated players. New entrants would probably start with services in the payments business, but would eventually broaden their scope to eventually offer credit and fully-fledged alternatives to deposits.

With respect to the potential benefits for banks, they would indeed benefit from any aggregate output gains, just like other stakeholders would. Furthermore, banking regulation might ease as the sector would be less concentrated and their activities might turn out to be less prone to systemic disruptions. Finally, benefits might accrue from new business opportunities facilitated by CBDC, such as the management and protection of the keys for CBDC wallets<sup>17</sup>.

### 3.3 Alternative scenarios

However unlikely, the eradication of cash is always an option (or at least a partial eradication as suggested by Rogoff (2016), where only low-denomination bills and coins are maintained). The recognition of such a possibility is particularly pertinent under this scheme, where the CBDC can be seen as a digital version of physical cash.

Eradicating cash poses a great challenge, especially in cash-dependent economies. Conversely, it would be easier in developed economies where most transactions already use no cash. Bearing this in mind, eliminating cash could generate some costs for end users, although they would benefit from the reduction in informality and illicit activities that would benefit society as a whole. Although the introduction of CBDC would not sort out these issues as it remains anonymous, there might be a greater reluctance to use CBDC for illicit purposes, for tax evasion, etc., at least if there is some fear that anonymity can be reverted at certain points in time.

For banks, the elimination of cash would be good news, as some prior users of cash would then convert part of their resources in bank deposits. For authorities, the benefits of eliminating cash (reduced informality and potentially lower maintenance costs) would have to be balanced with the risks related to the exclusive reliance on a digital platform<sup>18</sup>.

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16: Faced with fees, even those people favoring the use of checking accounts might be swayed to convert their deposits to costless CBDC before carrying out a given payment.

17: For more on this potential opportunity, see FirstRand Bank (2016).

18: Potential risks range from a malfunction in devices that access CBDC wallets to a temporary lack of connectivity or a serious cut in the infrastructure, due to technical reasons or cyber-attacks.

## 4. Scenario C: CBDC as a new policy tool

This CBDC scheme retains universality, P2P and anonymity. However, in contrast to cash, in this case CBDC would bear interest.

The technology behind CBDC allows the CB to alter the face value of the whole stock of CBDC, a prerogative that would transform the CBDC into an interest-bearing currency.<sup>19</sup> An interest-bearing currency would be a revolutionary change which would create possibilities for monetary policy that are currently unavailable, or at least very difficult and costly to implement.

Allowing CBs to reduce the face value of digital currency is tantamount to setting rates as negative as monetary authorities may want, unfettered by any zero lower bound. In other words, this scheme allows for unlimited financial repression and the possibility, argued by many, of responding aggressively and effectively against recessionary threats. Conversely, a rise in the face value of CBDC would amount to positive interest rates, implying an automatic expansion of the monetary base.

But technological feasibility does not necessarily translate into political-social desirability. Allowing the CB to reduce the face value of circulating currency can be easily interpreted as expropriation. It is true that via inflation, expropriation in real terms has been a constant in modern economies, yet it remains to be seen how society would respond to a nominal confiscation of wealth. At the other end, allowing the CB to raise the face value of circulating currency would probably find few detractors among currency holders, but it would also amount to a transfer of wealth that in current societies is the prerogative of fiscal and not monetary authorities, and which would in any case have a hard job in justifying transfers towards those holding more currency. Thus, the introduction of positive or negative interest rates raises legitimacy issues regarding the right of CBs to interfere and implement fiscal policies.

Furthermore, the role of currency as a unit of account might be put to the test: leaving aside periods of high inflation, domestic currency has served as the unquestioned reference for most prices in modern economies. How much has this reliance on currency as a numeraire hinged on the fact that currencies bear no interest?

Finally, it is worth noting that the yield rate applied to the CBDC could be aligned or not with the monetary policy interest rate. Depending on the objectives of CBs, it could be set at different levels<sup>20</sup>.

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19: It would also be feasible to embed CBDC with smart contracts that trigger changes in face value contingent on any pre-stipulated event.

