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# Central Bank Digital Currency

Objectives, preconditions and design choices

**DeNederlandscheBank**

EUROSYSTEM

Central Bank Digital Currency

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# Summary

**In principle, DNB has a favourable attitude to central bank digital currency (CBDC) which is money issued by a central bank and generally accessible to households and businesses.** We believe the continued use of a public form of money is important. After all, the fungibility between private money and public money bolsters confidence in money when it is needed most - in periods of uncertainty including war, financial crisis or disruption of private payments. It is at those times that the demand for public money increases. Cash has fulfilled this role, but given the decrease in the use of cash this may be set to change in the future. The trend of declining use of cash has long been ongoing and appears to be of a structural nature. CBDC could provide the desired policy options to protect the balance between public and private forms of money and safeguard the fungibility between private and public money.

**The aim of this report is to contribute to the public debate on CBDC.** The introduction of CBDC would involve a structural reform affecting users and the financial system as well as DNB's tasks and objectives. The social impact of such a reform requires broad public debate both in the Netherlands and the euro area as a whole.

**This study therefore serves as DNB's input for the debate on CBDC within the euro area.** The euro was introduced in the Netherlands in 1999, involving a transfer of monetary policy autonomy to the European System of Central Banks (ESCB). That holds for CBDC as well. As a consequence, this study also looks at the European institutional and legal framework for CBDC.

**Public debate begins with the objectives for CBDC, to which the design can be tailored.** This study lists possible objectives to support the public debate. DNB's favourable attitude is due to the possible contribution that CBDC can make to the smooth operation of the payment system. The main aim is to retain public money for general use. This is highly relevant, particularly if the use of cash - currently the only form of central bank money accessible to the public - decreases further. Depending on the design, CBDC can serve as a back-up for payments in commercial bank money. This potential back-up function grows in importance as the risk of digital disruption becomes increasingly prominent. Furthermore, CBDC could contribute to the diversity and privacy in the payment market as well as to the efficiency of cross-border payments. Possible effects of CBDC on monetary policy, financial stability and supervision must be taken into account, but the positive considerations with regard to CBDC in these areas are not a reason per se for DNB to introduce CBDC.

**Risks posed by CBDC for credit intermediation by the private sector and financial stability must be mitigated.** That requires an understanding of the amount of CBDC needed to achieve the chosen objective. After all, a larger amount of CBDC in circulation leads - *ceteris paribus* - to a larger footprint of the central bank in the financial system. Moreover CBDC could exacerbate a bank run during financial crises. That effect also applies to cash, but CBDC has no physical restrictions on transactions and saving. It is therefore crucial that control measures for CBDC are in place. It also makes sense to introduce CBDC gradually given the uncertainty about the degree of substitution between commercial bank money and CBDC.

**The design of CBDC should be a response to the objectives that the central bank wishes to achieve and the needs that users have.** Introduction of CBDC implies that the central bank not only determines the standards for the infrastructure relating to use and solidity but also its design. In this study we have broadly identified a number of design options, relating to technology, payment services, privacy and measures to control the amount of CBDC in circulation.

# 1 Introduction

**The international debate on central bank digital currency has recently gained momentum.** CBDC refers to digital money, issued by the central bank. There are a number of reasons that explain the greater interest. One is the announced introduction of new cryptos, including Libra of which value changes over time are backed by other assets. On the one hand, these cryptos could help global payments becoming faster, cheaper and more inclusive. On the other hand, if new globally operating cryptos were to be used as a means of payment on a greater scale, risks could emerge for monetary policy, financial stability and competition, to name a few (G7, 2019). As CBDC is able to contribute to improved interoperability of international payments, the central banks cooperate internationally (BIS, 2020a). Another development that has piqued interest in CBDC is the decline in use of cash, particularly in Scandinavian countries, Canada and the Netherlands. This means that the availability and use of a public form of money issued by the central bank has come under pressure for an increasing number of people.

**CBDC decision-making falls within the policy autonomy of the ESCB.** The euro was introduced in the Netherlands in 1999, which involved the policy autonomy for monetary policy being transferred to the European System of Central Banks (ESCB). As a result, this study also looks at the European institutional and legal framework for CBDC. At the beginning of 2020 a task force was set up within the euro area aimed at possible scenarios to introduce and design CBDC.<sup>1</sup> This study serves as DNB's input for that debate.

