



## Central Bank Digital Currency: A Primer

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*The author documents the benefits, costs, difficulties and risks associated with the potential implementation of a central bank digital currency (CBDC), whether on a wholesale basis, i.e. accessible to designated financial institutions, or on a retail, i.e. universally accessible, basis. He takes deliberately a perspective that is a euro area one and is more practical than that typically adopted in CBDC-related work. He looks first at the potential reasons for issuing a CBDC. He then considers technical and operational aspects. He refers to the legal framework as a third step. He eventually addresses the macroeconomic, monetary and financial consequences. Wherever appropriate, he draws a distinction between the wholesale and retail versions of CBDC, since it is possible to dissociate issuance of one type from the other. He concludes that the retail version, that has attracted most attention, is also the one that raises thornier issues and for which the need seems less pressing in developed economies.*

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\* This Policy Note is based on the author's report to the Banque de France (Pfister, 2020). The views expressed are those of the author and do not represent those of the Banque de France or the Eurosystem.

A central bank digital currency (CBDC) may be defined as an element of the monetary base that is traded at par against fiat currency and reserves, that only the central bank may issue or destroy, that is available 24/7, that may be used in peer-to-peer transactions and that circulates on digital media that are at least partially different from existing media (Pfister, 2019, 2020).

### Potential reasons for issuing a CBDC

In general, introducing a CBDC is warranted only if the expected social benefits outweigh the costs, which include the potential social costs linked to accelerated infrastructure obsolescence and staff training.

Potential benefits of issuing a *retail CBDC* would include:

- Ensuring universal access to central bank currency in digital form. In a situation where cash usage has declined significantly, as in Sweden, a retail CBDC could offer a public, risk-free alternative to private digital solutions. Issuance of a retail CBDC might also make it possible to avoid the distortions that could arise from an oligopoly, at the risk of excluding private undertakings, and prevent the operational risks linked to a solely “private” currency, while at the same time imposing a major security constraint on the central bank;
- Promoting the inclusion of vulnerable populations, such as disabled people, provided that access to the currency is sufficiently straightforward, e.g. via a mobile app;
- Lowering costs. An ECB study found that merchants bear half of the total cost of cash payments, or approximately 1% of GDP (Schmiedel *et al.*, 2012);
- Allowing hoarding, as already done by other central bank liabilities (banknotes and reserves);
- Responding to issuance of a CBDC by another central bank;
- Satisfying demand for anonymous transactions. In the case of a token-based retail CBDC (see below), anonymity could likely be guaranteed. Like cash, this CBDC would be a payment instrument that ensured privacy, subject to the risk of personal data capture in the event of hacking. However, anonymity would have the disadvantage of allowing unlawful activities to be funded up to such limits as may be set. Conversely, with an account-based retail CBDC (see below), it would be impossible to be anonymous, since all transactions would by construction be known to the account keeper. However the case may be, a retail CBDC would offer less anonymity than cash, since the latter can be used without going through an intermediary, while an account-based retail CBDC would circulate between accounts;
- Slowing the growth of cryptoassets and safeguarding monetary sovereignty, in the face of such initiatives as the Libra project. A native European solution could help preserve the EU’s full sovereignty in the area of transactions.

At present, there is no explicit demand in the European Union from market participants (payment services providers, merchants and users) for a retail CBDC. This situation reflects the characteristics of the European market, with high levels of access to banking services among consumers and businesses, and plentiful and diversified supply of cashless instruments, which is evolving to integrate the latest technological innovations. Meanwhile, in the financial sector, a number of European commercial banks have carried out initiatives to issue securities on a blockchain that could fuel demand for a wholesale CBDC: Société Générale, via its Forge start-up, Santander and Commerzbank in partnership with Deutsche Börse have issued tokens representing a new class of financial assets settled in commercial bank money.

The reasons for issuing a *wholesale CBDC* in this setting are typically as follows:

- Ensure that participants are able to exchange new classes of digital assets for currency units within a framework that keeps a distributed infrastructure operating approach and makes it possible to reduce the settlement costs and times arising at present from the existence of numerous intermediaries in the processing chain, while also ensuring transaction traceability;
- Provide the market with an asset whose value is strictly equivalent to that of other forms of currency issued by the central bank, that is exempt from any liquidity or credit risk, unlike stablecoins, and that can be moved through blockchain-type protocols.

A potential CBDC could also offer the following benefits:

- Reduce the frictions that block some transactions, particularly online (Engert and Fung, 2017);
- Promote competition in payment services, by facilitating the access of new participants to the payments market;
- Potentially make monetary policy more effective (see below);
- Support the euro's international role (see below).

