

## CENTRAL BANK DIGITAL CURRENCY

Summary.....	2
1 Potential reasons for issuing a CBDC.....	4
1.1 Cash-related aspects .....	4
1.1.1 Reasons for issuing a retail CBDC .....	4
1.1.2 Would a retail CBDC be a substitute for or complement cash in circulation? .....	8
1.2 Payment aspects.....	10
2 Technical and organisational aspects.....	18
2.1 At the launch stage.....	18
2.1.1 General aspects .....	18
2.1.2 Specific aspects connected with a retail CBDC.....	19
2.1.3 Specific aspects relating to blockchain use .....	27
2.2 Under a permanent regime.....	29
3 The legal framework.....	30
3.1 Could the ECB issue a CBDC?.....	30
3.2 The question of legal tender .....	31
<b>4 Macroeconomic, monetary and financial consequences .....</b>	<b>32</b>
4.2 Monetary policy consequences.....	33
4.2.1 The objective of monetary policy and the money/inflation relationship .....	33
4.2.2 Monetary policy implementation.....	34
4.2.3 Monetary policy transmission .....	34
4.3 Impact on the financial system .....	37
4.3.1. Impact on the banking system .....	37
4.3.2. Impact on financial stability .....	39
References.....	43

## Summary

This document reports on the work done by an internal Banque de France central bank digital currency (CBDC) taskforce led by Christian Pfister.<sup>1</sup> The taskforce's objective was to document the benefits, costs, difficulties and risks associated with the potential implementation of a CBDC, whether on a wholesale basis, i.e. accessible to financial institutions or to designated financial institutions, or on a retail, i.e. universally accessible, basis. The group deliberately took a more operational perspective than that typically adopted in CBDC-related work, much of which has been driven by theoretical approaches. Part One of the report looks at the potential reasons for issuing a CBDC, Part Two considers technical and operational aspects, Part Three deals with the legal framework, while Part Four addresses the macroeconomic, monetary and financial consequences. Wherever appropriate, a distinction is drawn between the wholesale and retail versions of CBDC, since it is possible to dissociate issuance of one type from the other.

A CBDC may be defined as a digital asset that only the central bank may issue or destroy, that is traded at par against banknotes and reserves, 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. In general, introducing a CBDC is warranted only if the expected social benefits outweigh the costs. The primary reason for issuing a CBDC would be to offer a perfectly liquid and safe payment instrument that is adapted to technological changes. Within the framework of the Eurosystem, which has sole authorisation to issue a CBDC in the euro area, a European solution is thus proposed that would be capable of preserving the European Union's (EU) sovereignty in transactions while being independent of private or foreign participants. In the case of a wholesale CBDC, this solution could be employed to carry out end-to-end transactions, including final settlement, using assets that are tokenised on a blockchain. This would stimulate innovation and productivity in the financial sector. A retail CBDC would primarily make it possible to lower the social costs of retail payments while ensuring universal access to central bank money in a digital form that would act as a complement to fiat currency.

In terms of technical and operational aspects, CBDC issuance would have to meet the strictest security objectives. To satisfy level playing field requirements, use of the CBDC would likely have to be priced. In the case of a wholesale CBDC, the only social benefit would come through use of the blockchain, since institutions already have digital assets through reserves. With a retail application, use of the blockchain could run up against users' technical capabilities or even their interest in acting as nodes in the system. A retail CBDC could therefore be merely an electronic currency issued by the central bank, but a blockchain would have to be used if the central bank wanted to integrate smart contracts. Use of a retail CBDC would have to comply with data privacy as well as anti-money laundering and combatting the financing of terrorists (AML/CFT) requirements. More flexible than a token-based approach, in which the CBDC is linked to a physical medium characterising ownership, an account-based model would offer better results for a retail CBDC. However, it might also lead to a greater loss of resources for banks than a token-based model, which would be closer to the concept of a retail CBDC that is merely a digital complement to banknotes. Whichever circulation approach is used, a

---

<sup>1</sup> This document reflects the views of the authors and not those of the Banque de France or the Eurosystem. Taskforce contributors included David Adam (DGSO-DSF), Adeline Bachelier (DGSO-DSPM), Jean Barthélémy (DGSEI-DSMF), Jérôme Coffinet (DIMOS), Bertrand Couillault (SGACPR-DE), Yolaine Fisher (DSJ), Natacha Isslame-Rocher (DGSO-DMPM), Julien Lasalle (DGSO-DSPM), Andrés Lopez-Vernaza (Oi-DIGIT), Clément Martin (DGSO-DSF), Emmanuelle Politronacci-Stephanopoli (DGSER-DAF) and Lionel Potier (DGSEI-DEMS).

retail CBDC could be distributed via intermediaries, as is done already with banknotes, making it possible to tap into the experience of these intermediaries in Know Your Customer (KYC) and AML/CFT aspects. In the case of a wholesale CBDC, transactions in the currency would be approved by participants, potentially in the absence of the central bank, which would however have full traceability of all transactions. A wholesale CBDC would have to be remunerated to safeguard the unity of the monetary base, the simplest solution being to apply the same treatment as for reserves, while a retail CBDC could be exempt, as fiat currency is. Conversely, a retail CBDC would have to be accessible to non-residents, as legal tender already is in the form of fiat currency or bank money, while a wholesale CBDC could be accessible. This would increase the technical and operational challenges involved in setting up a retail CBDC while meeting security requirements and complying with the regulations mentioned above.

From a legal standpoint, the European treaties do not provide expressly for the ECB to issue CBDC. Unless it is considered simply as a technical procedure used to carry out the ECB's standard tasks, CBDC issuance would need to be integrated in existing treaty provisions to avoid having to amend the legal texts. Then there is the question of whether the CBDC should be legal tender. As the law stands, only banknotes issued by the Eurosystem and coins are considered to have legal tender status in the euro area. If a retail CBDC that is considered to be equivalent to a digital form of banknote is introduced, it would therefore be legal tender. Alternatively, if the European System of Central Banks (ESCB) undertakes to exchange CBDC promptly against fiat currency with any CBDC holder, the security provided by this commitment must be perceived as being equivalent to that offered by legal tender. However the case may be, in a society where cash usage has become marginal, a retail CBDC with legal tender status or covered by the exchange commitment mentioned above would make it possible to maintain the linkage between public and private money by guaranteeing the obligatory conversion of the latter to the former. It would thus help to maintain confidence in the financial system.

As regards the macroeconomic, monetary and financial consequences, issuance of CBDC should make it possible to lower transaction costs, both using more efficient technology and through increased competition in the payments market. This should spur increased productivity and innovation in the financial services sector and in the wider economy, leading to temporarily higher economic growth. It would also boost the euro's appeal and international role, especially if the euro area moves sufficiently early in issuing its CBDC. Owing to the increased productivity brought about by issuing a CBDC, inflation might be temporarily curbed somewhat. Most importantly, the risk that bank money could be crowded out by a retail CBDC, which is a key difference between a wholesale and a retail CBDC, should be carefully assessed. Changes in CBDC holdings at times when the central bank is closed should lead to the formation of an intraday wholesale CBDC market. Issuance of a retail CBDC would probably expand the monetary base and could make monetary-base demand more volatile. Unless distortionary holding caps are imposed, non-remuneration of a retail CBDC would cause the effective lower bound on interest rates to be raised to zero as, by holding the retail CBDC, institutions could avoid negative interest rates much more easily than they can today by holding banknotes. A retail CBDC could be remunerated at the deposit facility rate or at a slightly lower rate. This would allow monetary policy rates to pass through to lending rates more swiftly but might also lead to reduced profitability in the banking sector. Finally, a retail CBDC might be accompanied by more frequent bank runs, but by providing a payment instrument that is perfectly safe at all times, it would also help to shield the economy from financial crises.

\*

\* \*

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. Part One of the report looks at the potential reasons for issuing a CBDC, Part Two considers technical and operational aspects, Part Three deals with the legal framework, while Part Four addresses the macroeconomic, monetary and financial consequences. Wherever appropriate, a distinction is drawn between wholesale, i.e. accessible to financial institutions or to designated financial institutions, and retail, i.e. universally accessible, versions of CBDC, since it is possible to dissociate issuance of one type from the other.

## **1 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. Cash-related aspects (1.1) are addressed separately from payment-related aspects (1.2).

### **1.1 Cash-related aspects**

A CBDC playing a fiat role like notes and coins would be a retail CBDC. The reasons for introducing such a currency are addressed first (1.1.1) followed by a discussion of its role as a substitute for or complement to fiat currency (1.1.2).

#### **1.1.1 Reasons for issuing a retail CBDC**

Unless otherwise indicated, the following discussion assumes a retail CBDC that does not bear interest for the holder and is without prejudice to technology choices.

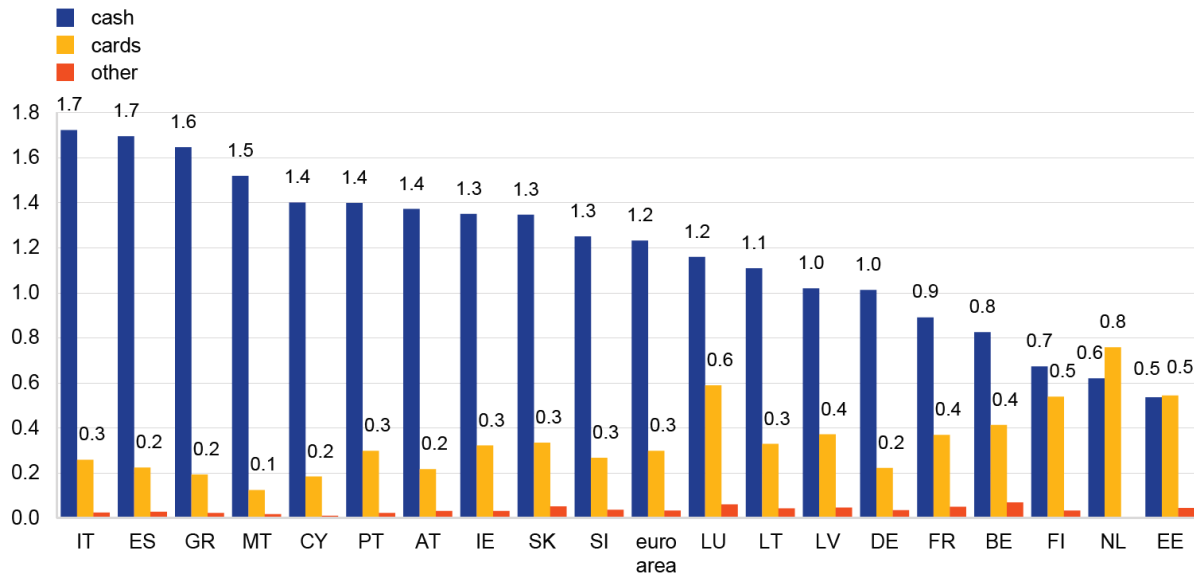
##### *(i) Ensure universal access to central bank currency in digital form*

The first advantage of a retail CBDC is that it is a central bank currency and thus has the same benefits as cash: compared with cashless payment methods, a retail CBDC is a perfectly liquid and safe payment instrument.

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. A decline in cash leading eventually to its disappearance does not look like a credible scenario for the euro area in the foreseeable future.

### Chart: Use of payment instruments by consumers in Europe

Average number of transactions per person per day, by payment instrument



Source: European Central Bank, 2016

A retail CBDC could also provide a way to promote the inclusion of vulnerable populations, such as disabled people, provided that access to the currency is sufficiently straightforward, e.g. via a mobile app. This central bank money-based payment solution would compete with commercial solutions.

#### (ii) Lower costs

With banknote and coin processing flows on the decline, the cost of cash management is a major economic issue for all cash cycle stakeholders. The Eurosystem’s 2018 qualitative survey of a selection of banks, merchants and cash transportation companies identified the main cost centres for the cash industry (transportation and sorting of banknotes and coins) (ECB, 2019). An older ECB study found that merchants bear half of the total cost of cash payments, or approximately 1% of GDP (ECB, 2012). The same study, however, assessed the average unit cost of cash payments at EUR 0.42, making cash the least costly payment instrument. France’s Banking Federation estimates the net cost to the banking sector of cash management at approximately EUR 2 billion a year.<sup>2</sup> The costs involved in developing and managing the circulation of a CBDC should be considerably lower than those connected with cash, for the central bank and the banking sector alike.

From the consumer’s perspective, a retail CBDC should make it possible to lower the costs resulting from the time spent getting to a cash delivery point, withdrawing money and then using it to make payments (Engert and Fung, 2017). Admittedly, the last of these stages is not terribly time-consuming: the Bundesbank, for example, has released a study that estimates the time taken to make a cash payment at 22 seconds, or 7 seconds less than a payment using a contact smart card (Cabinakova et

<sup>2</sup> The overall cost breaks down as follows: human resources 40%, outsourced services 24%, materials 14%, security 11%, information system 7%, and property 5%. These data were collected in May 2019 as part of work undertaken by the Banque de France in partnership with the Ministry for the Economy with a view to developing a national cash management policy.

al., 2019). A retail CBDC could help to shorten this time if it was stored on a card or a mobile app, depending on the terms for initiating transactions. Since use of a systematic authentication or authorisation method is by definition more time-consuming, a token-based solution, also referred to as a value-based solution, would be better able to address the need for speed than an account-based approach (3.1.2). Last but not least, compared with cash, a retail CBDC should lower the risks of error, loss or theft.