**In principle, DNB has a favourable attitude to CBDC, because it offers additional policy opportunities to safeguard the role of public money in the 21<sup>st</sup> century.** The declining use of cash and increased use of bank deposits have been ongoing trends for a considerable time. These trends are linked to increasing role of the banking sector in the process of credit intermediation during the 20<sup>th</sup> century (WRR, 2019a), and to the increasing convenience of digital payments. In the coming decade, technological innovation is generally expected to accelerate rather than decline, although the exact dynamics are of course uncertain. The debate on CBDC therefore also touches on the socially desired role of money in the future. Should a permanent role for public money for general use be deemed appropriate, this will require a structural policy response.

**There is already considerable public awareness of CBDC in the Netherlands.** In early 2019, the Netherlands Scientific Council for Government Policy (WRR) issued its report 'Money and Debt' at the request of the Minister of Finance (WRR, 2019a). Recommendations in the report included seriously considering introducing CBDC, to increase diversity in the financial sector and safeguard public functions. Following a request by the government, DNB indicated it would continue to conduct research into CBDC and issue this report in early 2020.<sup>2</sup> Relevant in this respect is that the WRR indicated in a separate report that digital technology creates vulnerabilities for society due to the increasing dependence on the critical infrastructure of the private sector. Digital disruption can affect critical processes in society including the payment system (WRR, 2019b). Seen from this perspective, the question arises whether CBDC can help to absorb those vulnerabilities through a strengthening of the public digital infrastructure.

**The question is therefore whether the central banks should introduce a digital currency and what it should be like.** Should steps be taken to continue to safeguard the fungibility between private and public money, with digital public money as an alternative and back-up for private money? Are the added value and safety of specific new technologies large enough to apply them when issuing public money? If so, what would these be? In light of the importance of the debate on CBDC, DNB also contributed to an exploratory international study of the Bank for International Settlements (BIS, 2018a).

<sup>1</sup> See also the introduction to the press conference held by the President of the ECB, 12 December 2019, <https://www.ecb.europa.eu/press/pressconf/2019/html/ecb.is191212~c9e1a6ab3e.en.html>.

<sup>2</sup> Cover letter, Government response to WRR report 'Money and Debt' and the SP's initiative policy document, Ministry of Finance, 11 June 2019, <https://www.rijksoverheid.nl/documenten/kamerstukken/2019/06/11/aanbiedingsbrief-kabinetsreactie-wrr-rapport-geld-en-schuld-en-initiatiefnota-sp>.

**The aim of this study is to inform the policy debate on CBDC both nationally and within the euro area.**

The introduction of CBDC would involve a structural reform within the monetary system affecting users and the financial system as well as the DNB's tasks and objectives, and not all effects can be predicted in advance. The social impact of such a reform requires broad public debate both in the Netherlands and the euro area as a whole.

**This study identifies possible objectives and prerequisites important to DNB as well as the corresponding design options.** That analysis underlines the complexity of the issue: a new form of public money means that all aspects of it will have to be restructured. Further elaboration therefore first requires policy choices relating to the objectives for introducing CBDC to which the design can subsequently be accommodated.

**Every specific design option for CBDC is preceded by a range of considerations.** In this study we have broadly identified a number of design options, relating to technology, payments services, privacy and control measures for the amount of CBDC in circulation. We explain the considerations made for each design option by showing how the choice was made for three existing forms of money and two crypto assets.<sup>3</sup>

**The rest of this study is structured as follows.** Chapter 2 deals with the definition of CBDC including the difference between CBDC for general use (*general purpose CBDC*) and use by professional operators only (*wholesale CBDC*). Chapter 3 identifies possible objectives for introducing CBDC and discusses the role of public and private money (section 3.2). Chapter 4 examines the possible effects of CBDC for the tasks and objectives of DNB and the ECB. Chapter 5 looks at the preconditions important to DNB: sufficient supply and demand given the chosen objective, control of substitution between CBDC and commercial bank money and execution in line with DNB's mandate. Chapter 6 subsequently discusses possible design options for CBDC. Chapter 7 presents conclusions and discusses the following steps including the policy debate within the ESCB and possible experiments with CBDC.

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<sup>3</sup> Cash, central bank reserves, commercial bank money, Bitcoin and Libra. At the time of writing, Libra is not yet operational.