20: On the one hand, a lack of harmonisation among them could undermine the effectiveness of monetary policy actions but, on the other, a lower interest rate on CBDC than the official interest rate could safeguard both financial stability and credit markets as banks would have higher flexibility to remunerate deposits above the CBDC yields.

## 4.1 How does the CBDC compare to other moneys?

The coexistence of cash and CBDC under this regime would be problematic if not impossible. If interest rates were negative, people would deplete their stocks of CBDC in favor of zero-yield physical cash<sup>21</sup>. In other words, CBDC could sustain significantly negative rates only if physical cash were mostly abolished. At the other end of the policy lever, if CBDC bore positive rates, people would transform cash into CBDC (i.e., get closer to a cashless society).

As in scenario B, this CBDC would exhibit advantages in comparison to bank deposits, especially when viewed as a medium of exchange with no intermediaries. Similarly, bank deposits would likely keep their advantage as a store of value (better safeguards) and continue attracting those looking for specific financial services. As a result, and also as in scenario B, demand for bank deposits relative to that for CBDC would depend on the yield spread between them. Consequently, the impact on the level of deposits would probably be similar to that in scenario B. But one could argue that any volatility would be higher as the spread between CBDC and deposits would be fluctuating at both of its margins<sup>22</sup>.

CBDC would still compete with other currencies and assets. The perceived stability of CBDCs versus other currencies/assets would certainly play an important role in the demand for CBDC. With regards to foreign currencies, the situation would not necessarily be different to what exists today, where flexible-exchange currencies coexist while maintaining their own level of domestic interest rates. Yet uncertainty-instability might escalate with negative rates, making CBs willing to impose capital controls as a last resort<sup>23</sup>.

## 4.2 Advantages and disadvantages for major stakeholders

This scheme might incur even greater drawbacks for society than the previous ones. Although positive rates would be an option, in principle this scheme would be adopted to allow the CB to implement negative interest rates, which would imply direct losses to end users of CBDC, losses that are tantamount to confiscation. Moreover, similar to scenario B, the threat of losing anonymity due to technological or legal issues would always be present, yet end users would face the added difficulty of having no cash to run to. In addition, the near elimination of cash would magnify the costs to the end user brought by any internet disruption or power shortage, for example.

As this scheme demands the near elimination of cash in order to work, authorities would bear the high cost of guaranteeing universal access to CBDC, reducing barriers on both the technology and the educational fronts. Moreover, negative rates may also raise questions about whether authorities -especially monetary

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21: More precisely, for any agent, a turning point would emerge when the loss in yield of CBDC were to surpass the costs of storage and transportation of physical cash.

22: As suggested before, CBDC interest rates could be set at a sufficiently low level such as to guarantee that demand for bank deposits does not fall significantly, driving credit levels down.

23: Uncertainty might rise because CBs are only held accountable for keeping inflation under control (and their credibility on that front has led to stability in international exchange markets). However, central banks are not held accountable for sustaining rates above any level (and for investors in global exchange markets, very negative rates would bring the same loss in value as would very high inflation). It is not clear a priori how that uncertainty would be contained.

authorities- have the legitimacy to adopt policies of financial repression<sup>24</sup>. Therefore, before allowing CBDCs to bear interest rates, it would be important in the first place to carefully discuss what the CB's roles and mandates are, and then to establish a framework that provides the correct incentives for major stakeholders.

On the plus side, the benefits to society would be twofold: i) a capability for stronger and more flexible monetary stimuli in case of recessions, and ii) a faster path to digitization.

The impact on the banking sector would be similar to that in the previous scheme, although banks would benefit from the abolition of cash, which would reduce informality. Similar to the previous scheme, some customers would reallocate deposits into virtual wallets and opt for new non-bank sources of finance which would be readily available thanks to CBDC. The impact on deposits would be greater, the higher the CBDC interest rate is, especially if it is not set below the policy interest rate<sup>25</sup>. The volatility of bank deposits is likely to be even higher than in the prior scenario, because demand for deposits would not only be impacted on by movements in the policy rate, but also by those in the CBDC yield rate. Finally, regarding payment services, while the domestic business would practically come to an end, as in scheme B, the cross-border payment business could be significantly impaired by the eventual adoption of capital controls.