*(iii) Allow hoarding*

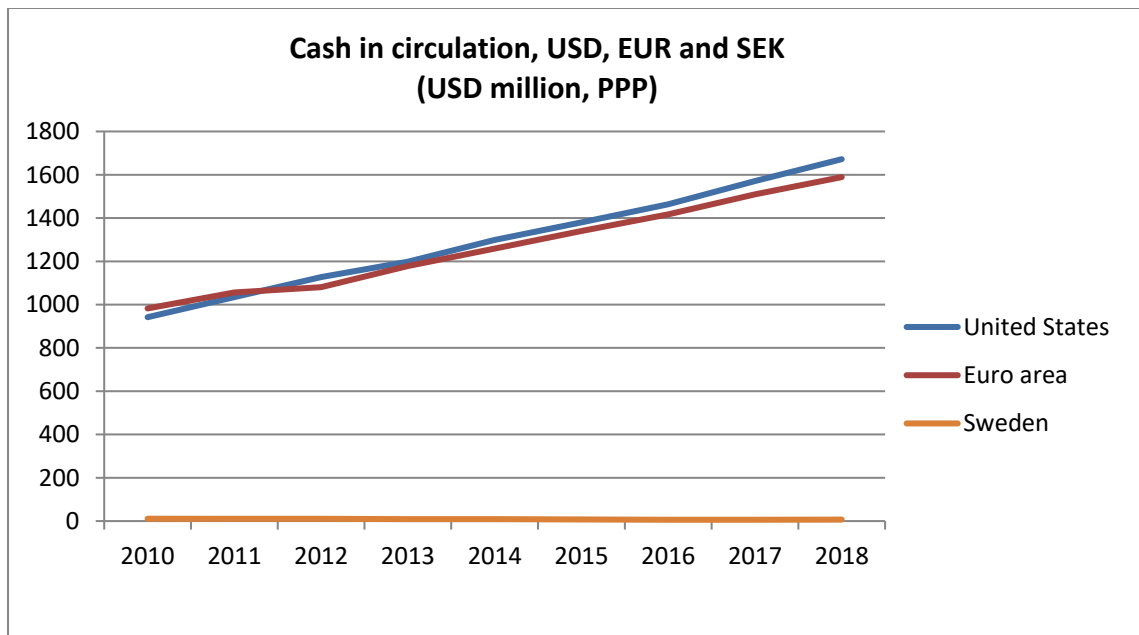
Hoarding is hard to measure, as illustrated by the difference between the ECB's aggregate estimate (45%) and consumer survey data. In the SUCH survey by the ECB in 2016 on cash usage by euro area households, just 24% of respondents said that they kept precautionary cash reserves (Esselink and Hernandez, 2017). It has however been shown that demand for banknotes increases sharply during natural or financial crises (Fung, 2019). The same is therefore expected to apply to a retail CBDC. Moreover, hoarding-related demand for a retail CBDC could partially replace demand for fiat currency (see below), a large portion of which is hoarded, with the ECB estimating that euro area residents keep 45% of cash in circulation as a store of value. It is thus important to assess whether a CBDC could perform this function (2.1.2).

*(iv) Respond to issuance of a CBDC by another central bank*

The Eurosystem's motives for issuance might differ depending on the size of the issuing central bank:

- In the case of a central bank that is very different from the Eurosystem, whether in terms of size or location, the issue would primarily be a reputational one (ECB, 2018), with the Eurosystem seeking to maintain its technological advance in financial innovation in the payments sector;
- In the case of a central bank that is close to the Eurosystem and assuming that the retail CBDC issued is available internationally (4.2.2), the main aim would be to prevent the risk of competition between currencies. This would be achieved by addressing the difference in the range of payment solutions offered by the central bank and the potential consequences for the euro area payments market (potential substitution for domestic payment instruments). This would especially be the case if currency risk is lowered because the foreign currency in question is pegged to the euro. Given the headway made by the Riksbank, the central bank of an EU member state, on the question of an e-krona, this is a credible scenario. However, the risk of substitution for the euro remains highly hypothetical at this stage insofar as issuance volumes for the Swedish krona are not comparable to those of the euro or dollar, as the chart below shows.

Note that in most monetary areas, including the euro area, the use of foreign currencies between residents is not prohibited.



Source: European Central Bank, Federal Reserve Board and Sveriges Riksbank

*(v) Satisfy demand for anonymous transactions*

In the case of a value-based retail CBDC (3.1.2), 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 (3.1.2), it would be impossible to be anonymous, since all transactions would by construction be known to the account keeper (Shirai, 2019). 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.

*(vi) Slow the growth of cryptoassets and safeguard monetary sovereignty*

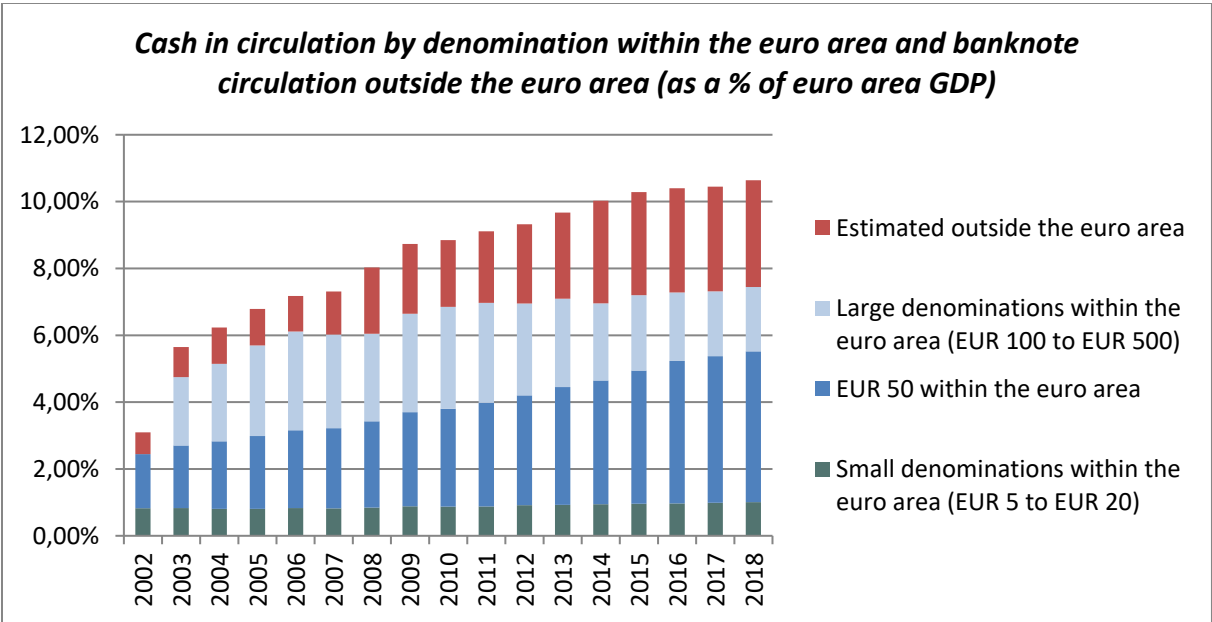
A retail CBDC could be issued to stem the growth of cryptoassets. In their “traditional” format of units issued on public blockchains, cryptoassets pose numerous risks, including high volatility, elevated operational risk and liquidity risk. (Agur, 2018). Yanagawa and Yamakoa (2019) suggest that a CBDC could discourage speculation in cryptoassets, which would become less attractive in comparison with a retail CBDC offering the advantage of being a true payment instrument. Some of these risks can be mitigated by issuing stablecoins. However, in many instances, risk mitigation is merely limited or just surface deep (Berentsen and Schär, 2019). In particular, stablecoins with a global reach raise specific risks relating to AML/CFT, consumer and investor protection, monetary policy, financial stability, competition and, ultimately, monetary sovereignty (Group of Seven, 2019).

Yet a retail CBDC would only partially address the issues driving stablecoin initiatives such as Libra, namely the deficiencies of mechanisms handling cross-border payments, which typically involve two different currencies, and low levels of financial inclusion in some parts of the world (Box: Two stablecoin initiatives). Regarding the second issue, there is not much room to improve financial inclusion in Europe, given the high levels already reached. Cross-border payments, meanwhile, have

mushroomed since the early 1990s, particularly in connection with fund transfers, but there is currently no solution combining low costs and risks with high execution speeds. A retail CBDC would not resolve risks relating to KYC security and AML/CFT implementation, which contribute to long execution times and, along with liquidity costs, to high costs. In Europe in particular, priority issues include addressing the fragmentation of European payment solutions and strengthening payment sovereignty (including the question of customer data use). An initiative by European banks, spearheaded by France, has been launched to respond to this challenge and, if a retail CBDC were to be issued in the euro area, steps would need to be taken to ensure that the two initiatives were compatible. Conversely, in countries where few people have bank accounts but where modern communication resources such as smartphones are available, issuing a CBDC could help to promote financial inclusion and accelerate the importance of financial markets in these economies, while also allowing them to maintain their monetary sovereignty in the face of global stablecoin initiatives (Group of Seven, 2019).

1.1.2 Would a retail CBDC be a substitute for or complement cash in circulation?

The degree to which issuance of a retail CBDC affects demand for cash will depend on the size of demand for the CBDC but also on the digital currency’s ability to substitute for cash. Substitutability in turn depends on the reasons underpinning demand and notably on the proportion of international demand. The ECB estimates that, in terms of value, approximately 30% of euro banknotes are held outside the euro area (see chart). High-denomination notes, i.e. from EUR 100 to EUR 500, are the most likely to be held abroad. Even though the EUR 500 note is no longer issued – a move that was announced in May 2016 and became effective at the end of April 2019 – it still makes up a significant share of euro circulation, at around 20% at end-May 2019.



Source: European Central Bank

(i) Substitute for cash demand outside the euro area

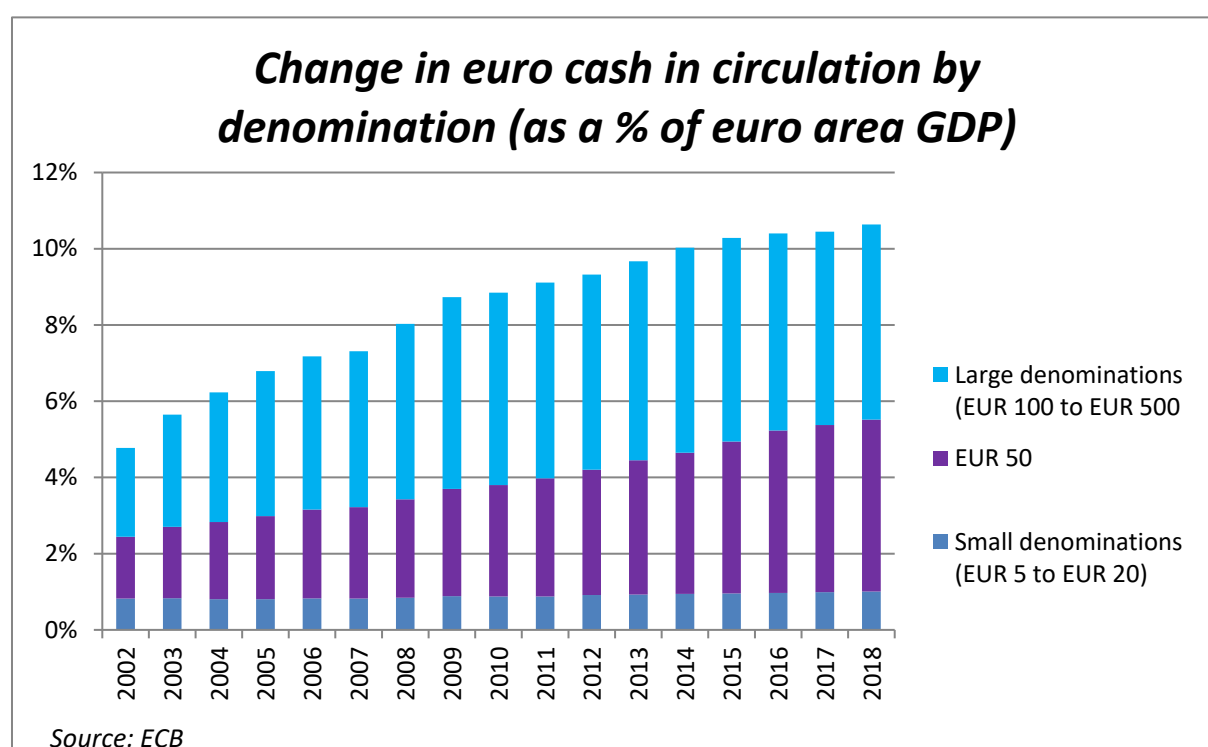
Substitution depends on the underlying reasons why non-residents hold euro banknotes:



- Citizens of neighbouring countries hold euro cash for precautionary reasons. In Romania, Bulgaria and Serbia, for example, a large portion of domestic savings is held in euro banknotes (ECB, 2017). These countries could see a trend towards substitution of digital euro for cash;
- It is doubtful whether people who hold cash in order to carry out unlawful international transactions would be attracted to a retail CBDC that was not anonymous above a certain amount (Judson, 2018).

*(ii) Substitute for domestic demand for high-denomination banknotes*

A distinction needs to be drawn between domestic demand for high-denomination banknotes, which are primarily held for hoarding purposes, and demand for small and medium denominations, which are used for transactions. High-denomination banknotes account for one-half of euro currency in circulation (see chart): it is therefore important to consider how a retail CBDC might impact these holdings.



Source: European Central Bank

Given the lack of in-depth literature on this question, several scenarios may be considered:

- If demand is driven by a desire for confidentiality or unlawful activities, substitution for cash demand will be weak;
- In a situation of demand during a crisis, substitution would likely take place essentially at the expense of bank deposits rather than banknotes;
- In a situation of demand in a negative interest rate environment, the substitution effect would likely be extremely significant, as the costs of holding the retail CBDC (security, storage, use) would be considerably lower than those associated with cash (4.2.3).

*(iii) Substitute for domestic demand for small and medium denominations*

There might be some demand for a retail CBDC for use in transaction purposes. However, there is limited research on this point.

In France, cash usage is heavily concentrated in small-value purchases, with the lowest average value in the euro area (Bounie *et al.*, 2018). Some substitution might be seen in this segment as the CBDC competes with cash and contactless payments (Engert and Fung, 2017). This substitution could vary depending, for example, on:

- The characteristics of the retail CBDC, e.g. whether it could be used for person-to-person payments, as is very likely to be the case (3.1.2);
- Point of sale (POS) equipment, e.g. whether POS adopt the technology needed to accept the retail CBDC. This would be greatly facilitated by the possibility of integration in existing equipment, which is something that the Riksbank is working towards for its e-krona (3.1.2).

Given the inertia of payment habits among certain demographic groups, demand for cash as a payment instrument is likely to be maintained over the foreseeable future. Accordingly, the sum of the value of banknotes in circulation and a potential retail CBDC is likely to be higher than the amount of cash in circulation when the retail CBDC is launched (Engert and Fung, 2017). An article from the Sveriges Riksbank's economic review says that transaction demand for the e-krona could be close to demand for cash, at around 1% to 2% of GDP (Segendorf, 2018).

*(iv) What is the likely scale of substitution?*

When considering this question, one avenue is to look at the pace at which deposits have replaced cash in recent decades. In the Netherlands, for example, Boeschoten (1992) found that the adoption of deposit accounts led to a 40% decline between 1965 and 1975 in currency in circulation as a share of GDP. In France, the share of cash in M1 fell by half between 1965 (38%) and 1980 (18.2%), while the value of FRF banknotes in circulation doubled, and the value of sight deposits increased fivefold.