# 2 What is Central Bank Digital Currency?

## 2.1 Definitions

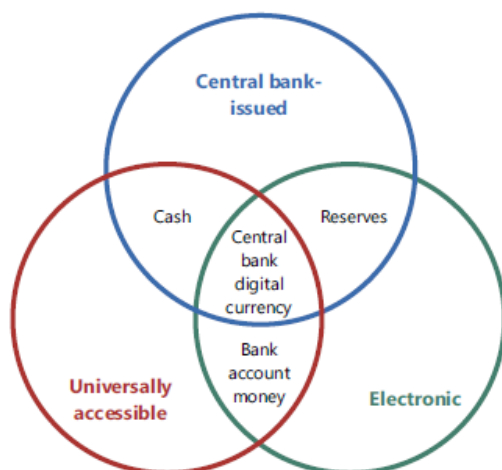
**Central Bank Digital Currency is already being used by certain professional operators.** The term Central Bank Digital Currency consists of two elements that define the main preconditions for this form of money. It is digital currency and therefore only exists electronically. And it is central bank money and thus is issued directly by the central bank. It is therefore a public form of money and not an account with a commercial bank. Any account balance with a commercial bank is referred to with the term 'private money' or 'commercial bank money'. Broadly speaking you could say that the electronic form and issuance by the central bank are the only conditions which central bank digital currency has to meet. Commercial banks, financial market infrastructures and governments have (digital) reserve accounts with central banks. The money in those accounts is therefore digital central bank money for professional operators, i.e. *wholesale CBDC*.

**General purpose CBDC assumes general access for households and businesses.** General purpose Central Bank Digital Currency includes the following:

- 1) Digital currency;
- 2) issued by the central bank; and
- 3) universally accessible.

This is what we mean in the rest of this report when referring to central bank digital currency for general use, or *general purpose CBDC*.

**Figure 1.** Classification of CBDC and other forms of money.



Source: Bjerg (2017).

**CBDC implies a third form of central bank currency, in addition to cash and reserve accounts.** Figure 1 shows central bank digital currency and the adjacent forms of money. Only banks, suppliers of market infrastructure and governments may hold reserve accounts with the central bank. Those balances cannot be held by households or businesses and therefore do not constitute general purpose central bank digital currency. Cash does constitute central bank currency for general use but is not digital. Lastly, credit balances in bank accounts are digital and used by almost all citizens as a means of payment. But credit balances are created by commercial banks. For that reason credit balances in bank accounts are not considered central bank digital currency.

**In our definition, a claim on a private institution is not CBDC.** The term synthetic CBDC was coined to describe the event in which private institutions would issue electronic money that would be fully backed by balances in an

account with the central bank (Adrian and Mancini-Griffoli, 2019). The BIS (2020b, p. 89) refers to this as indirect CBDC. In our definition, however, this is not CBDC because the customers in this case do not hold their money directly with the central bank. In this case, their money is still a liability of a private institution and not the central bank. For that reason balances with a public or private deposit bank are not general purpose CBDC in our definition.

**Technically speaking, CBDC can be designed as a locally stored digital value, but in practice it would probably be an account with the central bank.** In international debates on CBDC, the distinction is often made between CBDC as the balance in an account, or *account-based*, and CBDC as a locally stored digital value, or *value-based* CBDC<sup>4</sup> (inter alia BIS, 2018, 2020b). Where CBDC is an account, the balance is stored in a single or distributed database. The value of *value-based* CBDC is stored locally, for example on a smart card. However, there are some serious drawbacks to this latter option, not least because of the risks of hacks, loss, challenges in preventing money-laundering, less effective centralised control of the system<sup>5</sup> and because of the lack of an identity (BIS, 2020b, p. 94). Hacking in particular poses a significant risk. Should the cryptography of, for example, smart cards be cracked, large amounts of CBDC could be created outside of the central bank. This explains why almost all digital payment systems used on a large scale work with credit balance in an account. According to the above definition, these are therefore *account-based*. The technology behind *account-based* digital payment systems has proven itself to a far greater extent than *value-based* digital money.

**Such an account-based CBDC infrastructure would focus on a ledger with balances and transactions in CBDC** (Bank of England, 2020). Intermediaries would be given access to the data in that core ledger through *Application Programming Interfaces* (APIs). Based on that data, intermediaries could in turn develop user-friendly applications with which regular consumers and businesses are able to make CBDC payments. We examine this in greater detail in chapter 6.