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24: Although a change in the face value of currency would be similar to a change in yield, there would be a fundamental difference when implementing such a policy. Under normal conditions, CBs currently change interest rates in open market operations by changing their total balance, but not by creating deficits or surpluses (those may eventually arise due to revaluations of assets and liabilities in the CB, but that is a different story). A reduction in the face value of CBDC would imply a reduction of the CB's liabilities without a corresponding fall in its assets: increasing the surplus (or reducing the deficit) of the consolidated fiscal account. The implementation of such an instrument would thus be a major change of policy rules, where deficits are the sole prerogative of governments, not of CBs. It is true that since 2008 the Fed has joined the ECB and the BoJ in directly setting the interest paid for bank reserves, (which is a liability for CBs), but they do so under intense questioning by Congress and under the premise that the return on their assets is significantly higher, (and thus are not generating any significant impact on the consolidated deficit).

25: Deposits with rates significantly above the policy rate would be unsustainable for banks and might lead to the banking system's unwarranted reliance on CB or other types of funding. Deposit rates below CBDC yields would be hard to sell to depositors, unless they perceive benefits in bank deposits that counterbalance a lower remuneration.

## 5. Scenario D: CBDC as public deposits in the central bank

This CBDC scheme retains all the major attributes of physical cash except for that of anonymity. By making the CBDC non-anonymous, it would more closely resemble a checking account -in this case held by the CB- than physical cash. In the words of Mersch (2017), it would constitute “an account-based CBDC”.

The fact that CBDC is identified rather than anonymous, and the fact that it is kept as a public deposit in the CB make it intrinsically safer; not only safer than other moneys, but also safer than the three CBDC schemes previously studied in this document.

### 5.1 How does CBDC compare to other moneys?

Anonymity is valued not only by tax defrauders and those carrying out other illegal activities, but by agents' skeptic of governments and concerned about having their legal transactions monitored<sup>26</sup>. Therefore, the fact that CBDC is non-anonymous, as are indeed bank deposits, means that it will be less desirable than cash as a medium of exchange, at least for some people. However, as in previous cases, demand for CBDC as a medium of exchange will also arise as a consequence of it being a more efficient technology to carry out monetary transactions. All in all, in this scenario CBDC would be less in demand as a medium of exchange than in both scenario B and scenario C when it does not bear negative rates.

In contrast, demand for CBDC as a store of value would increase in comparison to other scenarios because it is now a safer money than before. In fact, it will likely be a safer money than physical cash not only due to technological issues but also because it is identified, which means that recovering it, will be easier in cases of loss, theft, etc. Moreover, it will be a safer money than bank deposits, as the risks of maintaining it at the CB are clearly lower than maintaining it as a deposit in a bank. However, in spite of this advantage, some would still demand bank deposits due to higher remuneration and services. Regarding the former, we are assuming in this scenario CBDC yield is zero, but below we will also discuss the case where CBDC bears non-zero interest rates. With respect to the latter, in our view, what is most likely is that CB will not move into the business of providing financial services as it will likely lack the incentives and the skills to do so<sup>27</sup>.

As in previous cases, in scenario D, CBDC will work as a proper unit of account, like cash and bank deposits, and in contrast with private and foreign currencies. Regarding these currencies, we note again that their basic features prevent them from displaying superior properties as far as a medium of exchange and store of value is concerned.

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26: For a discussion about this issue, see Koning (2016) and Kahn, McAndrews, and Roberds (2004).

27: As pointed out before, we regard it unlikely that CBs purposely decide to provide financial services (such as wealth management, advisory services, easier access to credit, etc.), but acknowledge the fact that some types of services can be intrinsically attached to a CBDC.

All in all, CBDC will be in general a better store of value and a worse medium of exchange than in the previous scenarios. Whether the demand for it in scenario D is higher or lower in comparison to these scenarios will depend on how people in each society value safety and anonymity.