### Technical and organisational aspects

General aspects are discussed, and then specific aspects connected to retail CDBC's and to blockchain-based infrastructure.

*General aspects* relate to the merits of a DLT-type infrastructure, security and pricing.

Regarding the merits of a DLT-type infrastructure, the main determining factor in whether to use DLT technology is the target use case:

- In a wholesale scenario, central banks already provide their financial sector with real-time settlement services through RTGS systems, which offer interbank settlement in central bank money. The only innovation would be the introduction of a CBDC through a blockchain, enabling end-to-end transactions in tokenised assets, including settlement;
- In a retail scenario, use of a blockchain could run up against users' technical capabilities or even their interest in acting as nodes in the system. For this reason, the retail model could use an electronic money type distribution approach handled either directly by the central bank or through one or more intermediaries, such as banks and public entities. However, blockchain technology could also be employed, notably in order to integrate smart contracts.

Regarding security, if blockchain-type infrastructures are standardised internationally, a process currently being taken forward by Technical Committee ISO/TC 307 of the International Organization for Standardization, special attention will have to be paid to compliance with the standards applicable to the establishment of such infrastructures. Standard-setting in relation to the IT security of DLT could involve liability issues. For example, a central bank could be held liable if it set standards that turned out to contain security loopholes. Similarly, if a central bank encouraged the use of DLT without making sure that it was governed by sufficiently reliable security standards – potentially set by a third party – the central bank might be exposed to legal action in the event of security problems arising from inadequate standards.

As regards pricing, issuance of a digital currency may be viewed through two complementary prisms:

- First, the long-term goal of the Eurosystem as market infrastructure operator is to ensure the fair recovery of its investment and management costs, without seeking to make additional profits;
- Second, the constraints resulting from competition law necessitate a specific analysis once the model is chosen.

*Specific aspects connected with a retail CBDC* relate to privacy and AML/CFT requirements, the forms a CBDC could take (token or account-based), and the distribution channels (direct or intermediated).

Privacy is a principle that must be upheld in the event that a retail CBDC is issued. The regulations applicable to data privacy, which are set down at the European level, form one of the pillars of this principle and must be strictly applied. Furthermore, a number of consumer protection rules, which add to the risks linked more generally to the legal liability of the issuing central bank, might also apply depending on the characteristics of the retail CBDC. They could cover such aspects as protection against risks of financial loss, protection against risks to user security, and equal user access to the retail CBDC. Whether these rules apply or not to central banks, it would seem risky for them to not voluntarily agree to a level of requirement equivalent to that provided by PSD2 (for example in the areas of data protection, fraud protection and transaction confidentiality) or more generally to the OECD principles on financial consumer protection.<sup>2</sup> The same goes for AML/CFT rules: not voluntarily applying rules equivalent to those applying to the private sector would create reputational risk for the Eurosystem, just as it would in consumer protection.

A retail CBDC could circulate in one of two forms:

- In token form, where digital currency units are linked to a physical medium, which may be, but does not have to be, dedicated (e.g. mobile phone, hard drive or payment card), and which characterises ownership. This case is most similar from a functional perspective to cash: the holder of the physical medium is the only one who can pay using units stored on the medium;
- Using an account-based model, where digital currency units are stored in an account linked to the holder and accessible online. In this case, payments are made from account to account and the issuer and the beneficiary must have an account denominated in the digital currency. Accounts could be held either directly by the central bank or with financial intermediaries.

Besides the technological model associated with the conditions under which digital currency units are held, the choice of distribution channel will also shape how a central bank might manage a retail CBDC. Two options look possible:

- A direct model, where no intermediaries are involved and central banks (CBs) themselves provide the digital currency to end users, thus obtaining a view over the currency's lifecycle, which will be an overall view in the case of account-based model, or restricted to loading/unloading transactions and to payments in online mode in the case of a token-based model;
- An intermediated model, where CBs use intermediaries to provide the digital currency to end users. In this model, control over the assets' lifecycle would be dependent on consolidating the information provided by

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<sup>2</sup> High-level principles on financial consumer protection developed by the OECD and endorsed by G20 finance ministers in October 2011.

intermediaries. For this, the level of granularity would need to be specified (for example, should the central bank have the identities of end users?).

The direct model certainly has the advantage of allowing the CB to retain full control of a large portion of the lifecycle of digital currency units. However, adopting this model would be severely restrictive for central banks, which are not used to dealing with so many counterparties, while their remit does not include monitoring retail transactions by all economic agents. Furthermore, transactions by holders of a retail CBDC would no longer be visible to payment services providers, which would lose access to information.