## 2.2 Policy options

**Policy options mainly depend on the following: (1) who is allowed access to CBDC and (2) the degree of technological innovation.** That difference in access determines the distinction between *wholesale* CBDC (access only for certain professional operators) and general purpose CBDC (access for households and regular businesses). The introduction of *wholesale* CBDC would imply less sweeping reforms than the introduction of *general purpose* CBDC, which is accessible to the general public. Central Bank Digital Currency already exists in the form of balance in reserve accounts with the central bank of professional operators. *Wholesale CBDC* thus refers to technological innovations in that existing form of central bank currency. But that is not a response to the structural declining trend in cash use. Partly for that reason, this report is mainly concerned with *general purpose* CBDC.

**One form of technological innovation that has recently garnered a great deal of attention is programmable digital money.**<sup>6</sup> CBDC can be offered as a traditional account for simple transactions or with features that make its use programmable. In the payment system, transactions are carried out that reach the payment processor as a message in a particular format. When that message is processed, the balances are

<sup>4</sup>The term *token-based* is sometimes used as a synonym of *value-based CBDC*. In our opinion this is a less appropriate term than *value-based*, and so in our report we will use *value-based*.

<sup>5</sup>This is illustrated by the caps on contactless payment which have recently been increased because of the outbreak of the coronavirus. In the Netherlands this can be done within a matter of weeks, whereas this proved impossible in countries where the cap is stored locally on the chip of the debit cards as it requires all debit cards to be replaced. See also Auer, Cornelli and Frost (2020) on the impact of the corona virus on payments.

<sup>6</sup>One example of this is the recent argument by the German banking sector for the introduction of a programmable digital euro, see German Banking Association (2019). In the German Banking Association's view (2019) this could also be a digital euro issued by banks, therefore a private form of money.



transferred. In the case of programmable money, the payment processor can receive not only payment orders but also conditions for that payment. Households could therefore opt to effect certain transactions, such as paying the rent, as soon as the salary has been deposited. In contrast to standing orders currently used, the date could therefore change each month. Balances could also be earmarked more easily. For example, a transaction using programmable digital money earmarked for healthcare would be refused if the spender tried to use it to buy unrelated items. Naturally other applications are conceivable.

**The degree of technological innovation determines whether CBDC takes the form of an existing account with a commercial bank or applies new technologies such as programmable money.** That results in the four policy options outlined in Table 1. In the case of programmable money the conditions for payment instructions are defined in advance as code. These conditions drawn up as computer language could take the form of a *smart contract*.<sup>7</sup> If the conditions are met, the transaction will be conducted automatically. The money – in the form of CBDC<sup>8</sup> – and the assets or goods to be exchanged are then both taken to a programmable platform. Transaction costs could thus be reduced, as delivery takes place against immediate payment to mitigate the risk of one party failing to deliver. That could be equal exchange in, for example, security trading. That is referred to as *Delivery versus Payment*. Another option is equal exchange of different currencies, for example a euro/dollar transaction, which is referred to as *Payment versus Payment*. Both *Delivery versus Payment* and *Payment versus Payment* require the tokens of both goods to be traded on the same platform or on different platforms that are interoperable. That is not yet the case for many goods or currencies. The potential applications for programmable money are therefore expected to increase further as the amount of *tokenised assets* grows. Chapter 6 looks in more detail at the technological design of CBDC.

**Table 1.** Main policy options.

<b>Innovation technology?</b>	Yes	Wholesale CBDC Programmable	General purpose CBDC Programmable
	No	Current reserve accounts	General purpose CBDC Traditional account
		No	Yes
<b>Accessible to general public?</b>			

<sup>7</sup> Many systems in which users can create *smart contracts*, use *Distributed Ledger Technology* (DLT). However, as we argue in chapter 6, *smart contracts* do not depend on the use of DLT.

<sup>8</sup> In addition there are private initiatives underway to introduce private asset-backed cryptocurrency that is backed by central bank money. According to our definition that does not constitute central bank money because in this case it concerns a claim on a private institution. For example see Fnality (2019).