## 5.2 Narrow banking

From the point of view of end users, deposits at the CB are much safer than bank deposits, among other things, because they do not carry any credit risk. Due to that feature of CBDC deposits, the situation for end users is comparable to keeping deposits in a so-called narrow-bank, i.e. in a financial institution that is compelled by authorities to maintain the public's resources under custody in a liquid and safe form, such as in government bonds, rather than leveraging on them in order to create credit<sup>28</sup>. In that sense, we argue that a type of narrow-banking system would emerge as a consequence of the CB accepting CBDC deposits; as a matter of fact, as a consequence of making CBDC non-anonymous<sup>29</sup>.

It is important to note that even with the CB functioning broadly as a narrow-bank, banks will likely continue to work according to a fractional-reserve banking model, i.e. transforming part of the public's deposits into credit and keeping only a fraction of them as reserves<sup>30</sup>. In that sense, we can refer to this scenario as a partial narrow-banking system, as opposed to a full narrow-banking system in which banks are also compelled to operate as narrow-banks rather than as fractional-reserve banks.

From the point of view of the monetary authority, this scenario is not a main departure from scenarios B and C, at least in qualitative terms: as in the previous scenarios, the increase in the demand for CBDC means that the CB will have more resources under its management. In other words, the size of the CB's liabilities will increase, generating an increase in the size of its balance sheet.

To match the increase in its liabilities, the CB will have to somehow increase the size of its assets. Taking into account the nature of CBDC deposits, particularly the fact that they shall remain fully available to depositors, what is most likely is that the CB will predominantly buy safe and liquid assets, such as public securities, to counterbalance CBDC deposits.

In our view, the deposits that the CB obtains with an identified CBDC should not be used to either grant loans to the non-financial private sector or finance governments. The former is not recommendable because the CB lacks the expertise to do so and mainly because it can create some perverse incentives for policymakers. The latter would also be problematic: it would generate unreasonable incentives for the government, increase the risks of fiscal slippage, and create problems for the CB regarding the maintenance of its independence and its focus on its traditional objectives. In fact, some pathological cases could arise in this case: a non-independent CB could, for example, have incentives to compete more aggressively with banks, in order to gather more deposits and thus have more room to finance its government.

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28: For more details about narrow-banks, including the different forms they can adopt, see Koning (2016) or Laina (2015), for example.

29: As bearing credit risk is a common feature of bank deposits and not of the CB's liabilities, the narrow-bank concept applies suitably to a bank, but not necessarily to a CB. Anyway, we follow the literature and refer to scenario D as a case of narrow-banking.

30: For that reason, in a fractional-reserve system banks are exposed to bank runs, while in a typical narrow-bank -and also in a CB- that is not the case. Moreover, it is worth noting that another difference between the two systems is that deposits held in a fractional-reserve style system represent a mechanism through which banks create money, while that is not true in the case of a narrow-bank.

As we further discuss below, the advantage of this type of narrow-banking arrangement is that the costs to society related to the instability of the banking system (such as bailing-out unsound banks in the event of crisis, maintaining deposit guarantee schemes and last resort lending facilities, etc.) will be lower. This is basically because the size of the banking system will be smaller (as bank deposits will fall as a consequence of allowing end users to keep deposits at the CB). However, this scenario would exhibit a relevant drawback: as bank deposits will fall, banks will have less room to grant loans and, therefore, the aggregate credit level in the economy will be lower.

To reduce this negative effect on credit, authorities could decide to reduce reserve requirements, increase the monetary base, impose a tax on the use of CBDC (which would be similar to making it bear negative interest rates), or inject part of the CB's extra liquidity into the financial system.