Establishment by the central bank of a *blockchain-based infrastructure* raises a set of technical and functional questions:

- Settings of the blockchain used to circulate digital currency units. In the case of a wholesale CBDC, the choice and number of blockchain participants would be determined by the central bank according to criteria that it has set (in the same way as happens for payment systems, for example). This would be compatible exclusively with a blockchain operating in private mode;
- Interaction with other blockchains. Smart contracts represent the most promising way forward in this area and are already being used to secure the issuance of tokens against cryptoassets in ICOs (Howell *et al.*, 2018). However, the ability to have the wholesale CBDC interact with other blockchains would entail two prerequisites. On the one hand, standards must be established so that the wholesale CBDC blockchain can communicate with blockchains it accepts as backings of the central bank's counterparties. On the other hand, smart contract templates approved by the central bank must be developed for the various categories of transactions proposed. Otherwise, only tokenised assets issued on the blockchain accepting the wholesale CBDC could be settled in CBDC;
- Potential circulation of the wholesale CBDC on several blockchains. Oversight by the central bank of this circulation would be complex and could have implications for financial stability and monetary policy transmission (see below) that are difficult to anticipate at this stage. Two different approaches could be taken to address this question:
  - The central bank puts itself in a position to issue wholesale CBDC units on any blockchain that can be used as a medium of exchange at its counters. This solution would be extremely complex to manage and would result in the central bank having to organise circulation of the wholesale CBDC on blockchains whose technology and governance framework are out of its control;
  - Units issued on the wholesale CBDC's native blockchain could be transferred to other blockchains. However, during circulation on secondary blockchains, entities exchanging these assets would not in principle be able to check their authenticity, integrity and uniqueness.

These two approaches raise difficulties and risks for the issuing central bank and are not necessarily compatible with the principle of a strictly wholesale application. They could notably lead to very widespread ownership of the CBDC among non-residents, in a potential retail scenario. Consequently, if the central bank wanted to avoid unregulated distribution of the wholesale CBDC, it could for example require participants in the blockchain accepting the wholesale CBDC to circulate the currency only within the original blockchain.

## The legal framework

Two questions are discussed here: could the ECB issue a CBDC? Should that currency be legal tender?

The European treaties do not provide expressly for the *possibility for the ECB to issue CBDC*. Unless it is considered simply as a technical procedure used to carry out the ECB's standard tasks, which would depend on the selected model, CBDC issuance would have to be integrated in the existing treaty provisions to avoid having to amend the legal texts.

If, however, it were necessary to amend the treaties, in principle this would have to be done through a new treaty, with the attendant difficulties linked to the need for unanimity and ratification processes in the Member States. Exceptionally, under a derogation in Article 129(3) of the Treaty on the Functioning of the European Union (TFEU), the Statute of the ESCB and of the ECB can be amended using the legislative procedure. However, the derogation is restricted to a limited number of Statute articles, including Article 17 on opening accounts, and authorises only marginal amendments to the content of the articles.

In a scenario involving CBDC issuance that goes beyond a mere technical procedure, two main options are available. First, TFEU Article 128 gives the ECB the right to authorise the issuance by the ECB and national central banks (NCBs) of banknotes within the Union and specifies that banknotes issued by the ECB and CBs shall be the only such notes to have legal tender status within the Union. One option, which would have a restrictive impact on the CBDC's characteristics, would therefore be to equate the CBDC to a digital form of banknotes so that the regime provided for by Article 128 could apply. This would mean that the CBDC would have to work in a very similar to the way that banknotes are used, which would correspond to the scenario of a non-remunerated retail CBDC. It is certainly true that the treaty's authors did not imagine that banknotes and coins might be in any form other than physical. However, the EUCJ could take account of a change in the situation (in this case, the rise of digitalisation) to accept that the interpretation of the Statute cannot remain static. Another and potentially complementary option would be to include CBDC issuance under one of the basic tasks of the ESCB set down by TFEU Article 127(2). For example, it could be by shown that such issuance had become necessary, given the rise of digitalisation, to maintain the ability to implement monetary policy – if for instance tokenised assets had to be accepted as collateral in monetary policy operations – or to promote the smooth operation of payment systems.

Regarding the issue of *legal tender*, as the law stands, only banknotes issued by the Eurosystem (TFEU Article 128) and coins (Article 11 of Council Regulation EC/974/98) are legal tender in the euro area. Assuming that it was possible, given the constraints detailed above, to introduce a retail CBDC that was equivalent to a digital form of banknotes, under TFEU Article 128, it would automatically benefit from legal tender status.