Given the role played by the share of large denominations in cash in circulation, behavioural inertia and the respective characteristics of banknotes and a retail CBDC, a digital currency is likely to act as a complement in the short/medium term, but may be a substitute over the long run.

## 1.2 Payment aspects

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:

- High levels of access to banking services among consumers and businesses;
- Plentiful and diversified, if fragmented, supply of cashless instruments, which is evolving to integrate the latest technological innovations. Payment services providers, for example, have gradually expanded their product and service ranges in the areas of mobile banking, mobile payments using various technologies (NFC, QR-code, P2P payments), and, more recently, instant

payments. All of these innovative payment solutions are private sector initiatives and generally rely on commercial bank money;

- The payments sector is governed by European regulations, both at the level of payment services (PSD2 and EMD2, MiFID and SEPA regulations) and infrastructure (finality directive, SIPS regulation), which provide uniform Union-wide operating procedures and rules as well as oversight mechanisms (surveillance and supervision) that greatly reduce risk;
- Payment systems are mostly connected, as exogenous systems, to the Eurosystem's real-time gross settlement (RTGS) system, Target2, which settles transactions in central bank money in accordance with the *Principles for financial market infrastructures* (BIS/OICV-IOSCO, 2012);
- Regulatory measures have been introduced to the procedures for managing electronic payment instruments in order to cap the amount of certain fees (European Regulation on Interchange Fees) and foster competition between payment services providers. Accordingly, the rise of payment initiation services and mobile payment solutions based on instant SEPA credit transfers is expected to lead to growing use of credit transfers as an alternative to the main solutions now, namely payment cards and private electronic money schemes such as Paypal and Lydia. The example of German-speaking countries, with the development of payment initiation service SoFort in e-commerce and massive use of SEPA direct debits in face-to-face payments, may signal greater competition ahead in the payments acquisition segment, with an attendant decline in the fees charged to merchants.

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. These initiatives have created a climate conducive to experimentation by central banks, particularly the Banque de France (Box: Trials carried out by the Banque de France within the framework of the Eurosystem).

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

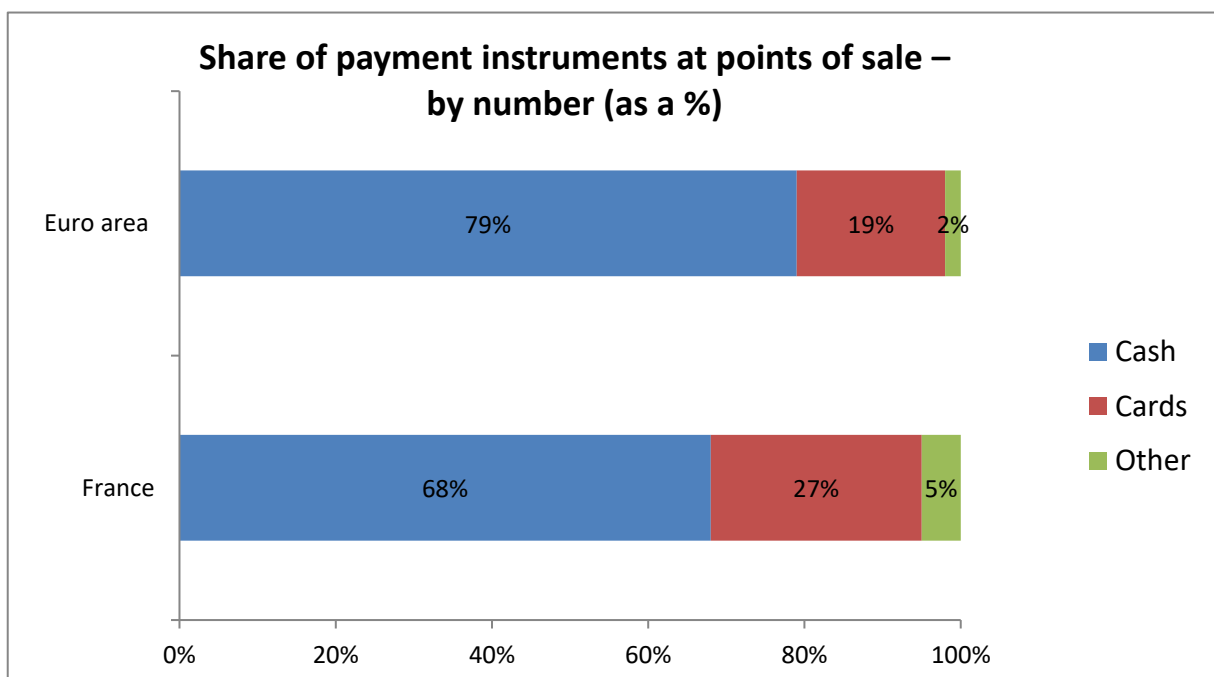
- Ensure that participants are able to exchange new classes of digital assets for currency units within a framework that keeps a distributed infrastructure operating approach and makes it possible, using a distributed infrastructure rationale, to reduce the settlement costs and times arising at present 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 (Box: Two examples of stablecoins) and that can be moved through blockchain-type protocols.

A potential CBDC could offer the following benefits:

- Open up avenues for modernising market infrastructures, including the settlement portion handled by Target2, with blockchain/distributed ledger technology employing a wholesale CBDC, thus preventing the disorderly tokenisation of infrastructures. One of the main applications would be to allow central banks to provide a solution to settle transfers of tokenised securities that maintains both the benefits of the DLT environment (peer-to-peer,

fast execution, shared record) and use of central bank money (like standard securities settlement systems such as Target2 Securities);

- Keep step with declining cash use by offering a retail CBDC that can provide an alternative to cashless payment solutions managed by PSPs and that would be equivalent to a direct claim on the central bank or to a form of direct value ownership, like banknotes;
- Reduce the frictions that block some transactions, particularly online. Some consumers who do not shop online for a variety of reasons, such as a fear of hacking or a desire to avoid private data being used for commercial purposes, might be reassured by a retail CBDC (Engert and Fung, 2017), for example because the central bank would not use transaction data for commercial purposes;
- Promote competition in payment services, by facilitating the access of new participants to the payments market: for example, non-bank PSPs might take part in the intermediated provision of a retail CBDC (Barrdear and Kumhof, 2016);



Source: ECB, SUCH data (2016)

- Propose, through the issuance of a wholesale or retail CBDC, a native European solution that can preserve the EU's full sovereignty in the area of transactions and that is independent of private or foreign participants' interests. This could be welcome whereas the European payments market remains largely dominated by outside participants (notably VISA and MasterCard for cross-border payments within the EU) and currently becomes a target for international internet giants, including America's GAFAM<sup>3</sup> and China's BATX.<sup>4</sup> For example, Google Payment, Amazon and Facebook have obtained licences to operate as electronic money institutions in the European Union as they grow their services in the area of payments and peer-to-peer transfers via online messaging services and mobile apps;
- Support the euro's international role (4.3.3);

<sup>3</sup> Google, Amazon, Facebook, Apple and Microsoft.

<sup>4</sup> Baidu, AliBaba (Alipay), Tencent (WeChat) and XiaoMi.

- Potentially make monetary policy more effective (4.2).

#### Box: Trials carried out by the Banque de France within the framework of the Eurosystem

The many private initiatives being conducted around the world and particularly in Europe aimed at enabling the settlement/delivery of entirely digital assets (securities and cash legs) are prompting central banks to do bold and methodical work on the opportunities opened up by technological innovation. As part of this, they are looking at the potential benefits of creating new digital forms of central bank money.

On 4 December 2019, the Governor of the Banque de France announced the launch of CBDC trials involving private-sector innovators from the French financial community. The trials will focus on the possibility of integrating a wholesale CBDC in innovative procedures for the exchange and settlement of tokenised financial assets. To this end, the Banque de France will put out a call for projects by the end of the first quarter of 2020. This initiative will fuel discussions being taken forward within the Eurosystem, including research on the potential e-euro mentioned by Christine Lagarde before the European Parliament.

The Banque de France's work forms part of trials involving new DLT-type technologies carried out by central banks in recent years. The joint ECB/BoJ Stella project looks at DLT's potential uses in financial market infrastructures, while the Ubin project by the Monetary Authority of Singapore (MAS) and the Bank of Canada's Jasper initiative are specifically interested in the technology's potential in large-value payments.

The goal of the Banque de France's trials is to examine the benefits of a CBDC, while avoiding the potential negative externalities linked to issuing a CBDC. Specifically, the aim is to ensure that a potential CBDC as a settlement asset could at least equal the conditions under which cash and securities resources are used in Target2-securities in Europe. As regards the risks, the aim is to conduct a close study of impacts in the areas of market infrastructure, financial stability, monetary policy (Part Four) and regulations, keeping in mind that the role of central banks is to maintain the confidence needed to foster innovation.

The Eurosystem will have final say over any decision to set up a CBDC.

#### Box: CBDC Initiatives. Examples from Sweden and China

##### Sweden's e-krona initiative

Sweden has seen a pronounced, long-run decline in demand for cash, as illustrated by a few key numbers:

- Currency in circulation has fallen markedly in the last decade, contracting by more than half between 2008 and 2018;
- Merchants are less accepting of cash: in 2018, more than 50% of consumers had encountered a merchant that did not accept cash payments (up from 30% in 2014) and 50% of merchants were planning to stop accepting them by 2025. This is not considered to be inconsistent with Swedish law and the principle of legal tender provided that a posted message informs the

consumer of this, insofar as the choice of payment method is then covered by the contract governing the relation between merchant and consumer. Only in the specific case of vital goods and services, such as medicines for example, could a refusal to accept cash be challenged.

The Riksbank has noted a rapid trend towards substitution as cash is replaced by electronic solutions, led primarily by cards (especially VISA), notwithstanding the swift growth of Swish, an instant payment solution.

In this setting, the Riksbank's discussions around the concept of a CBDC are focused on maintaining public access to central bank money with a view to managing counterparty risk. This approach, however, does have to contend with conflicting considerations:

- On the one hand, the payments market looks efficient and resilient. It is growing quickly and enjoys high levels of user confidence. There is thus little evidence of demand for additional payment solutions;
- On the other, with the decline of cash, the public is losing access to the currency's function as a store of value: in the case of a banking, financial or economic crisis, there is no universally accessible substitute at present with the ability to safeguard citizens' assets.

Analyses by the Riksbank beginning in 2017 led to in-depth discussions with stakeholders, including public consultations and some 50 external communication meetings at national and international levels. This work also resulted in several publications, including two reports on the e-krona initiative (September 2017 and October 2018) and several articles in the Riksbank's economic review in the third quarter of 2018. After deciding that this preliminary work had done enough to identify the challenges and issues associated with the concept of a digital currency, the Riksbank went ahead and formally launched its e-krona initiative in late 2018 with a view to deployment by 2020/2021 (Sveriges Riksbank, 2018) of:

- One or more pilot solution(s) capable of handling issuance and circulation management for such a currency;
- a scheme rulebook.

#### **People's Bank of China (PBoC) announces the launch of a digital renminbi**

In late August 2019, the PBoC announced the forthcoming launch of its Digital Currency Electronic Payment (DCEP) project, which it had been working on for four years. The Libra initiative appears to have accelerated China's timetable, although no official start date has been given.

The PBoC's stated goal is to offer an alternative to cash for retail payments. Back in 2018, the bank's governor argued that a digital renminbi (RMB) would:

- i. Reduce production and management costs compared with cash;
- ii. Enhance transaction security;
- iii. Track financial flows in real time more effectively and improve fraud prevention;

- iv. Make monetary policy tools more efficient, particularly the indicator showing circulation of the monetary base (M0);
- v. Promote a more stable financial system, as contrasted with the use of volatile and unsafe cryptoassets;
- vi. Support an increased international role for the RMB, acting ahead of other central banks, while controlling circulation.

The PBoC also wants to offer an alternative to the payment solutions proposed by the large Chinese companies Alipay and Wechat Pay.

The PBoC would issue DCEP, potentially using blockchain technology, but distribution would rely on commercial banks and the payment solutions offered by large Chinese web firms. Seven institutions have been named to handle DCEP's launch, including commercial banks and other financial institutions. They are Alipay (which is owned by e-commerce giant Alibaba), WeChatpay (which is owned by Tencent), Industrial and Commercial Bank of China, Bank of China, Agricultural Bank of China, China Construction Bank and Union Pay.

DCEP would be readily accessible to consumers and companies via a mobile app.

In practice, commercial banks and other financial institutions would be the only ones to have direct access to DCEP and would be responsible for dealing with the public to open and manage DCEP portfolios. To restrict DCEP's use to retail payments, a maximum amount per transaction would be set.

According to the information available at this stage, DCEP might take the form of electronic commercial bank money that is 100% backed by commercial bank deposits with the PBoC, rather than a true CBDC.

DCEP issuance is to be trialled in the city of Shenzhen, which has 13 million people and is one of the fastest-growing cities in China from an economic perspective. Shenzhen Financial Technology Co. Ltd, a company specialising in blockchain and 100% owned by the PBoC's Digital Currency Institute, was set up there in 2018. The city's proximity to Macao and Hong Kong could further facilitate DCEP's international expansion.

### Box: Two examples of stablecoins

Even as central banks are exploring the concept of a digital currency, some private participants are also looking to take advantage of the absence of a CBDC by putting forward stablecoin-type initiatives (Berentsen and Schär, 2019) that can address market needs in this area, both in the retail and wholesale segments. One example for each segment is provided below.

#### **Retail: the Libra initiative**

Facebook's forays into the field of payments, as the company seeks to expand uses around its social media solutions (Facebook, Messenger, WhatsApp), are not a new development. Its Facebook

Credits initiative flopped a number of years ago, while the P2P transfer solution integrated in Messenger in 2017/2018 proved unsuccessful as well and was scrapped in Europe in early May 2019.

Libra, then, is the group's latest offensive in this area and seeks to tap into the popularity of bitcoin and cryptoassets. Facebook's stated goal is to associate a private digital asset with its network so that users can exchange funds, including on a CtoB<sup>5</sup> basis, whereas the group's focus was previously on PtoP<sup>6</sup> payments. Some of Libra's key features are as follows:

- It is scheduled to be launched at the end of the first half of 2020 and will be linked to a basket of currencies in an effort to ensure universal use while mitigating currency risk;
- It will circulate on a permissioned blockchain;
- Libra units will be issued by Libra Association, a Swiss-domiciled fund made up of the entities authorised to approve transactions. A number of major institutions that initially expressed interest have pulled out of the project.