In the latter case, the CB would have a more direct -perhaps excessive- control of credit markets. A new set of policies would have to be detailed by policymakers in order to try to generate the correct incentives for the involved agents, which would not be straightforward. As in other cases studied in this paper, it would be essential to define the goals of the CB under this scheme. Would the monetary authority be given the additional responsibility of reaching credit/employment targets, or would it remain focused on inflation and financial instability? Any alternative would be challenging: having credit/employment goals would likely imply that the CB would display a higher degree of tolerance with respect to inflation; while concentrating on inflation may result in a sub-optimal level of credit; and focusing on financial stability would probably create the risk that the public's deposits at the CB may be used to sustain and even rescue the banking system. In any case, once the objectives of the CB are defined, a criteria would have to be set to grant funds to banks, specifying exactly who will bear the credit risk, whether banks should be required to provide collateral guaranteeing loans, whether to price-discriminate across banks depending on how sound they are, whether to continue guaranteeing deposits maintained at banks, which interest rate to charge banks, etc. All in all, we see a risk of policy slippage and of the rise of wrong incentives for policymakers and banks, if CB deposits were channeled back into the banking system.

Finally, it is important to note that although we see it as most likely that the CB operates as a narrow-bank, and banks continue to work according to the fractional-reserve model, we see there being a risk that, once a non-anonymous CBDC is adopted, authorities decide to take a more drastic measure and adopt a full narrow-banking system, i.e. one in which not only the CB but also financial institutions are forced to work as narrow-banks<sup>31</sup>.

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31: In general, in a full narrow-banking system storing deposits and creating credit will be two separated activities. Therefore, banks will have two options: i) to work as narrow-banks, capturing deposits but maintaining them in a very liquid and safe format (such as government bonds or at the CB, for example); or ii) to work as investment banks or mutual funds, selling investment opportunities to agents looking for higher remuneration (i.e. maintaining liabilities other than deposits, and credit as part of its assets).

## 5.3 Advantages and disadvantages for major stakeholders

In our view, the aggregate costs of adopting this scheme would outweigh its total benefits. Consequently, scenario D would be less likely than those previously discussed.

For policy makers, the introduction of a non-anonymous CBDC would potentially have two main benefits. First, the identification of CBDC and the possible traceability of monetary transactions would grant policy makers greater powers of surveillance, which could contribute in the prevention of illicit activities and reduce tax evasion. Moreover, identification and traceability would make easier the programming of CBDC with the goal of enforcing or preventing some transactions<sup>32</sup>. The second main potential advantage for policy authorities is that the adoption of a type of narrow-banking system could reduce the costs related to the instability of the banking system: as a potentially significant part of public deposits would now be under the custody of the CB, and therefore at least implicitly guaranteed, rather than in the hands of financial institutions, so banking-related risks would be less important.

Nonetheless, each one of these two main advantages would be closely accompanied by important disadvantages. This higher surveillance power would likely raise concerns about whether the State and especially the CB have legitimacy to potentially watch people's transactions. In fact, the CB could not only watch but also directly interfere in people's lives by reducing their room for maneuver in the taking of some decisions. For example, by using smart-contracts, CBs could potentially force economic agents to buy or not to buy certain types of products. Does the monetary authority have the legitimacy to use this powerful tool to favor or not to favor certain operations?<sup>33</sup> On top of these legitimacy issues, there also exists another type of problem related to the higher powers of surveillance granted to CBs. Would it not create some perverse incentives and prevent the monetary authority from independently managing monetary policy? These are issues that need to be carefully taken into account before moving into a scenario like the one we are describing in this section<sup>34</sup>.

With respect to the adoption of a type of narrow-banking system, lower instability would be accompanied by a reduction of credit<sup>35</sup>. That would be particularly harmful in emerging economies which have not yet reached high bancarization levels.

In scenario D, as in previous scenarios, the adoption of a CBDC would also present other advantages (higher efficiency, a way of competing with other digital currencies, reduction of informality). As well as disadvantages (implementation costs) for policy makers in comparison to the current situation, i.e. with the situation prevailing before the introduction of any type of CBDC.

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32: In other words, the underlying blockchain technology could be adjusted to allow the introduction of smart contracts, i.e. computerized protocols that can enact the terms of a contract. For example, the CBDC could be programmed in a way that it cannot be used to buy some products or for an automatic payment of certain debts, such as a tax or a loan.

33: In that sense, would it be legitimate for the CB to encourage the purchase of healthy food or goods produced by only one set of countries?