The consequences of the CBDC having legal tender status, i.e. the obligation to be accepted as payment, would not be neutral from a practical point of view, as payees would need to have the technological equipment required to receive a payment in CBDC, raising questions of equal access. In this regard, consideration should be given to the question of whether this might result in an obligation for the public authorities to provide such material resources to affected sections of the public (on the possibility of pricing access to public services, see above).

In the second option considered above, the CBDC would not have legal tender status in the strict sense of the word, i.e. with the obligation to be accepted as payment. However, if the ESCB undertakes to exchange its CBDC promptly with any holder of the currency, against other forms of currency, the security provided by this commitment must be perceived as equivalent to that offered by legal tender status, which would therefore become immaterial to the CBDC.

## Macroeconomic, monetary, financial and international consequences

Regarding *macroeconomic consequences*, issuance of a wholesale CBDC would stimulate the development of transactions in tokenised financial assets, help to boost financial sector productivity and promote innovation.

A retail CBDC would lead to more efficiency in retail transactions, in comparison with those done using coins and banknotes (see above). If it used a blockchain, a retail CBDC would also make it possible to integrate payment with the provision of good or service or with processes that are more complex, by means of smart contracts. This would allow companies to simplify invoicing and accounting follow-up processes, but also to shorten payment times. A CBDC would additionally be an alternative to standard electronic payments, such as credit transfers and bankcards, which could accelerate the decline in the rents earned by established operators, a trend that has already begun with the emergence of new players in the mobile payments market. Overall, a retail CBDC would represent a new payment instrument that could accentuate the positive effects of the increased role of electronic payments on consumption, commerce and activity.

Regarding *monetary policy consequences*, issuing a CBDC could affect the objective, implementation and transmission of monetary policy (Pfister, 2019, 2020).

As regards the objective, whether it is issued in a wholesale or a retail version, a CBDC could create a productivity shock in the financial system that would spread to the wider economy, exerting a temporarily deflationary impact.

As regards monetary policy implementation, the CBDC would have to be issued and exchanged at par with other forms of central bank money (banknotes and reserves) to avoid disrupting the fungibility of the monetary base.

To make the most of the benefits of using the blockchain, a wholesale CBDC should be able to be used 24/7 and on a peer-to-peer basis, i.e. without central bank intermediation, for real-time settlement. As a consequence, an intraday money market, i.e. transactions in wholesale CBDC at maturities of less than a day, would probably appear. This would raise the question of moving to real-time implementation of monetary policy (Pfister, 2018, 2019).

Issuance of a retail CBDC would probably expand the monetary base, and could profoundly change the pattern of demand for central bank money by making it more volatile. Switches between bank deposits and CBDC could occur in particular during times of financial crisis. Likewise, access by non-residents to a retail CBDC could fuel demand that is more volatile, notably by passing on confidence shocks affecting economies with less stable financial systems than that of the CBDC-issuing economy.

As regards monetary policy transmission, in the case of a wholesale CBDC, the consequences for monetary policy transmission look to be minor. A wholesale CBDC would form part of the monetary base just like banknotes and reserves and as such, the status of the wholesale CBDC could be defined relative to the minimum reserves, with remuneration determined on this basis. The simplest approach would be to consider the wholesale CBDC as being able to contribute towards meeting minimum reserve requirements, alongside reserves held by credit institutions. This would mean that remuneration could be differentiated for the portion of the wholesale CBDC counted in the minimum reserves, which would be remunerated at the main refinancing operations rate, and the portion that is not, which would be remunerated at the deposit facility rate.

The remuneration of a retail CBDC raises issues that are more difficult. Technical feasibility-related constraints primarily explain why reserves are remunerated<sup>3</sup> but banknotes and coins are not. This arrangement also allows banks to collect deposits at lower cost from the public, which does not have access to a remunerated investment that is both risk free and a payment instrument. Issuing a retail CBDC that is remunerated, could change this state of affairs. One advantage of remunerating a retail CBDC would be the possibility of transmitting monetary impulses faster and more efficiently, since the interest rate on the CBDC, which is a perfectly liquid and risk-free asset, would provide a floor for the interest rate on bank deposits. Remunerating a retail CBDC would also have negative impacts. For example, it could reduce the quantity of lending to the economy if it led to a significant increase in banks' funding costs and reduce also the Eurosystem's seigniorage revenue if this new form of money replaced existing cash. All in all, if a retail CBDC were remunerated, one option would be to do this at a slightly lower rate than the rate paid on excess reserves in order to (i) maintain a minimum margin for central banks to protect their seigniorage and hence their independence; (ii) avoid excessive competition with commercial banks.