The proposed mechanism would therefore be more like a kind of electronic money than a Bitcoin-type decentralised cryptoasset, and Facebook's initiative would be like the private equivalent of the sort of retail CBDC proposed by the Riksbank (see Box: CBDC initiatives. Examples from Sweden and China). Libra's native wallet would be Calibra, which is offered by Facebook, and it is therefore probable that Calibra will be widely adopted by Libra holders, giving Facebook access to high-quality personal information, potentially raising privacy issues.

#### **Wholesale: JP Morgan's JPM Coin initiative**

The JPM Coin initiative seeks to develop a dollar-linked crypto-asset to allow major clients, such as institutions, large investors and major companies, to exchange funds instantaneously. It is strictly intended for wholesale use. The idea is that JPM Coin would allow major clients to generate cash management savings by enabling them to carry out their transactions faster and in all circumstances, regardless of constraints relating to, for example, counterparty location or the opening times of payment systems, especially RTGS systems. This initiative would thus offer an alternative to international transfer mechanisms based on correspondent banking, in which the group is heavily invested but whose limits in terms of accessibility, efficiency and transparency are regularly pointed out.

Unlike the stablecoins already in circulation, such as Tether, Circle or Gemini, which have struggled to demonstrate the stability of their value over the long run for want of sufficiently credible backing, JPM Coins would be backed by the JP Morgan group, which has a USD 2.6 trillion balance sheet. The Interbank Information Network (INN) of banks set up by JP Morgan in connection with its project included 365 banks as at mid-November 2019. Each unit would be issued and redeemable on a continuous basis and at par against the dollar from JPM Chase Bank NA, which has branches worldwide.

Given the targeted use case, JP Morgan has focused on setting up a private and permissioned blockchain. The prototype that is currently under development will use Quorum, the private Ethereum-derived blockchain developed by the bank itself.

---

<sup>5</sup> Consumer to business.

<sup>6</sup> Person to person.



Besides payment-related uses, JP Morgan is not ruling out broader applications, such as:

- Settling transactions in security tokens using smart contracts linking two blockchains and handling the DvP function;
- Issuing stablecoins on other blockchains with the same guarantee mechanism: JP Morgan is cautious on this prospect. It considers that, while it might be technically possible to carry JPM Coin's attributes onto other blockchains, such as Hyperledger, Corda and even Ethereum, the lack of permissioning on open blockchains might create overly high risks, particularly from an anti-laundering perspective, and divert JPM Coin from its wholesale focus.

The following diagram illustrates the lifecycle of JPM Coin units:



1. Issuance: the client commits deposits to a designated account and receives an equivalent number of JPM Coins.
2. Transfer: these JPM Coins are used for transactions over a blockchain network with other JP Morgan clients.
3. Redemption: holders of JPM Coins redeem them for USD at JP Morgan.

### Legal status of stablecoins

In France, the legal definition of a stablecoin is determined by a case-by-case analysis of the proposed project, as recommended by the European Banking Agency. Until now, private initiatives have come under two legal definitions provided by France's Monetary and Financial Code, namely electronic money issuance and token issuance:

- If the stablecoin is issued on receipt of funds with legal tender status in a nominal value equal to that of the funds received in exchange (cf. Article L.315-3 of the Monetary and Financial Code - MFC), it is considered under EU and French law to be equivalent to a form of electronic money within the meaning of MFC Article L.315-1.<sup>7</sup> This definition makes it necessary for the stablecoin issuer to be licenced as an electronic money institution or a credit institution, which triggers the application of prudential regulations in areas including capital, KYC, protection of client funds, payment security and customer protection;

<sup>7</sup> Under Article L. 315-1 of the Monetary and Financial Code, electronic money means electronically, including magnetically, stored monetary value as represented by a claim on the issuer, which is issued on receipt of funds for the purpose of making payment transactions as defined in MFC Article L. 133-3 and which is accepted by a natural or legal person other than the electronic money issuer. Electronic money units are said to be units of value, each one representing a claim embedded in a security.

- In other cases, stablecoins are covered by the framework applicable to cryptoassets, as introduced to France's MFC by Act No. 2019-486 of 22 May 2019 on business growth and transformation.

International work by the FSB under the auspices of the G20 is under way to determine the most appropriate legal definition for stablecoins. The final G20 report, which is expected in July 2020, should build on the G7 report on the issue (Group of Seven, 2019). It is expected to formulate proposals for regulation, policy stance and supervision and put forward high-level principles that take account of developments to payment systems and the impact of cryptoassets.

## **2 Technical and organisational aspects**

The launch of a CBDC (2.1) is considered separately from the permanent regime (2.2).

### **2.1 At the launch stage**

General aspects are discussed first (2.1.1), followed by specific aspects connected with retail CBDCs (2.1.2) and blockchain use (2.1.3).

#### **2.1.1 General aspects**

##### *(i) Merits of a DLT-type infrastructure*

Although DLT-type technologies are generally associated with the circulation of different forms of new digital assets, they do not feature in all the CBDC projects identified to date:

- A CBDC can be managed through a blockchain. This is the model used for example in trials by the Bank of Canada (Jasper) and the Monetary Authority of Singapore (Ubin);
- It is also possible for a central bank to issue digital currency using an account-based or value-based model, without employing blockchain technology. In this case, the digital currency units would not be equivalent to cryptoassets, i.e. coins or tokens, but rather to a form of electronic currency. This is the model being followed by the Riksbank in its e-krona initiative.

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 direct transactions in tokenised assets without the involvement of the central bank, including in 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. It seems implausible that all citizens, businesses and government agencies that want to hold the CBDC will spontaneously become participants in a complex, continuously operating IT 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.

##### *(ii) Security*

In accordance with the *Principles for Financial Market Infrastructures* (BIS/OICV-IOSCO, 2012), the Eurosystem has embarked on an approach aimed at ensuring the interoperability of infrastructures

used in the area of payments. As part of this, steps have been taken to promote international standards, particularly ISO20022 on message formats, both at the level of instruments (within the framework of SEPA) and in terms of how payment systems operate (migration of T2 platform to ISO20022 provided for within the framework of T2/T2S consolidation).

Further, 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.

### *(iii) Pricing*

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.

The question also arises whether a CBDC with legal tender status could be priced. In this regard, if there is no law or regulation requiring legal tender to be free and no principle of free access to public service, there would be no legal obligation to refrain from pricing access to a CBDC, including in a situation where the currency was legal tender and where its use was thus obligatory for a payment recipient.

It therefore seems implausible that a totally free model could be introduced in a segment that is open to competition. Pricing could take one of the following forms:

- In the case of a wholesale CBDC, pricing could be applied to outgoing payment flows, as happens with RTGS and other payment systems;
- In the case of a retail CBDC, use costs could be passed on to professionals, notably merchants when using CBDC payment acceptance systems.

#### 2.1.2 Specific aspects connected with a retail CBDC

##### *(i) Privacy and AML/CFT requirements*

Privacy is a constitutional 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 in particular by *Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement*

of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), 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. Determining whether these rules apply would require a case-by-case analysis based on the characteristics selected for the CBDC, paying particular attention to the applicability of rules protecting users of payment services provided for by *Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services (PSD2)*. In principle, the first article of the directive excludes the ECB and national central banks from the category of “payment services provider” when they are acting in their capacity as monetary authority or other public authorities.<sup>8</sup> An assessment is therefore needed to determine whether issuing a CBDC would qualify as acting in a Eurosystem capacity. At any rate, it would seem risky 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>9</sup>

The same goes for AML/CFT rules, which are essentially derived from *Directive (EU) 2015/849 of the European Parliament and of the Council of 20 May 2015 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing* (amended in 2018 by *Directive (EU) 2018/843*).

At this stage, note that the abovementioned 2018 directive requires providers of exchange services between virtual and fiat currencies to abide by AML rules and sets rules designed to counter the anonymity of virtual currencies. However, it defines virtual currency as “*a digital representation of value that is not issued or guaranteed by a central bank or a public authority, is not necessarily attached to a legally established currency and does not possess a legal status of currency or money (...)*”. As the European legislation currently stands, a CBDC could not therefore be treated as a virtual currency within the meaning of AML/CFT rules.

More generally, however, the scope of application of AML/CFT rules depends on the status of operators, as determined by their business activities. If a central bank manages a retail CBDC beyond issuance, its AML/CFT requirements would depend on whether the implementation procedures for the digital currency resulted in the provision of one of the services listed in Annex 1, points 2 to 12, 14 and 15 (loans, payment services, issuance of electronic money, etc.) of *Directive 2013/36/EU*. In this case, the issuing central bank would be placed in the category of “financial institutions” within the meaning of the laundering directive and would therefore be subject to AML/CFT rules (in accordance with article 2 of the directive). In any case, even if it were not subject to these rules, the fact of not voluntarily applying equivalent rules would create reputational risk for the Eurosystem, just as it would in consumer protection.

---

<sup>8</sup> PSD2 Article 37 requires Member States to prohibit natural or legal persons that neither are payment service providers nor explicitly excluded from the scope of the directive from providing payment services.

<sup>9</sup> High-level principles on financial consumer protection developed by the OECD and endorsed by G20 finance ministers in October 2011.

(ii) *Token- or account-based?*

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. Procedures for exchanging this form of digital currency are directly tied to the nature of the medium, but the transfer of units has to happen electronically from medium to medium and not by transferring the medium itself, otherwise this approach would operate in the same way as cash and amount to the creation of a new type of banknote (e.g. replacing a paper-based banknote with a card-based banknote);
- 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 (see diagrams showing the 3-corner model, or closed system<sup>10</sup> and the 4-corner model, or open system).

The choice of circulation model dictates the technical management of transactions and the associated security, as shown by the following table.

	Token-based model	Account-based model
Management of ownership of digital currency units	Handled through physical ownership the medium: units of account are evidenced by a computer file that is stored locally and securely and protected against counterfeiting risks	Handled through procedures for accessing the online account, which may be subject to PSD2 requirements <sup>11</sup>
Conditions for carrying out transactions	Offline model may potentially be accepted: possibility of transferring tokens between media without being connected to the web (same as banknotes)  Payer and beneficiary media must be physically present to carry out the transaction, which may be done remotely	Online model only: initiating an asset transfer requires access to online account  Payer and beneficiary accounts must be identified to carry out the transaction

<sup>10</sup> In the 3-corner model, or closed system, participants have a direct link to the payer and payee, unlike in the 4-corner model, or open system, where a market infrastructure is interposed.

<sup>11</sup> PSD2: Second European payment services directive, which came into application in January 2018 and establishes the requirements covering the security of electronic payment transactions and access to payment accounts.

	Token-based model	Account-based model
<b>Transaction security / Strong authentication as defined by PSD2</b>	PSD2 requirements met by: <ul style="list-style-type: none"> <li>- Holding a medium considered to be an element that authenticates possession based on its security attributes (impossible to falsify / reproduce)</li> <li>- Second factor must be associated: knowledge (password) or biometrics</li> </ul>	PSD2 requirements met through the use of two authentication factors from different categories, namely: <ul style="list-style-type: none"> <li>- Knowledge</li> <li>- Possession (non-intuitive as it refers back to the token model)</li> <li>- Biometrics (requires a medium)</li> </ul>
<b>Procedures for loading/unloading commercial bank money</b>	Through a physical interface (face-to-face) or a logical one (remote) used to manage (i) recognition of the medium and secure transfer of tokens and (ii) flows of commercial bank money provided in return (physical payment terminal or online payment interface)	Through a logical interface only (in principle online), used to manage account loading and flows of commercial bank money provided in return (online payment interface)

Given these attributes, the way that a digital currency operates from the user's perspective, whether an individual, merchant or company, would be equivalent:

- in the case of a token, to a physical digital wallet. This type of solution has thus far been deployed solely using cards, but with relatively limited success. Examples include Moneo, an interbank wallet that is no longer in service, and a number of prepaid cards. It is worth noting that these products feature some severe usage restrictions, such as not permitting person-to-person payments. Token-based solutions where units are recorded on the user's personal medium, such as a mobile phone, could get round these constraints;
- in the case of an account-based model, the digital currency would work like private PayPal or Lydia-type solutions, i.e. online accounts operating in preload mode (although this can be automated and tailored to requirements, e.g. using a card or direct debit). Mobile money solutions that have been deployed in recent years in emerging countries (Orange Money or m-Pesa in Africa, WeChat and AliPay in China) operate in a similar way.

*(iii) Which distribution channels?*

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

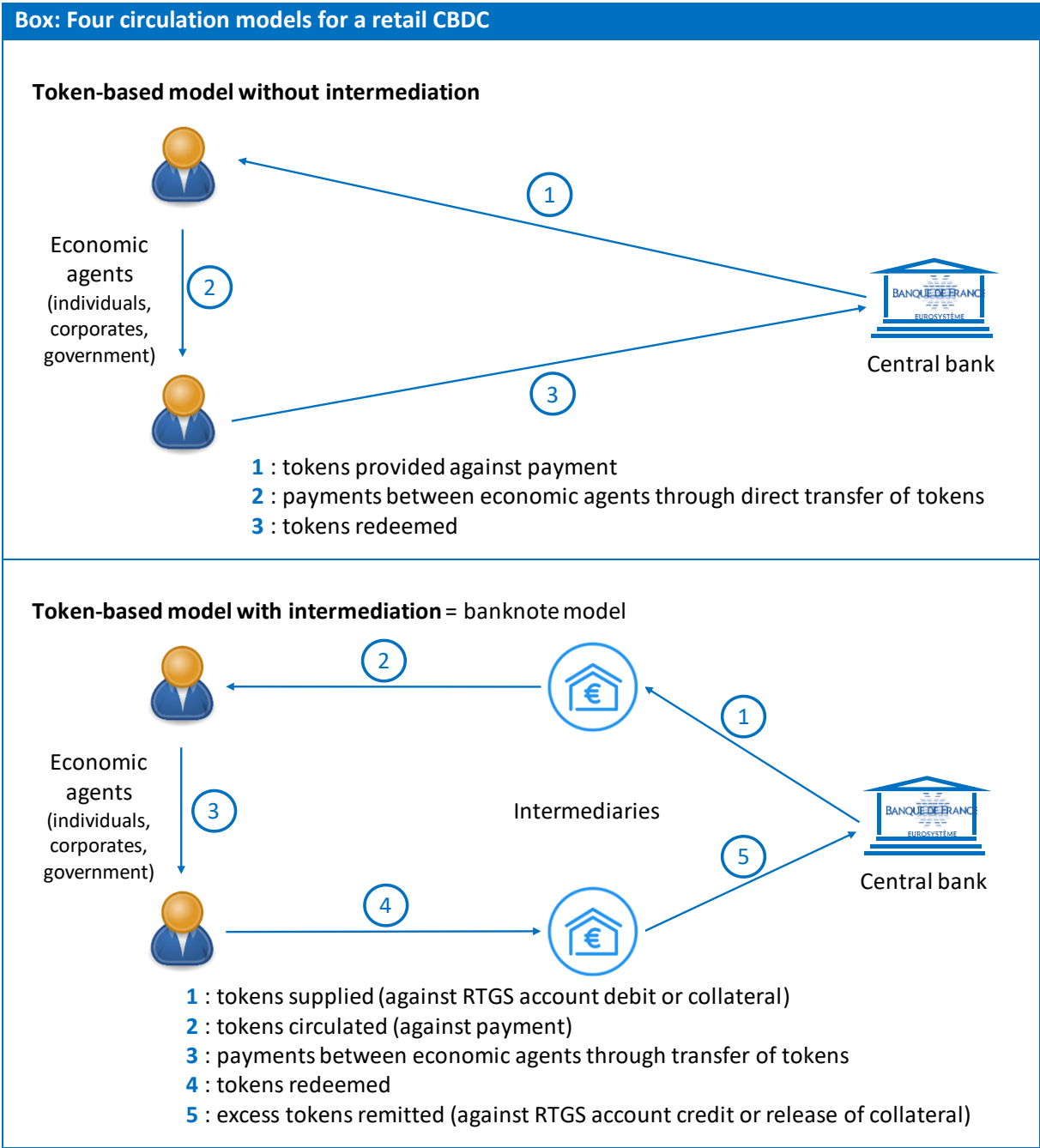
an overall view in the case of account-based model, or restricted to loading/unloading transactions and to payments in online mode in the case of a token-based model;