34: To minimize these types of problems, some, such as Koning (2016), wondered whether blockchain developments could advance in such a way as to allow CBDC transactions up to a certain amount to be anonymous, and for CBDC transactions that exceed that amount to be non-anonymous.

35: As the advantages, i.e. lower financial instability risks, and the disadvantages, i.e. lower credit, in this scenario go hand-by-hand, any compensatory measure taken by policy makers with the aim of reducing the impact of an identified CBDC on credit would also reduce the gains for society in terms of lower financial instability.

For banks, the introduction of CBDC would likely generate a sharp fall in deposits, as agents would have a safer alternative to store value. The fall would be higher the lower the coverage of the deposit protection scheme is, the lower the remuneration of bank deposits are, and the worse the services provided by banks are. Moreover, the impact on bank deposits could be somewhat reduced, if the CB were to take some of the measures cited above to prevent a sharper contraction in credit. Although banks would continue to attract clients interested in their services, the fact that banks would compete for deposits directly with the CB means that they would tend to retain the most risk-loving clients, those who are willing to accept higher risks in exchange for potentially higher returns. Then, to some extent commercial banks will look more like investment banks and mutual funds, with whom they would compete more directly. Finally, some of the other costs discussed in previous scenarios would also be present in this case: the business of payment services would practically disappear, funding would be less stable and fiercer competition with fintechs would emerge.

On the other hand, banks would benefit from efficiency gains related to the adoption of a CBDC, which to some extent would boost economic activity, and perhaps by less severe regulation which will be allowed by the fact that risk-averse agents will now allocate their deposits in the CB and also because of the lower risk banks would represent for the economy. However, in our view these benefits will not offset the negative effects the CBDC would have. Banks would be negatively impacted in this scenario. We would see the end of the banking system as we know it.

For its end users, the CBDC would also create some advantages and some disadvantages. On the one hand, in addition to benefiting from efficiency gains, cheaper and faster money transfers and lower informality, agents would now have a safer option in which to keep their resources, will gain from higher competition for resources between banks, CB and fintechs and from lower aggregated financial risks. On the other hand, end users would suffer the consequences of the likely reduction in credit levels and of a higher level of surveillance, not to mention the previously noted costs and risks to accessing and using the CBDC.

## 5.4 Other implementation alternatives

The existence of physical cash would make it difficult for policy authorities to use the higher surveillance power enabled by a non-anonymous CBDC to reduce tax evasion and fight illicit activities, as people engaging in these types of ventures would naturally avoid CBDC. That makes the argument for an identified CBDC less convincing. However, to circumvent this problem, policy makers could decide to take a drastic measure: abolish physical cash or at least severely restrict its use.

That shows that, even though we have assumed as our baseline scenario in this section that physical cash and CDBC would coexist, there are reasons to think that policy makers may decide to eliminate cash in scenario D<sup>36</sup>.

In fact, to maximize its powers of surveillance, which is in fact one of the main reasons for the adoption by officials of a non-anonymous CBDC, not only the use of cash would have to be constrained, but probably

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36: On this issue, in a recent speech, Yves Mersch, Member of the Executive Board of the ECB, explicitly emphasized that “freedom of choices for users of means of payments” would be one of the four “high-level principles” to be taken into account over an eventual decision about the implementation of a CBDC. According to him: “if Digital Base Money for non-banks were introduced, it would exist alongside cash for the foreseeable future. It would merely be an additional option for non-banks to hold funds. In particular, those who are skeptical about digital devices would naturally continue to use cash.” For more, see Mersch (2017).

also the use of other anonymous moneys such as private and foreign currencies, gold, etc. This would be no easy task.

As commented on in previous sections, the elimination of cash would reduce informality, but would create potentially significant costs for the government in making CBDC accessible to all agents, especially in economies where the use of cash is widespread.

The elimination of cash would pave the way for a scheme that would be scrutinized by several central banks: a CBDC that is both non-anonymous and interest bearing (i.e., a combination of scenarios C and D).<sup>37</sup> Such a scheme would amount to a generalization of the one in scenario D, where fixing interest rates at zero would be only one of the possibilities among the many available.