Not remunerating a retail CBDC could impact the effective lower bound for interest rates. As pointed out by Armelius *et al.* (2018), a non-remunerated retail CBDC would offer banks and depositors alike an easy way to get round negative interest rates. It could also limit the impact of asset purchases because having a zero rate instrument available at any time in the future would place a zero bound on forward rates.

As regards *financial consequences*, the banking system would be especially affected by the issuance of a CBDC. Beyond that, the question arises of the impact on financial stability.

The risk that a retail CBDC could substitute for bank deposits could lead banks (i) to increase the remuneration of bank deposits (ii) seek other funding sources.

Pfister (2017) and Bindseil (2020) consider the effects of substituting a CBDC for bank deposits and banknotes on the balance sheets of different financial institutions. The substitution effect depends on the CBDC's characteristics and implementation procedures. Bindseil (2020) considers only a retail CBDC, while Pfister (2017) considers various issuance scenarios ranging from a narrow framework in which only banks have access to the CBDC, to a broader framework in which the public has access to the currency in remunerated or non-remunerated form.

In a situation where demand for a retail CBDC is very high, leading to the creation of a substantial structural liquidity deficit in the banking system, institutions will have to have a sufficient collateral pool, amid scarcity linked to regulatory requirements and increased demand for collateral in interbank and clearing transactions. The experience of the euro area crisis showed however that the Eurosystem's collateral management framework offers considerable flexibility.

Regarding the impact on financial stability, issuance of a retail CBDC could compromise financial stability through transfers of bank deposit funds to the retail CBDC in times of crisis. In other words, the retail CBDC could facilitate bank runs. However, it could be that the threat of more frequent runs might actually encourage banks to adopt a more cautious approach from the outset. Similarly, if the central bank were to become banks' main depositor following a large increase in retail CBDC at the expense of bank deposits, the risk of deposit flight based solely on a rumour would be reduced, since a central bank is not sensitive to rumours. To limit the risk of a run, proposals have been made to set maximum amounts for retail CBDC holdings (Mancini-Griffoli *et al.*, 2018), to remunerate the retail CBDC at a tiered rate according to the amount held (Bindseil, 2020) or to apply fees to

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<sup>3</sup> Minimum reserves are remunerated to offset the taxation effect imposed on the banking system. Banknotes, except in their original form of promissory notes, do not bear interest.

converting bank deposits and banknotes to retail CBDC (Mancini-Griffoli *et al.*, 2018; Bordo and Levin, 2019). These proposed administrative arrangements could be circumvented, however, with straw men for example, and could even lead in the event of a crisis to the formation of an exchange rate between the retail CBDC and banknotes, on the one hand, and bank money on the other.

Furthermore, whether the retail CBDC is distributed directly by central banks or whether intermediaries are involved, the use of central bank money eliminates any liquidity or counterparty risk and can be made available under most situations. For this reason, even if runs were to become more frequent following issuance of a retail CBDC, the economy would be better sheltered against them.

As regards the *international consequences*, issuance of a wholesale CBDC could strengthen the euro's international role if it promoted the development of a digital ecosystem in euros (see above) and if non-residents had access to it. It might even be that the first major country to issue this type of currency would enjoy a lasting first-mover advantage. This might also be true if a retail CBDC was accessible to and used by non-residents, although the scale might be smaller. Conversely, keeping the status quo might mean allowing private initiatives, such as JPM Coin, to satisfy demand for a high-calibre digital currency and, in so doing, support and even increase the dollar's domineering influence.

## Conclusion

Both in media and in academic discussions, it is the retail version of CBDC that has attracted most attention whereas there is no clear demand for it from the public. In contrast, most of the work in the finance industry has focused on the use of DLT for the processing of wholesale transactions and the related need for a final means of settlement on the blockchain. Furthermore, with the exception of international transfers, retail payments can be considered as very efficient nowadays in developed economies. Finally, as explained in this note, the issues raised by the retail version of CBDC are much more complex and difficult to anticipate than those raised by the wholesale version. Perhaps, one reason to explain that paradox is that the possibility for payment service providers to issue digital versions of deposits (Pfister, 2017) has been overlooked. In what has been presented as "synthetic CBDC" (Adrian and Mancini-Griffoli, 2019) or "indirect CBDC" (Auer and Böhme, 2020), such "stablecoins" could be backed by reserves or wholesale CBDC and act as close substitutes for a retail CBDC (Melachrinou and Pfister, 2020).

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