- An intermediated model, where CBs use intermediaries to provide the digital currency to end users. Banks would be a fairly natural choice, as they already distribute banknotes and interact directly with the Eurosystem through its infrastructures. However, a more extensive vision could be explored, including options such as payment services providers, insurers, agents/brokers, foreign exchange offices and post offices. In this model, control over the assets' lifecycle would be dependent on consolidating the information provided by 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 choice of the distribution model dictates the level of CB intervention in the operations involved in the circulation of a digital currency, as shown in the following table.

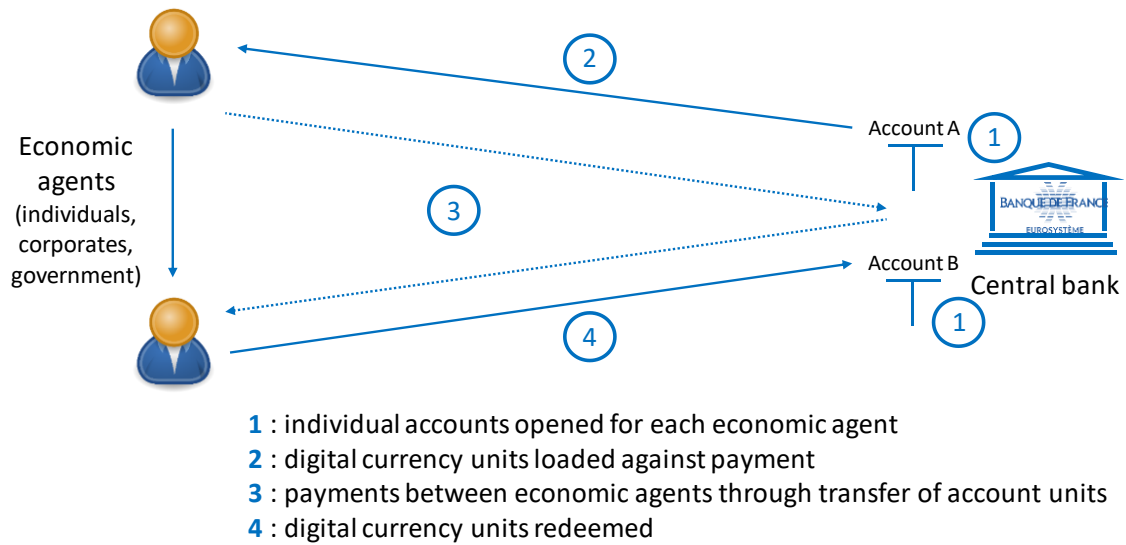
	Direct model	Intermediated model
Token/account management	Handled by the CB for end users	Handled by distributors for their customers
Loading/unloading	Sole responsibility of CBs, which are in charge of token issuance /account transactions and also for managing flows provided in return, i.e. acquisition of payment flows pertaining to the “purchase” of digital currency units in commercial bank money (cashless or cash payment)	Responsibility of intermediaries, which are in charge of loading tokens/account transactions based on the units allocated by CBs and may also manage flows provided in return via customer accounts held in commercial bank money
Definition and implementation of security requirements	Sole responsibility of CBs, which are in charge of technical and security specifications and also for providing customers with means of authentication	Technical specifications defined by CBs but possible delegation of implementation, particularly as regards authentication tools
KYC and AML/CFT requirements	CBs know all users, direct AML/CFT inspections by CBs	KYC and AML/CFT due diligence delegated to intermediaries, with the possibility that the same user could be registered with multiple intermediaries  CB oversight capacity dictated by the level of granularity of information collected by intermediaries

Given these elements, the two models are deeply different, in terms of the organisation for the central bank, information access for payment services providers and the consequences for holders of the retail CBDC. 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 (Box: Four circulation models for a retail CBDC). However, adopting this model would be severely restrictive for central banks, which are not used to dealing with so many counterparties (to give a comparison, Target2 is accessible solely to banks, investment firms and designated public institutions), 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 (4.3.1).

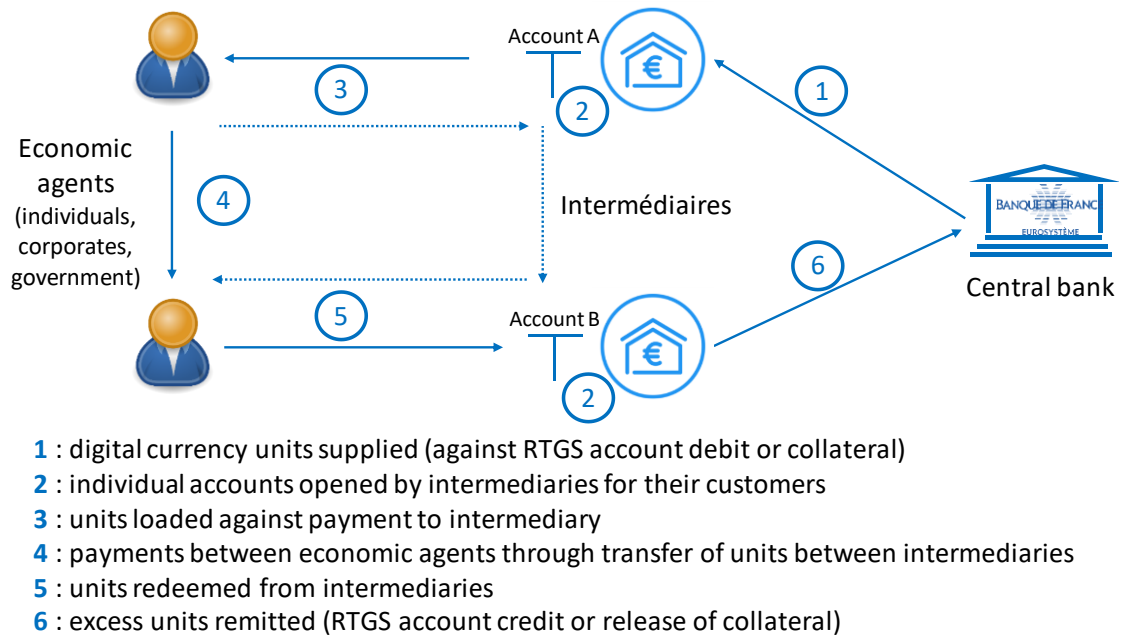




**Account-based model without intermediation = 3-corner cashless payment model**



**Modèle *account-based* avec intermédiation = modèle de paiement « 4-coins »**



**Box: The Sveriges Riksbank's proposed retail CBDC model for its e-krona**

Following preliminary work by the Sveriges Riksbank from 2017 to 2018 (Sveriges Riksbank, 2018), the main attributes of the future e-Krona proposed at this stage are as follows:

- It would operate according to a value-based approach equivalent to an electronic currency issued by the central bank, whose units would represent a direct claim for holders on the Riksbank. Under the proposed intermediation arrangements (see next point), accounts would

be opened in the name of payment services providers, which would be responsible for ensuring that these accounts match the identities of the final clients who hold e-krona;<sup>12</sup>

- Distribution to the general public would be provided through intermediaries operating as payment services providers, which would be responsible for (i) customer relationship and KYC aspects relating to e-krona account keeping, (ii) providing associated payment services, which could use previously deployed instruments, such as payment cards or mobile solutions, while integrating a supplementary e-krona payment function), (iii) managing transactions on accounts held for their customers with the Riksbank, through a dedicated application programming interface (API, as defined within the framework of second European payment services directive). In this regard, the Riksbank does not wish to offer end users a direct interface, and only intermediaries would get an access interface for e-krona accounts;<sup>13</sup>
- Issuance to intermediaries would be handled under conditions equivalent to those applicable to the issuance or withdrawal of cash, i.e. through the debit and credit of RTGS accounts. This means that non-bank payment services providers<sup>14</sup> will require RTGS access if they are involved as e-krona intermediaries / distributors;
- Functionality would be reserved for retail transactions and would not be intended to substitute for the RIX large-value payment system operated by the Riksbank. Accordingly, maximum unit amounts could be established to ensure that issued transactions comply with this end goal;
- Credit interest would not be paid, at least initially, nor would there be access to overdrafts on accounts held in e-krona;
- Terms of access would be equivalent to those of standard payment services: no discrimination between Swedish and EU citizens as regards the opening of e-krona accounts by intermediaries; possibility for non-residents to subscribe to issues of non-anonymous electronic money up to the limits imposed under anti-laundering regulations (5th European AML/CFT Directive);
- As with card payment schemes, offline transactions would be possible, subject to strict ceilings (by total value of successive transactions or number of successive transactions) to prevent the risk of large-scale transactions (laundering, credit risk, etc.).

Given these characteristics, the e-krona project is expected to lead to the development of a centralised management platform performing issuance and account-keeping functions for digital currency units. The system would have internal and external interfaces with various functions and participants, namely:

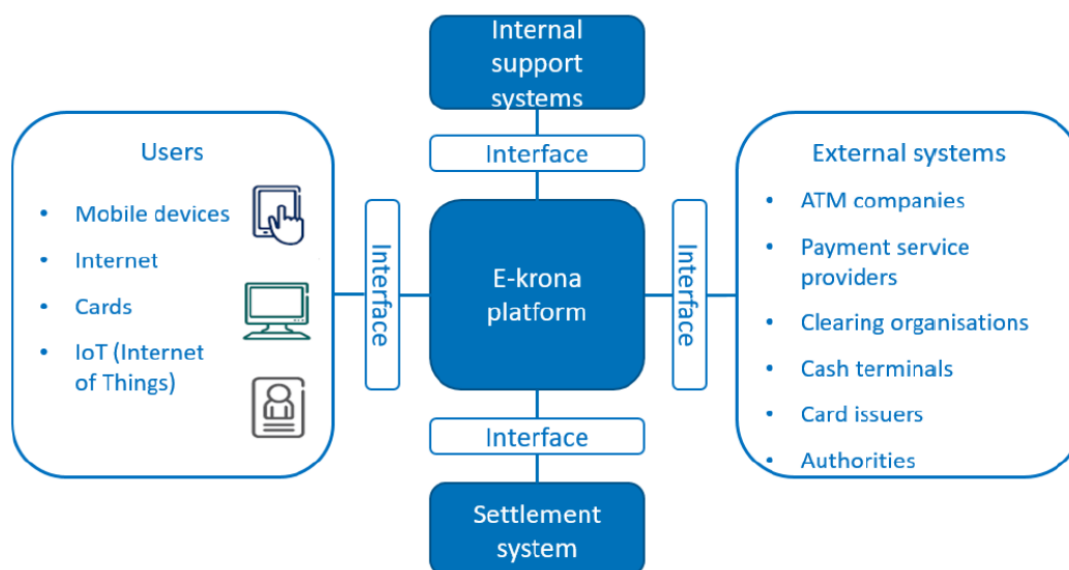
---

<sup>12</sup> This set-up would be similar to that of payment institutions and electronic money institutions, which generally operate on the basis of a segregated account opened with a credit institution and holding all the client assets of the payment institution or electronic money institution.

<sup>13</sup> This intermediated approach is deemed necessary to ensure that the e-krona is properly distributed/circulated and integrated into the payment habits of consumers and merchants. In particular, it allows the Riksbank to relieve itself of its AML/CTF obligations.

<sup>14</sup> Such as payment institutions or electronic money institutions, as provided for by the corresponding European directives (PSD2 and EMD2 respectively).

- The RTGS system operated by the Riksbank for transactions relating to the issuance and destruction of digital currency units;
- The Riksbank's internal IT support functions for platform hosting and administration;
- Intermediaries' information systems to ensure the integration of e-krona flows in transaction flows: e.g. card payment schemes to support payments and withdrawals in e-krona using merchant terminals and ATMs;
- Intermediaries' user interfaces, through the PSD2 API to be developed by the Riksbank to handle account monitoring/consultation and record user transactions.



### 2.1.3 Specific aspects relating to blockchain use

The idea behind the concept of a wholesale CBDC is to enable central bank money to circulate in a decentralised manner for settling transactions between financial or non-financial institutions. It would be associated with a blockchain-type technology offering an alternative to standard types of infrastructure (RTGS and other payment and securities settlement systems). As this could potentially also be the case for a retail CBDC (1), many of the questions raised in this section are therefore also germane to a retail CBDC and can be added to those discussed in the previous section; in the case of an intermediated distribution model, they would have to be addressed by payment services providers.