In line with the analysis included in the previous section, by allowing interest rates to be different from zero, policymakers would make monetary policy potentially more powerful: negative interest rates could then be adopted either to more quickly stimulate the economy in cases of recessions/deflations, or as mechanism to increase the demand for bank deposits in order to prevent a fall in credit levels. However, as highlighted before, allowing the CBDC to bear non-zero interest rates creates some disadvantages, including the legitimacy problems the CB would face<sup>38</sup>. All in all, we see a scenario D with non-zero interest rates not only as more general than others, in the sense that policymakers would have more policy alternatives, but also as a potentially more disruptive possibility.

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37: That is the baseline scenario analyzed by Ali et al. (2014), Barrdear and Kumhof (2016), FirstRand Bank (2016) and Raskin and Yermack (2016), among others.

38: For a more detailed analysis of the consequences of having an interest bearing CBDC, please see Section 4, where the focus is on this issue and not on non-anonymity, which is the main focus of Section 5.

## 6. Conclusions

After having analyzed the most relevant scenarios for the adoption of a digital currency by CBs, we consider it likely that a CBDC will be adopted by at least some CBs over the next few years. As the economic research and policy debate on CBDC deepens, and blockchain-related technology progresses over the forthcoming years, the path toward its introduction will definitely be laid.

In our view, scenario A, in which CBDC will work basically as a mechanism for interbank settlement, is the one that will most likely be adopted over the coming years, followed by scenario B, in which CBDC will be created so as to be as similar to cash as possible, where the two will coexist. We view scenarios C and D as being less likely.

This opinion is based on our assessment of the benefits and costs of each scenario. More precisely, in our view, scenario A will introduce more advantages than disadvantages for policy makers and end users. While banks will be negatively hit as they will lose part of the wholesale payment business, in other scenarios their losses will be greater. Thus, we see scenario A as one in which the overall benefits for the economy will likely exceed the overall costs. And for that reason, we view it as a likely scenario.

We also consider it likely that a scenario in which CBDC is anonymous, universal and non-yield bearing will be implemented, at least if it coexists with physical cash. This scenario would, for example, create bigger efficiency gains for the economy as in this case the use of CBDC would not be restricted to only a few players, but cheaper and faster money transfers would be available to all. Moreover, it would also help to reduce informality. However, this scenario would require policy authorities to bear the costs of implementing and maintaining the CBDC. Moreover, the negative impact in banks would be higher than in scenario A as the money transfer business would practically disappear, (as the distributed ledger system will make intermediaries in this activity dispensable), and deposit funding for banks will be scarcer and more volatile. In this case, preventing a fall in credit will require the CB to take some compensatory measures.

Here it is worth noting that we view a scenario similar to B where cash is eliminated as less likely, mainly due to implementation costs, which would include the costs that the government would have to incur to provide every agent with at least internet access and some kind of connected device to access CBDC. Nonetheless, in this case society in general and banks in particular would benefit from the forced increase in bancarization.