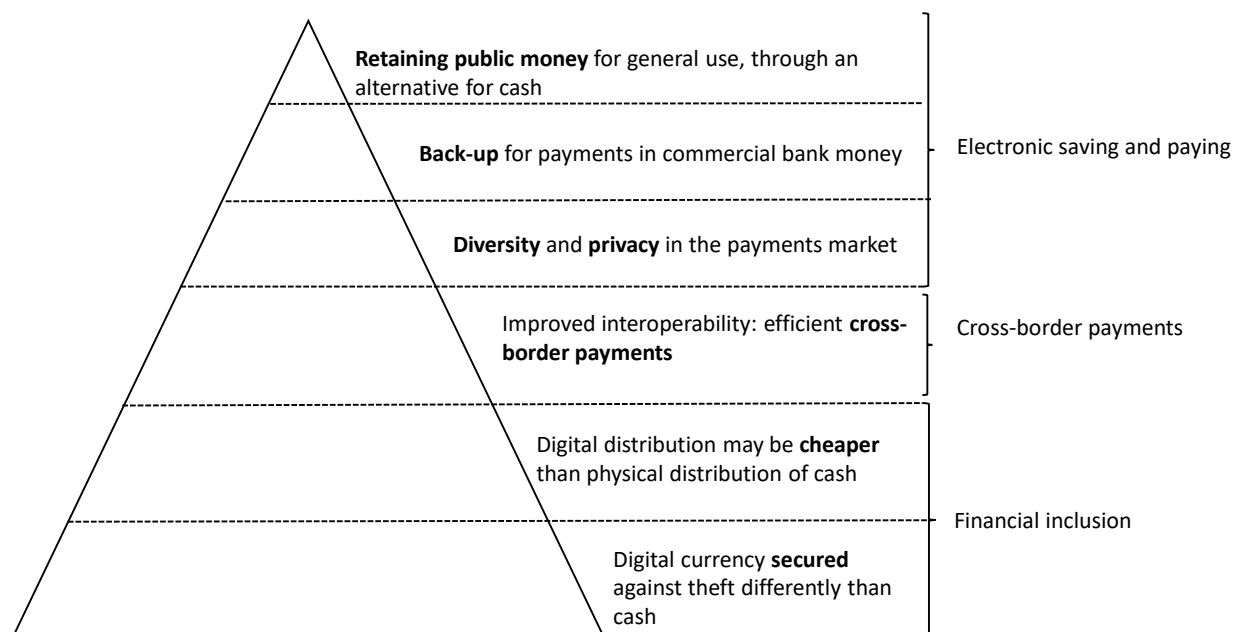
# 3 Objectives

## 3.1 Overview

**Literature and surveys held among central banks list a plethora of possible objectives for CBDC.**<sup>9</sup> This section therefore starts by outlining the possible objectives of CBDC in the interest of public debate. Next, section 3.2 contains a more in-depth deeper discussion of retaining public money for general use as one of the possible objectives of CBDC. First the objective is chosen, after which policy options to achieve that objective are examined.

**The different objectives are partly related to the differences in starting point, in particular between developed and emerging economies** (see also OMFIF, 2019). Figure 2 summarises possible objectives mentioned frequently in international circles. The figure has the pyramidal shape of the hierarchy of needs. In developed economies the objectives in the upper half of the pyramid are mentioned most often because they are appropriate to a digital economy with a highly developed financial system. The bottom half centres on financial inclusion because this objective is mentioned most by central banks in countries with a developing economy and financial system.<sup>10</sup> The possible objectives in Figure 2 are discussed below from the top down.

**Figure 2:** Possible objectives of CBDC



**With cash use declining, CBDC ensures policy options are available to retain public money for general use.** The increasing adoption of user-friendly digital money has a secondary effect, namely that the public form of money – cash – is used less and less. That could create a future scenario in which citizens only have access to private money, putting pressure on the one-to-one fungibility between public and private euros. It is hard to predict exactly what the effects would be, but it is clear that the loss of public money for general purpose leads to an

<sup>9</sup> One of the first questions in these surveys related to the objective: why is CBDC being considered at all? See Barontini and Holden (2019) and Boar, Holden and Wadsworth (2020).

<sup>10</sup> This is not a clear-cut distinction because financial inclusion is relevant to the Netherlands as well. For example dependency on cash is greater within certain specific groups such as the elderly, children and visually impaired persons. Security is also topical given the debate on risks of digital disruption on the one hand (see section 4.1) and ram-raiding of ATM machines on the other.

increased dependence on private operators. Consequently, section 3.2 takes an in-depth look into the origins of fungibility of different forms of money and their importance today.