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: unlike a retail CBDC, a wholesale CBDC would be by definition issued to a limited number of financial sector users. 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. Such an approach would also make it possible to reduce the operational constraints associating with approving transactions, by accelerating this process and avoiding the use of mining and reward processes;

- Interaction with other blockchains: one of the key advantages of the wholesale CBDC is linked to the ability to provide settlement in central bank money in exchange for other classes of tokenised assets or even other wholesale CBDCs.<sup>15</sup> For example, issuance of wholesale CBDC units could be made conditional, by means of a smart contract, on having an eligible tokenised asset, which could itself circulate on another blockchain, serve as security. But this type of approach would require the ability to interface blockchains in order to link the transactions. 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). In addition, every exchange involving the wholesale CBDC's blockchain would require a mirror smart contract to be set up on the blockchain on which the asset pledged as security circulates, necessitating total interoperability in terms of establishing the settings of the two blockchains. The ability to have the wholesale CBDC interact with other blockchains would therefore entail two prerequisites:
  - Standards must be established so that the wholesale CBDC blockchain can communicate with blockchains it accepts as backings of the central bank's counterparties;
  - 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 (4.3.2) and monetary policy transmission (4.2.3) 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. Since the attributes of a unit of the wholesale CBDC (file representing the currency unit, keys enabling use) may be integrated in a cryptoasset circulating on another blockchain, which is possible on Ethereum and Ripple, for example, it would then become possible to use the unit on this blockchain. At this point, from the central bank's perspective, the unit would be "immobile" (no movement would be recorded in the distributed ledger) until one of the users of the wholesale CBDC's original blockchain made it circulate. In the intervening period, the wholesale CBDC unit could be exchanged via the secondary blockchain between entities not belonging to the digital currency's formal circulation network. 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, (4.2.2) in a potential retail scenario.

---

<sup>15</sup> See trials by the central banks of Thailand and Hong Kong.

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.

## 2.2 Under a permanent regime

In the case of a retail CBDC, lifecycle management could be modelled on the approach used with cash and thus be determined by demand:

- Digital currency units would be created by CBs and provided to holders (direct model) or intermediaries (indirect model) in exchange for security;
- Exchange procedures would have to be more similar overall to those of cashless payments (token-based or account-based: exchange validated by strong payer authentication) than those of cash (except in the case of a token-based solution using a physical medium that is itself exchangeable). They should however allow direct payments to be made between any type of user and thus be closer to cash, as contrasted with cashless payments, some of which are exclusively for designated categories, such as creditors (issuance of direct debits) or merchants (acceptance of card payments).

Terms and conditions for holding and hoarding also need to be established, including remuneration and charges for deposits and accessibility to non-resident holders.

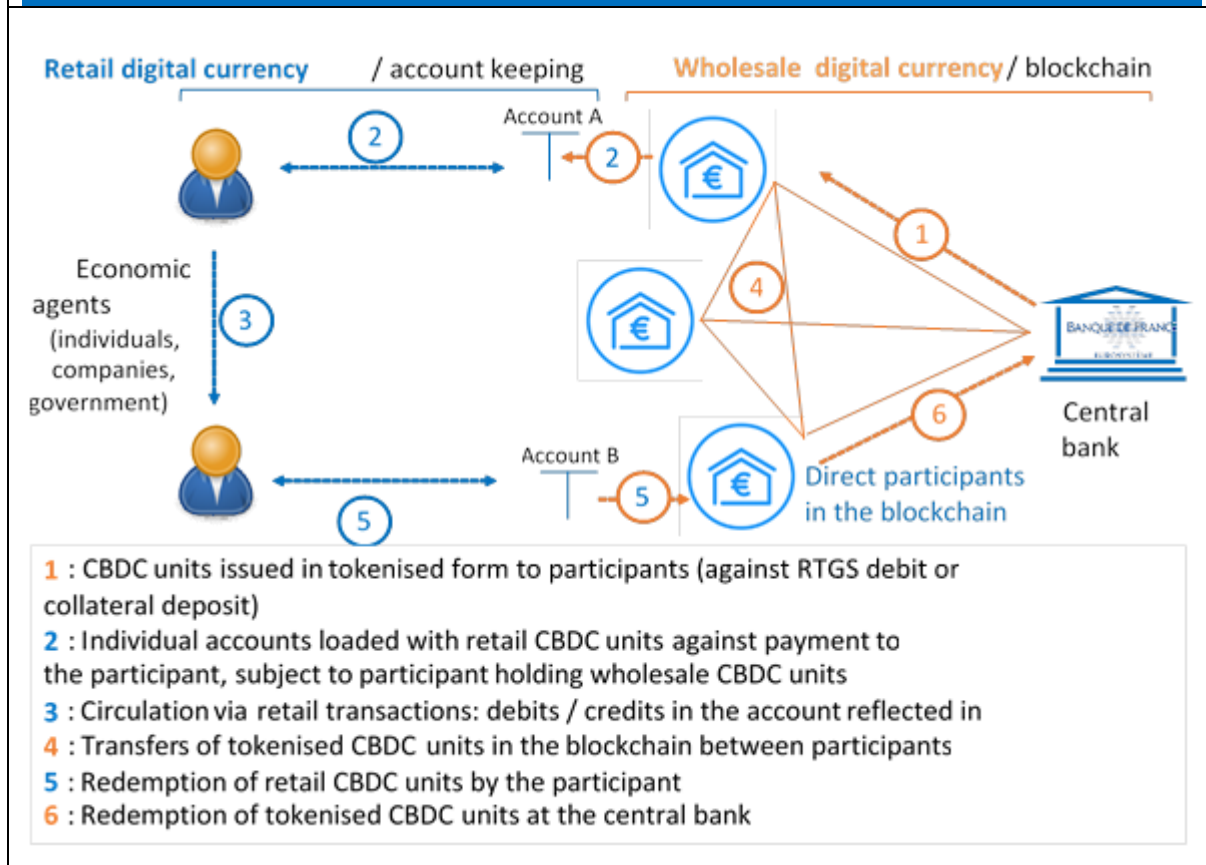
The lifecycle of digital currency units would be less complex in the case of a wholesale CBDC. The CB would issue digital currency units under conditions that would be in principle equivalent to those of other forms of currency issuance, i.e. against a debit applied to a central bank money account in the RTGS system. The unique aspect of issuance in this case would come from the creation and provision of these units to participants in a DLT/blockchain-type architecture, which would handle exchanges and traceability.

CBDC issuance would also open up prospects for access to central bank money.<sup>16</sup> For example, steps could be taken to open up direct access to exchanges in wholesale CBDC beyond the banking institutions that currently participate in Target2, in order to strengthen use of central bank money, for example by other financial sector participants, such as insurers, and even beyond that to large companies, for example. These categories of participants could thus benefit from non-intermediated payment services, most likely at costs that are more competitive, while benefiting from the protective framework of central bank transactions. Their terms of access should be strictly defined, however, notably to prevent any credit in their favour, even on an intraday basis.

---

<sup>16</sup> Only in terms of having accounts at the central bank, not of being a counterparty in monetary policy operations.

Box: Diagram illustrating the integration of retail and wholesale digital currencies



### 3 The legal framework

Two questions are discussed here: could the ECB issue a CBDC (3.1)? Should that currency be legal tender (3.2)?

#### 3.1 Could the ECB issue a CBDC?

The European treaties do not provide expressly 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. Making wholesale changes to the content of one of the articles covered by the derogation might, in particular, be viewed as circumventing the restrictive nature of this procedure.

In a scenario involving CBDC issuance that goes beyond a mere technical procedure to encompass, for example, the provision of credit to monetary policy counterparties, two main options are available

First, TFEU Article 128 gives the ECB the right to authorise the issuance by the ECB and CBs 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. This option would also impose denomination-related constraints because, unlike banknotes, coins are issued by Member States (TFEU Article 128(2)) – unless Member States agree to issue digital coins. Such a scenario would require a legal act of the Council because the Council is responsible for adopting the technical specifications for coins, which are used to make exact amounts and to provide change when there is not a round figure, since banknotes are available only in denominations of EUR 5 or more.

It is certainly true that the treaty's authors did not imagine that banknotes and coins might be in any form other than physical. This point appears to be corroborated by the second paragraph of Article 16 of the Statute of the ESCB: "The ECB shall respect as far as possible existing practices regarding the issue and design of banknotes"(ECB, 2018). However, the CJEU could take account of a change in the situation (in this case, the rise of dematerialisation) to accept that the interpretation of the Statute cannot remain static. Moreover, Article 16 of the Statute of the ECB and of the ESCB requires the ECB to respect existing practices regarding the issue of banknotes only "as far as possible". If it were shown that issuing a digital currency had become necessary, it might be possible to move away from traditional practices regarding the issue and design of banknotes.

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 dematerialisation, 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.

After demonstrating that the goal of creating a CBDC was consistent with one of the ESCB's main tasks, it would then be necessary to show that the ESCB had policy instruments at its disposal pursuant to its Statute. One option would be to refer to Article 17 of the Statute, which authorises the ECB and the CBs to open accounts for "market participants", an expression that would suit a wholesale CBDC and that would argue, in the case of a retail CBDC, for an intermediated token-based distribution model rather than for a direct account-based model (2.1.2). An alternative might be to use Article 20 of the Statute, which authorises the Governing Council to use "other methods of monetary control". In the event that Article 20 was employed, account would have to be taken of the fact that the Governing Council's decision would require the adoption of a legal act by the Council of the European Union if "other methods of monetary control" resulted in obligations for third parties. The question of the choice of the instruments authorised by the ESCB Statute would thus depend once again on the CBDC's characteristics.

### 3.2 The question of legal tender

This question will be touched on only briefly, given its significant political content.

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 2.1.1).

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). A commitment of this nature could create technical constraints that would have to be assessed, e.g. the need to be able to quickly provide a potentially large amount of cash. However, in a society where cash usage becomes marginal, a retail CBDC with legal tender status or covered by the abovementioned exchange commitment would make it possible to maintain the link between public and private money by guaranteeing the obligatory conversion of the latter to the former. It would thus help to maintain confidence in the financial system.

#### **4 Macroeconomic, monetary and financial consequences**

In the long term, issuance of a CBDC should make it possible to lower transaction costs, both with technology that is more efficient and through increased competition on the payments market. This should spur increased productivity and innovation in the financial services sector and in the wider economy (4.1). Such a move could also increase the euro's appeal and international role, especially if the euro area were to issue a CBDC sufficiently early (4.4). However, issuance of a retail CBDC could have mixed effects on the business cycle: the CBDC could improve monetary policy transmission and thus help to stabilise the business cycle (4.2) but it could also be a source of new vulnerabilities for the financial sector (4.3).

##### **4.1 Macroeconomic consequences**

Economists at the Bank of England (Barrdear and Kumhof, 2016) were the first to propose a quantified assessment of the consequences of issuing a CBDC. They found that introducing an interest-bearing retail CBDC that competed with bank deposits, as a medium of exchange would increase production due to reductions in real interest rates and transaction costs and an increase in seigniorage revenue enabling a reduction in distortionary taxes. They estimate that CBDC issuance of 30% of GDP could permanently raise GDP by 3% through a temporary acceleration in growth. Adoption of a countercyclical rule to set the interest rate could improve monetary policy transmission and help to stabilise the business cycle. It should be noted, however, that the authors assume a highly specific scenario, which is not that used by this report, in which the CBDC would be issued as a monetary policy



instrument and would circulate as a parallel currency; in addition, the positive impact on the GDP level would stem partly from CBDC-funded asset purchases.

Issuance of a wholesale CBDC would stimulate the development of transactions in tokenised financial assets, whether these are existing products that become accessible in this form or new products using smart contracts (2.2). By opening the way for cash management savings, a wholesale CBDC should also 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 (2.1.1). 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 (Hasan *et al.*, 2013; Humphrey *et al.*, 2006). As mentioned earlier (1.1.1), care would have to be taken to ensure that its launch did not interfere, in the euro area, with initiatives aimed at making payment solutions more efficient.

If a retail CBDC was distributed through a network of intermediaries, its integration in payments would enable these participants to gather, in accordance with the legal framework for data privacy, more extensive information on their clients, enabling them to propose new financial services, manage customer risk more effectively and allocate credit more efficiently. In the medium to long term, improved allocation of production factors should lead to higher productivity and economic growth. Conversely, if the central bank made the retail CBDC directly available to the public, then the partial substitution of the currency for bank deposits would lessen the information available to banks on their customers (4.3) and thus make the financial system less efficient.

## 4.2 Monetary policy consequences

Issuing a CBDC could affect the objective (4.2.1), implementation (4.2.2) and transmission (4.2.3) of monetary policy (Pfister, 2019).

### 4.2.1 The objective of monetary policy and the money/inflation relationship

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. In a setting of ultra-low interest rates and muted inflation, these productivity gains could affect the ability of monetary policy to achieve its price stability objective. In the retail version, if the currency promotes the execution of non-face-to-face transactions that agents might otherwise have skipped for various reasons (confidentiality, lack of confidence), a CBDC could fuel increased demand for goods and services, putting upside pressure on prices. Taken as a whole, the inflationary impact of issuing a CBDC would depend on the version used and would be hard to anticipate on an overall basis if the two versions – retail and wholesale – were implemented simultaneously.

Furthermore, if a retail CBDC is issued, the scope of monetary aggregates would have to be adjusted to include the currency in the narrowest aggregate, alongside cash, and to maintain the informational content (link with end demand) of the aggregates. If issuance of a retail CBDC allowed non-financial agents to save cash and equivalents, the stability of the relationship between money and activity could be more significantly and lastingly compromised. Whatever the case may be, issuance of a retail CBDC could lead to changes in the velocity of circulation that might temporarily lessen the usefulness of monetary aggregates, particularly the narrowest ones. Moreover, money and activity already have a tenuous relationship.

#### 4.2.2 Monetary policy implementation

The primary characteristic of a CBDC, which it would share with all central bank money, is that it would be issued and destroyed only by the central bank. 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 is done currently with cash. Since the distribution of wholesale CBDC holdings would not necessarily meet the needs of holders during times when the central bank is closed, issuance of a wholesale CBDC would probably lead to the creation of an intraday money market, i.e. to exchanges of wholesale CBDC for periods of less than a day. 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 made up of banknotes and reserves and could profoundly change the pattern of demand for central bank money by making it more volatile. If cash is already the “autonomous factor” in bank liquidity that is the hardest to predict, alongside Treasury deposits (ECB, 2008), this new autonomous factor will likely be even harder to predict than banknotes (Nessen *et al.*, 2018). Banknote demand is affected by frictions in terms of availability and accessibility that make it potentially more inert than demand for a retail CBDC, which would be easier to transfer (for example, through a simple credit transfer from a sight deposit bank account to a retail CBDC account). Switches could occur in particular during times of financial crisis (4.3.2). 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.

Issuance of a wholesale or retail CBDC could also raise questions about access of new counterparties to the central bank. New participants, for example from the fintech sector, might wish to enter the payments market and/or take advantage of possibilities opened by the blockchain. Their business might be facilitated by access to the central bank balance sheet, under terms that would therefore need to be determined, notably as regards potential access to credit facilities.