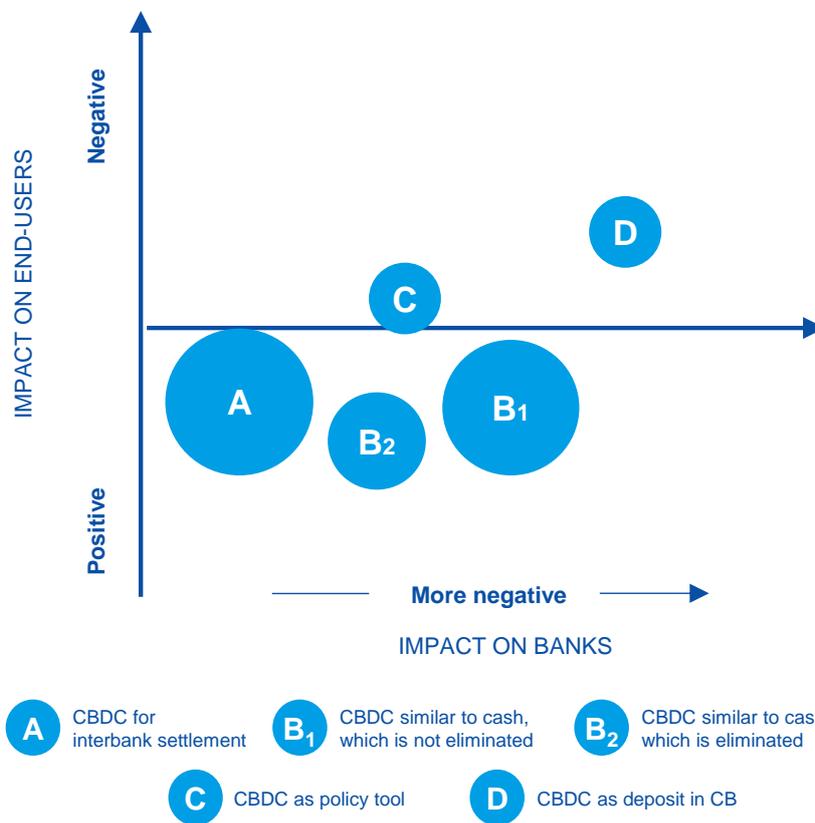
Although allowing CBDC to bear interest rates would make monetary policy more flexible, mainly because adopting negative rates would be a new possibility, this scenario would imply the elimination of cash and capital controls on other alternative currencies. Moreover, what would arise is the discussion about whether the CB has the legitimacy to charge negative rates, which to some extent is similar to imposing a generalized tax. We view scenario C as a less likely one, mainly due to these latter problems.

Finally, we see scenario D, in which a non-anonymous CBDC is adopted as also one that is less likely. This view builds on the perception that higher surveillance would in general not be welcomed by end users, and on the fact that credit will probably fall as the non-anonymity of CBDC will imply the adoption of a type of narrow-banking system. Anyway, we acknowledge that this scenario could arise in situations in which aversion to financial instability is particularly high, or when regulation is thought not to significantly reduce the likelihood of financial crises.

Assessing the exact effects of each scenario on each type of agents is a rather subjective task, but in an effort to summarize the main conclusions of our analysis we present Chart 6.1, which broadly illustrates our view about the probability and the impact of each scenario.

Chart 6.1

**Scenarios: impact and likelihood (size of the bubble represents the probability of each scenario)**



Source: BBVA Research

In this paper, we have analyzed what we consider are the main possible scenarios for CBDC as well as having explored their potential impact. In particular, we have studied some of the costs related to the introduction of CBDC. Even though we have recently heard some voices warning against the perils of moving in this direction, such as that of the ECB and BoE officials (see Broadbent (2016) and Mersch (2017)), in our view most of the opinions and of the literature about CBDC tend to overlook the negative consequences that the emergence of such a type of currency could have, especially on credit.

As a whole, our paper supports a strategy of gradual testing in which the adoption of less disruptive scenarios precedes the implementation of more complex schemes. Such a strategy would minimize potentially large disruptive costs to the current financial architecture and the temporal transformation of deposits, while ensuring efficiency gains linked to lower intermediation costs (especially in reference to the payment system), an eventual broadening of the policy scope and a reduction in informality, illicit activities and tax evasion.

Finally, we endorse the widespread view that additional research and debate is needed in order to understand CBDC and make it a good policy option for countries around the world. In this sense, we highlight some of the many issues that we think should deserve further attention: i) the quantification of the impact of CBDC in each scenario; ii) the extension of the analysis to consider the impact of CBDC on foreign countries and the interaction between CBDCs issued by different countries. In this regard, it is important to analyze what the implications for the global financial architecture would be, the existence or not of advantages for first-movers and followers, the consequences for local economic policy and for the banking system, etc.; iii) the analysis of the legal and institutional requirements needed to in each case provide the right incentives for all agents and minimize potential CBDC-related costs; iv) the analysis of money supply with CBDC, for example, to understand whether there is a case for a fixed money supply rule; etc.

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