#### 4.2.3 Monetary policy transmission

In the case of a wholesale CBDC, the consequences for monetary policy transmission look to be minor and not to warrant the creation of new instruments or procedures. However, a retail CBDC would likely

have a significant impact on monetary policy transmission. This effect would depend largely on the remuneration policy adopted.

*(i) Remuneration of a wholesale CBDC*

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. This could be done by imposing a priority rule on the two types of central bank money, for example by considering that the requirement to set aside reserves is met first by reserves and after that by the wholesale CBDC.

However, if the central bank wants to consider that the wholesale CBDC provides services that reserves do not (in terms of speed of execution, access, or programmability through smart contracts), then identical rates for the wholesale CBDC and reserves could lead to a drastic decline in demand for reserves. In this case, only a slightly lower rate would make it possible for the two forms of central bank money to coexist, if this was deemed worthwhile. Conversely, maintaining a currency that is technologically dominated by another might seem artificial. The most neutral approach would therefore be to treat the wholesale CBDC like reserves, subject to the priority allocation mentioned above, leaving market participants to choose the respective quantities of wholesale CBDC and reserves that they want to hold, with the central bank keeping control of the overall volume of central bank money.

*(ii) Remuneration of a retail CBDC*

Technical feasibility-related constraints primarily explain why reserves are remunerated<sup>17</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, even at a very symbolic level, 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.

This makes it necessary to examine two countervailing economic effects (see also 4.1). On the one hand, issuance of a remunerated retail CBDC could stoke competition in the deposit collection and payment instruments market, which could ultimately lead to an improvement in household purchasing power and a decrease in bank rents. On the other hand, issuance could push up the cost of financing

---

<sup>17</sup> Minimum reserves are remunerated to offset the taxation effect imposed on the banking system but the excess portion is also remunerated at a lower rate in the Eurosystem (main refinancing operations rate vs. deposit facility rate). Banknotes, except in their original form of promissory notes, do not bear interest.

bank loans to the real economy and therefore potentially curtail the loan supply or make it more expensive if banks, as is likely, have market power (Chiu *et al.* 2018; Bindseil, 2020). Bindseil (2020) proposes remunerating the retail CBDC using a tiered system to temper the competition with bank deposits (Box: CBDC impact on the balance sheets of financial and non-financial agents).

Overall, remuneration of a retail CBDC would have mixed effects on the economy and the financial system that are hard to quantify precisely. In terms of positive effects, a retail CBDC would make it possible to eliminate the implicit tax on holders of cash, allow all households, and particularly the poorest ones, who keep a large portion of their assets in cash, to earn interest on their savings. It would also reduce the untoward profit earned by retail banks when competitive forces are insufficient, and promote more effective monetary policy transmission, since the rates set by the central bank would affect a larger share of the money supply and would spread more quickly in the banking system owing to increased competition.

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;
- The Eurosystem's seigniorage revenue if this new form of money replaced existing cash. However, any substitution could only be very partial, at least initially (2.1.2). What is more, issuance would be profitable, i.e. seigniorage revenue would be positive, as long as the remuneration rate on the retail CBDC was lower than the rate on the corresponding assets on the central bank balance sheet, also if the cost of maintaining the retail CBDC was lower than the cost of maintaining banknotes, as is likely (2.1.1). Thus, while issuing a remunerated retail CBDC would lead to a sharp increase in the quantity of central bank money, overall issuance could bring in greater revenue in the event that the retail CBDC replaced deposits, even if each euro issued earned less.

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 also impact the effective lower bound for interest rates. Rogoff (2017) suggests that central banks could use the remuneration of a potential retail CBDC to scrap the lower bound on interest rates by setting significantly negative rates. However, he is assuming a situation where cash has vanished or where administrative measures make it possible to increase sharply the costs of acquiring and holding cash (large value bills phased out, deterrent fees applied to withdrawals). It is true that paying negative rates on a retail CBDC could then make it easier to pay negative rates on deposits. However, as long as coins and banknotes exist, the choice would always be there, making it impossible to reduce significantly the effective lower bound. Conversely, 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. These arguments suggest that a non-remunerated CBDC could limit the effectiveness of monetary policy in a low inflation situation.

Finally, by expanding global investment possibilities, remuneration of a retail CBDC, but more especially a wholesale CBDC, should strengthen monetary policy's exchange rate channel. Such a move would make an additional perfectly liquid and safe instrument available for global portfolio allocations, enhancing the substitutability of domestic and foreign assets and promoting international capital mobility.

#### 4.3 Impact on the financial system

The banking system would be especially affected by the issuance of a CBDC (4.3.1); beyond that, the question arises of the impact on financial stability (4.3.2).

##### 4.3.1. Impact on the banking system

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.

In connection with the e-krona initiative, Juks (2018) suggests that in Sweden approximately 5% of public deposits could migrate under normal circumstances, or SEK 120 billion. Under plausible assumptions, he estimates the additional bank funding cost at around 25 basis points, although this would vary according to the level of policy rates and the spread between these and the e-krona. In the event of a negative monetary policy rate, assuming this was still possible (4.2), the additional cost would however probably be zero. In the euro area, a similar decrease would correspond to approximately EUR 600 billion, as compared with a volume of excess reserves of around EUR 1.8 trillion. These estimates of transfers between retail CBDC and bank deposits are however subject to considerable uncertainty. Juks (2018) also considers a scenario in which demand for e-krona is around eight times higher than under normal circumstances (SEK 900 billion, corresponding to around one-third of public deposits and double the reserves held by Swedish banks with the Riksbank).

Pfister (2017) and Bindseil (2020) also 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 (Box: CBDC impact on the balance sheets of financial and non-financial agents), 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. However, the case may be, in a situation of positive interest rates, the substitution of central bank refinancing for sight deposits should make bank financing more expensive, which could reduce the quantity of lending to the economy. Andolfatto (2018) suggests however credit might not become scarce if competition between banks is low: in this instance, issuance of a retail CBDC would have the primary effect of reducing bank rents and hence of boosting household and company purchasing power but not necessarily of reducing the quantity of loans.

In other considerations, if a direct distribution model was adopted for a retail CBDC, banks would lose access to part of the information that they use to estimate default risk, and the quantity of lending to the economy could decline as a result of stricter lending conditions. Conversely, if the currency was distributed indirectly, banks would retain information on the customers whose accounts they manage.

**Box: CBDC impact on the balance sheets of financial and non-financial agents**

Bindseil (2020) discusses only a retail (or general purpose) CBDC, considering a framework in which it is distributed directly. No distinction is made between token-based and account-based options. Bindseil points out that if the central bank opens accounts for the public, this would mean the disintermediation of banks and would raise the question of the centralisation of the credit allocation process. He shows the impact of this disintermediation on the financial accounts of economic agents (see table below: 1. Households, pension and investment funds/insurance companies; 2. Corporates; 3. Government; 4. Commercial banks 5. Central bank) and maps out the overall ecosystem according to whether the CBDC substitutes for banknotes or bank deposits.

Bindseil shows that if the central bank issues a retail CBDC, its intermediation role becomes significant. To limit bank reliance on central bank refinancing, a portfolio of sovereign securities might prove useful. The current situation shows, however, in the absence of a CBDC, that a large securities portfolio does not cause refinancing demand to vanish.

According to Bindseil, a tiered rate mechanism that remunerates assets in retail CBDC according to their usage would make it possible to "control" the quantity of retail CBDC and alleviate the fears linked to its use. The mechanism would consist in remunerating an amount up to a certain limit, which is considered to be a means of payment (e.g. EUR 1,000), at a positive or zero rate (for example the higher between 0 and the deposit facility rate), while any deposit over that amount would be remunerated at a lower rate (e.g. -2%). Agents would then have an incentive to hold a maximum of EUR 1,000 with the Eurosystem and leave any excess amounts with the banking sector. The lower rate could be reduced in the event of a financial crisis to support the banking system. This mechanism seems complex and bureaucratic, however. Particularly in a time of crisis, it could result in the formation of a parallel market in the retail CBDC that would render the mechanism ineffective and potentially damage the issuer's reputation. Furthermore, an increase in the spread during a financial crisis could be viewed as punitive, especially if it resulted in negative interest rates, and play a part in triggering or fuelling public concerns.

Table: Financial accounts representation of CBDC (in EUR trillion)

Households, pension and investment funds, insurance companies			
Real Assets	20	Household Equity	40
Sight deposit	5 <b>-CBDC2</b>	Bank loans	5
Savings + time deposits	4		
<b>CBDC</b>	<b>+CBDC1 +CBDC2</b>		
Banknotes	1 <b>-CBDC1</b>		
Bank bonds	4 <b>+S1</b>		
Corporate/Governments bonds	7 <b>-S1</b>		
Equity	8		
Corporates			
Real assets	13	Bonds issued	3 <b>+DL</b>
Sight deposits	2	Loans	8 <b>-DL</b>
Savings deposits	1	Shares / equity	5
Government			
Real assets	11	Bonds issued	9
		Loans	2
Commercial Banks			
Loans to corporates	8 <b>-DL</b>	Sight deposits	7 <b>-CBDC2</b>
Loans to government	2	Saving + time deposit:	5
Loans to HH	5	Bonds issued	4 <b>+S1</b>
Corps/state bonds	5 <b>-S2</b>	Equity	3
Central bank deposits	0	Central bank credit	1 <b>+CBDC2 -S1-S2 -DL</b>
Central Bank			
Credit to banks	1 <b>+CBDC2 -S1-S2 -DL</b>	Banknotes issued	1 <b>-CBDC1</b>
Corp/Government bonds	0 <b>+S1+S2 +DL</b>	Deposits of banks	0
		<b>CBDC</b>	<b>+CBDC1 +CBDC2</b>

**Guide:**

CBDC 1: CBDC substituting for banknotes

CBDC 2: CBDC substituting for bank deposits

S1: CB purchases of bank bonds, S2: CB purchases of corporate bonds

DL: deleveraging

#### 4.3.2. 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 (Shirai, 2019). The response sometimes given to this accusation is that a retail CBDC would provide the central bank with an informational advantage, because it would learn at once that a run was starting. It could then step in more quickly as lender of last resort and stop a liquidity issue from turning into a solvency crisis (Brunnermeier and Niepelt, 2019). However, lots of real-time information on bank liquidity is already available through the infrastructures managed by central banks for interbank settlements and monetary policy operations. 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.

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 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.

If the possibility of more frequent runs is accepted in connection with the development of a CBDC, the question of the procedures used by the central bank to perform its function of lender of last resort (LLR) is being raised with greater urgency today. The literature on the lessons from the crisis has already shown the benefits for central banks of establishing ex ante mechanisms detailing the procedures for their involvement as LLR within a framework that minimises moral hazard (Pfister and Valla, 2018).

Furthermore, whether the retail CBDC is distributed directly by central banks or whether intermediaries are involved, the use of central bank money eliminates counterparty risk and coverage does not therefore need to be provided by a deposit guarantee mechanism.

For this reason, even in a scenario where the CBDC is distributed indirectly, the retail CBDC should be treated like banknotes and non-financial agents' holdings of the currency would therefore not appear on the balance sheets of financial intermediaries. Two qualifications, however, should be added.

First, in this case, the failure of an intermediary could give rise to operational difficulties. If an intermediary keeping CBDC ledgers is wound up, another must be able to take over quickly, by means of a mechanism that could potentially take the shape of a portability arrangement. Otherwise, liquidity and contagion risk could be created, in a situation, say, where a CBDC holder needed to convert its CBDC into bank money in order to make a payment and where it needed the failed intermediary to do this. It would therefore make sense to anticipate this type of risk by setting up mechanisms to ensure that a different intermediary (or the central bank) can take over the responsibilities for registering CBDC assigned to the failed intermediary.

Similarly, in a scenario where the CBDC is distributed indirectly, the risk of fraud connected with counterparty risk cannot be totally ruled out in theory. This is illustrated by comparing a CBDC to financial securities: the securities guarantee mechanism provided for by MFC Article L. 322-1<sup>18</sup> makes it possible to limit customer losses in the event that securities held in custody are fraudulently used by a defaulting bank that no longer has the means to redeem the lost securities. Anticipating a situation where it would be possible for an intermediary to misappropriate customers' CBDC, adopting a mechanism to guarantee intermediated CBDC, modelled on the securities guarantee mechanism, could be appropriate.

---

<sup>18</sup> Article L322-1: "With the exception of portfolio management companies, investment services providers approved in France and intermediaries authorised by the Autorité de Contrôle Prudentiel et de Résolution to provide clearing services or custody and administration services for financial instruments, and market undertakings authorised to provide the investment services mentioned in points 8 and 9 of Article L. 321-1, belong to a securities guarantee mechanism. The object of said mechanism is to compensate investors in the event of their financial instruments or their cash deposits being unavailable where they are linked to an investment service, to clearing or custody of financial instruments and falling outside the scope of II(1) of Article L. 312-4. Persons and funds excluded from compensation by Article L. 312-4-1 cannot benefit from the guarantee mechanism."



Finally, steps should be taken to protect against the operational risk that the traceability of a CBDC provided by an intermediary could potentially be “destroyed”, for example by a fire affecting the intermediary’s IT systems, to prevent any problems in terms of proving the CBDC’s existence.

4.4 Impact on the international role of the currency

The euro is now the second most-used currency in the international monetary system after the dollar. The European Commission considers that it is desirable to strengthen the euro’s international role and has put forward various arguments for this (European Commission, 2019). The Eurosystem supports this initiative (ECB, 2019). The impact of issuing a CBDC on the euro’s international role would depend primarily on the type of CBDC and the ease of access to the currency. Issuance of a wholesale CBDC could strengthen the euro’s international role if it promoted the development of a digital ecosystem in euros (3.1.3 on interactions between the wholesale CBDC and other blockchains). It is true that the dollar’s international domination is due to major network effects and lower utilisation costs than in other financial ecosystems (availability of market and payment system infrastructures, deep and uniform capital markets). While a wholesale CBDC might make the euro area’s financial ecosystem and market infrastructures more efficient, while demonstrating Europe’s innovative capabilities, removing the barriers associated with euro area fragmentation goes beyond the scope of this study and touches on initiatives aimed at completing the Economic and Monetary Union (notably, the Banking Union) and strengthening the Capital Markets Union.

If non-residents had access to the wholesale CBDC, the euro’s international role could be strengthened through this channel. It might 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, as suggested by Carney (2019; Box: A Synthetic Hegemonic Currency?) and Brunnermeier *et al.* (2019).

**Box: A Synthetic Hegemonic Currency?**

In a speech at the 2019 Jackson Hole Symposium, Mark Carney (2019), Governor of the Bank of England, suggested issuing a global Synthetic Hegemonic Currency, or SHC.

His starting point was two observations. First, the US dollar’s domineering influence on global trade and the international macrofinancial environment, with the attendant risks of a shortage of risk-free assets and a liquidity trap. The US dollar remains the dominant currency in the monetary system, despite the growing share occupied by emerging countries in global activity: more than half of all international payments are billed in USD, while emerging economies account for 60% of global activity (45% in 2009) compared with 15% for the United States. This situation exposes other countries to dollar fluctuations, even if they have few or no economic ties to the United States. It complicates monetary policy implementation for these countries by introducing volatility to their exchange rates that is not necessarily due to fundamental factors. Carney argues that these

imbalances are at the source of tensions in the financial system and that they promote protectionist and populist policies. In his view, the international monetary system needs to be reformed.

Carney goes on to point out that new technologies allow entrants on the payment services market to offer lower cost, more convenient services to cater to their customers' needs, the highest profile of these initiatives being Libra. Given the regulatory standards and obligations that Libra must meet before its launch, Carney asks whether "such a new Synthetic Hegemonic Currency (SHC) would be best provided by the public sector, perhaps through a network of central bank digital currencies". The SHC would be backed by a basket of currencies. However, Carney does not provide details about the currencies that could be included in the basket, or about the criteria that would be used to select them or to determine their relative weights. The advantages of a public SHC would be that the volatility of capital flows, particularly into and out of emerging countries, would be reduced. Furthermore, supply of safe assets would be increased and downward pressure on equilibrium interest rates would be lessened as currencies other than the dollar in the basket came gradually to be seen as reserve currencies as use of the SHC spread.

This attractive proposal raises two sets of questions, concerning:

- Its chances of success. An instrument already exists that is designed to play the role of a SHC and that is precisely a basket of the main currencies, namely special drawing rights (SDR). As Carney points out when discussing the replacement of a reserve currency, the network effects that support the currency in place have worked against the adoption of SDR in international commercial and financial transactions. Furthermore, countries issuing reserve currencies, starting with the United States, may not have wanted to see SDR imposed as a SHC. Similar arguments could act against a proposed SHC, since network effects continue to operate in favour of the dollar, and China is setting up its own network based around the renminbi. Last, might countries that do not issue reserve currencies fear that the SHC would replace their own currency in international and domestic exchanges and therefore also oppose the initiative?;
- Issuance procedures and governance arrangements. Who would decide on the makeup of the basket and according to what criteria? Who would issue the SHC and how would it be managed? The term "network of central bank digital currencies" suggests that CBDC-issuing central banks – or at least some of them – might cooperate to create a "super central bank" that would issue the SHC. However, how would issuance of the SHC be combined with that of the currencies in the basket? A potential configuration, given the "over determination" of the SHC's short-term interest rate by those of the currencies in the basket, might be perfectly elastic issuance (as with cash currently, all SHC demanded would be provided or destroyed). Even so, it is not certain that the supply of assets would be increased by this, because central banks issuing currencies in the basket would have to invest funds received in exchange for issued units in safe assets (or require the same from banks as collateral for increased refinancing), thereby depriving the market. Finally, how would the SHC be distributed? Would it be distributed through central banks, issuing the currencies in the basket, through banks and payment services providers, or even through a hybrid model involving the central banks issuing the currencies in the basket as well as banks and payment services providers?

## References

Agur I., (2018), “Central bank digital currencies: An overview of pros and cons”, in SUERF, *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions*, edited by E. Gnan and D. Masciandaro, 116-117,

[https://www.suerf.org/docx/s\\_cf0d02ec99e61a64137b8a2c3b03e030\\_7025\\_suerf.pdf](https://www.suerf.org/docx/s_cf0d02ec99e61a64137b8a2c3b03e030_7025_suerf.pdf).

Andolfatto D. (2018), “Assessing the Impact of Central Bank Digital Currency on Private Banks”, Federal Reserve Bank of St. Louis, *Working Paper 2018-026C*,

<https://s3.amazonaws.com/real.stlouisfed.org/wp/2018/2018-026.pdf>.

Armeliu s H., Boel P., Claussen C. A., Nessén M. (2018), “The e-krona and the macroeconomy”, *Riksbank Economic Review*, 2018:3,

<https://www.riksbank.se/globalassets/media/rapporter/pov/artiklar/engelska/2018/181105/20183-the-e-krona-and-the-macroeconomy.pdf>.

Bank for International Settlements/OICV-IOSCO (2012), *Principles for financial market infrastructures*,

<https://www.bis.org/cpmi/publ/d101a.pdf>.

Barrdear J., Kumhof M. (2016), “The macroeconomics of central bank issued digital currencies”, *Bank of England Staff Working Paper 605*,

<https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2016/the-macroeconomics-of-central-bank-issued-digital-currencies.pdf?la=en&hash=341B602838707E5D6FC26884588C912A721B1DC1>.

Berentsen A., Schär F. (2019), “Stablecoins: The quest for a low volatility cryptocurrency”, in *The Economics of Fintech and Digital Currencies*, edited by A. Fatás, A VoxEU.org Book, CEPR Press, 65-75,

<https://cepr.org/content/new-ebook-economics-fintech-and-digital-currencies>.

Bindseil U. (2020), “Tiered CBDC and the financial system”, European Central Bank, *ECB Working Paper 2351*, <https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2351~c8c18bbd60.en.pdf>.

<https://www.researchgate.net/publication/333149469>.

Boeschoten, W. (1992), *Currency Use and Payment Patterns*, Financial and Monetary Policy Studies, 23, Dordrecht/Boston/London: Kluwer Academic Publishers.

Bordo M. D., Levin A. (2019), “Central Bank Digital Cash: Principles and Practical Steps”, in SUERF, *Do we need central bank digital currency? Economics, Technology and Institutions*, edited by E. Gnan and D. Masciandaro, 125-144,

[https://www.suerf.org/docx/s\\_cf0d02ec99e61a64137b8a2c3b03e030\\_7025\\_suerf.pdf](https://www.suerf.org/docx/s_cf0d02ec99e61a64137b8a2c3b03e030_7025_suerf.pdf).

Bounie D., François A., Moret A., Politronacci E. (2018), “L’usage des espèces en France: priorité aux transactions de faible valeur”, *Bulletin de la Banque de France*, 220/2,

[https://publications.banque-france.fr/sites/default/files/medias/documents/bulletin-bdf-220\\_2\\_web.pdf](https://publications.banque-france.fr/sites/default/files/medias/documents/bulletin-bdf-220_2_web.pdf).

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

<http://niepelt.ch/files/EquivalencePrivatePublicMoney.01jan2019.pdf>.

Brunnermeier M.K., James H., Landau J.-P. (2019), “Digital currency areas”, 3 July 2019, VoxEU,

<https://voxeu.org/article/digital-currency-areas>.

Cabinakova J., Knüman F., Horst F. (2019), “Kosten der Bargeldzahlung im Einzelhandel”,

<https://www.bundesbank.de/resource/blob/776464/16e3a025236aa4d52f1b2c0a27e1b852/mL/kosten-der-bargeldzahlung-im-einzelhandel-data.pdf>

Carney M. (2019), “The Growing Challenges for Monetary Policy in the current International Monetary and Financial System”, Jackson Hole Symposium 2019.

<https://www.bankofengland.co.uk/-/media/boe/files/speech/2019/the-growing-challenges-for-monetary-policy-speech-by-mark-carney.pdf?la=en&hash=01A18270247C456901D4043F59D4B79F09B6BFBC>

Chiu, J., Koepl T. (2018), “Incentive Compatibility on the Blockchain”, *Bank of Canada Staff Working Paper 2018-34*,

<https://www.bankofcanada.ca/wp-content/uploads/2018/07/swp2018-34.pdf> .

Committee on Payments and Market Infrastructures – Markets Committee (2018), *Central bank digital currencies*,

<https://www.bis.org/cpmi/publ/d174.pdf>.

Engert W., Fung B. (2017) “Central Bank Digital Currency: Motivations and Implications”, *Bank of Canada Staff Discussion Paper*, No. 2017-16,

<https://www.bankofcanada.ca/wp-content/uploads/2017/11/sdp2017-16.pdf>.

Esselink H., Hernandez L., (2017), “Study on the Use of Cash by Households in the euro area”, *ECB occasional paper series*, No. 201,

<https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op201.en.pdf>.

European Central Bank (2008), “The Eurosystem’s experience with forecasting autonomous factors and excess reserves”, *Monthly Bulletin*, January, 89-98,

<https://www.ecb.europa.eu/pub/pdf/mobu/mb200801en.pdf>.

European Central Bank (2017), “Estimation of euro currency in circulation outside the euro area”,

[https://www.ecb.europa.eu/pub/pdf/other/estimating\\_eur\\_in\\_circulation\\_outside\\_the\\_euro\\_area-201704.en.pdf](https://www.ecb.europa.eu/pub/pdf/other/estimating_eur_in_circulation_outside_the_euro_area-201704.en.pdf).

European Central Bank (2017), “The international role of the euro”,

<https://www.ecb.europa.eu/pub/pdf/other/ecb.euro-international-role-201707.pdf>.

European Commission (2019), “The international role of the euro”,

[https://ec.europa.eu/info/business-economy-euro/euro-area/international-role-euro\\_en](https://ec.europa.eu/info/business-economy-euro/euro-area/international-role-euro_en).

Committee Fung B. (2019), “Cashless society: Are we there yet? Is it problematic?”, Presentation to Seminar on Understanding Cash Usage held in Athens, 19 February.

Group of Seven Working Group on Stablecoins (2019), Investigating the impact of global stablecoins, Committee on Payments and Market Infrastructures,

<https://www.bis.org/cpmi/publ/d187.htm>.

Hasan I., De Renzis T., Schmiedel H. (2013), “Retail payments and the real economy”, *ECB Working Paper 1572*,

<https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1572.pdf?0568b27871896eb01f54b0c4c40a8f63>.

Howell S. T., Niessner M., Yermack D. (2018), “Initial Coin Offerings: Financing Growth with Cryptocurrencies Token Sales”, National Bureau of Economic Research, *NBER Working Paper 24774*, June, revised in September 2019.

Humphrey D., Willeson M., Bergendahl G., Lindblom T. (2006), “Benefits from a changing payment technology in European banking”, *Journal of Banking and Finance*, 30(6), 1631-1652,

<https://www.sciencedirect.com/science/article/pii/S0378426605001780> .

Juks R. (2018), “When a central bank digital currency meets private money”, *Sveriges Riksbank Economic Review*, 2018-3, 79-99,

<http://prod-upp-image-read.ft.com/c080e86a-966c-11e9-8cfb-30c211dcd229>.

Judson R. (2018), “Big note, small note: central bank digital currency and cash”, in SUERF, *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions*, edited by E. Gnan and D. Masciandaro, 33-45,

[https://www.suerf.org/docx/s\\_cf0d02ec99e61a64137b8a2c3b03e030\\_7025\\_suerf.pdf](https://www.suerf.org/docx/s_cf0d02ec99e61a64137b8a2c3b03e030_7025_suerf.pdf).

Kostova G., Schmiedel H., Ruttenberg W. (2012), “The social and private costs of retail payment instruments – A European perspective”, Occasional Paper, 137, <https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp137.pdf>.

Mancini-Griffoli T., Martinez Peria M. S., Agur I., Ari A., Kiff J., Popescu A., Rochon C. (2018), “Casting Light on Central Bank Digital Currency”, *IMF Staff Discussion Note*, SDN/18/08,

<https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2018/11/13/Casting-Light-on-Central-Bank-Digital-Currencies-46233>.

Pfister C. (2017), “Monnaies digitales et politique monétaire: beaucoup de bruit pour rien?”, *Revue française d'économie*, 2, 37-63. Version in English: “Monetary Policy and Digital Currencies: Much Ado about Nothing?”, 2017, *Banque de France Working Paper 642*,

<https://publications.banque-france.fr/sites/default/files/medias/documents/dt-642.pdf> .

Pfister C. (2018), “Le temps (réel), c’est de l’argent”, 2018, *Revue française d'économie*, 32(4), 195-212. English version: “(Real-) Time Is Money”, 2018, *Banque de France Working Paper 675*,

<https://publications.banque-france.fr/sites/default/files/medias/documents/wp675.pdf>.

Pfister C. (2019), “Monnaie digitale de banque centrale: une, deux ou aucune?”, *Revue d'économie financière*, à paraître. English version: “Central Bank Digital Currency: One, Two or None?”, *Banque de France Working Paper 732*,

<https://publications.banque-france.fr/en/central-bank-digital-currency-one-two-or-none>

Pfister C., Valla N. (2017), ““Nouvelle Normale” ou “Nouvelle Orthodoxie”? Éléments d’un nouveau cadre d’action pour les banques centrales”, 2017, *Revue économique*, 68 – Hors-série, septembre, 41-62. English version: “‘New Normal’ or ‘New Orthodoxy’? Elements of a Central Banking Framework for the After-Crisis”, *Banque de France Working Paper 680*,

<https://publications.banque-france.fr/sites/default/files/medias/documents/wp680.pdf>.

Rogoff K. (2017), *The Curse of Cash: How Large-Denomination Bills Aid Crime and Tax Evasion and Constrain Monetary Policy*, Princeton University Press.

Segendorf B. (2018), “How many e-kronas are needed for payments?”, *Sveriges Riksbank Economic Review*, 66-78,

<https://www.riksbank.se/globalassets/media/rapporter/pov/engelska/2018/economic-review-3-2018.pdf>.

Shirai S. (2019), “Money and central bank digital currency”, *ADB Working Paper Series*, 922,

<https://www.adb.org/sites/default/files/publication/485856/adb-wp922.pdf> .

Sveriges Riksbank (2018), “The Riksbank’s e-krona project – Report 2”, October, <https://www.riksbank.se/globalassets/media/rapporter/e-krona/2018/the-riksbanks-e-krona-project-report-2.pdf>.

Yanagawa N., Yamaoka H. (2019), “Digital Innovation, Data Revolution and Central Bank Digital Currency”, *Bank of Japan Working Paper Series*, 19-E-2,

[http://www.boj.or.jp/en/research/wps\\_rev/wps\\_2019/data/wp19e02.pdf](http://www.boj.or.jp/en/research/wps_rev/wps_2019/data/wp19e02.pdf).