**Public demand for CBDC stems from the desire to couple security with convenience: a safe and user-friendly public digital euro.** The WRR (2019a) states that the first public alternative for private money disappeared in the early 90s with the privatisation of the Postbank. And cash as alternative is coming under increasing pressure. That shifting balance in the role of public and private money is adversely affecting diversity in the financial system, according to WRR. The WRR therefore calls for seriously considering CBDC as one of the options for a “*publicly anchored alternative for payment and savings, in addition to the current banks*”. The organisations ‘*Ons Geld*’ (Our Money) and the Sustainable Finance Lab emphasise the importance of public money for general use.<sup>11</sup>

**CBDC could act as a back-up for the critical infrastructure in the payment system.** Cash has an important function as back-up during failures in non-cash payments. If use and acceptance of cash declines, this back-up function could come under pressure. At the same time, the increasing dependence on digital payments leads to new risks. The WRR (2019b) points out that digital disruption could affect critical processes in society, including the payment system. The question then is whether CBDC could act as a back-up for that digital payment system. The infrastructure for CBDC would, from a technical point of view, have to be sufficiently separate from the current commercial payment infrastructure to prevent both becoming disrupted. On balance, if cash use continues to decrease, CBDC could serve as a parallel back-up and its role could gradually become more prominent.

**To prevent an unwelcome disparity in the market of the future, it makes sense to consider CBDC now before private solutions dominate the market.** CBDC is not only an alternative for cash but also for private forms of money. Because the payment market is a volume business (the greater the number of payments, the cheaper each transaction becomes), it could lead to a strategic dependence on one or several dominant private operators (or: *winner takes all*). In fact we already see that in the Netherlands the payment system for retail is highly dependent on one dominant US-based company (Mastercard). And in Sweden, seven out of ten Swedes use Swish, which allows the transfer between bank accounts in real time (Riksbank, 2019). Payments using Swish are free of charge to consumers but not for businesses. Where that gives rise to questions about market power, it is of course up to competition authorities to look into. But at the same time the dominance of private providers and the ensuing cost structure could also fuel the demand for CBDC as an alternative to payments in private money.

**The design of CBDC can be tailored to the preferences of the public, relating to privacy and the use of data for public goals.** New players on the scene of payments introduce new business models with a conceivable key motive being to obtain payment data from users, whether or not to combine those with data they already have. But some citizens and businesses highly value privacy when paying, as is the case with cash. When offering CBDC the design could be aligned to those preferences. The BIS (2020b, p. 95) recommendation is, when paying in CBDC, to only communicate that the transaction has been completed but not to send any further information about the account holder. The central bank would not use information about ownership and payments in CBDC for commercial purposes. The use of data by authorities could be restricted to just that information required for public duties such as compliance with anti-money laundering legislation.<sup>12</sup>

**International payments between the various currencies are expensive, can take several days and it is often unclear where the payment actually is** (CPMI, 2018; BoC, BoE and MOS, 2018; BIS, 2020b). One main

<sup>11</sup> See for example Sustainable Finance Lab (2019), <https://sustainablefinancelab.nl/wat-te-vinden-van-de-libra-vier-voordelen-en-vijf-nadelen/>. And Ons Geld (2019) talks about: “*a secure bank account for everyone*”. In Ons Geld’s view this would preferably be done by a public bank, but it does not rule out CBDC as an alternative.

<sup>12</sup> See also Garret and Van Oordt (2019) on the opportunities of CBDC in the area of privacy.

reason for this is that international payments generally pass through a series of links, where so-called *correspondent* banks from different countries hold accounts with each other. In principle CBDC could reduce the number of steps if a cross-border payment was able to pass directly from the account of the central bank to the account of the foreign central bank of the receiving party abroad. However this would need to be detailed further and would probably imply cooperation with private operators because the exchange of different currencies has to take place at the rate prevailing at that time. These details still need to be fleshed out including in the international debate on CBDC that is currently taking place at the Bank for International Settlements (BIS, 2020a).

**Depending on how it is designed, CBDC could contribute to more efficient cross-border payments within Europe.** In general, the Dutch payment system is considered to be safe, reliable and efficient (DNB, 2012 and 2018). Progress has been made within Europe towards an integrated European payment market, in particular for transactions involving international bank account numbers (IBAN) within the *Single European Payments Area* (SEPA). However, payment methods are still fragmented throughout Europe for point-of-sale and online payments, which is why the ECB launched a European payment strategy of which CBDC could become part, if insufficient progress is made by the sector (ECB, 2019).

**The reasons frequently highlighted by the central banks of emerging economies for introducing CBDC are shown in Figure 2** Financial inclusion is named as a key reason by the Bahamas, China, Senegal, Tunisia and Uruguay (Mancini-Griffoli *et al.*, 2018, p. 28). Central banks sometimes mention the fact that the telecoms network has wider coverage than the banking network. Or digital distribution between islands could be cheaper than the physical transport of cash. Security is also a consideration. Both cash and CBDC are vulnerable to theft but each in their own way, i.e. physical and electronic theft respectively, and each requires appropriate security.

**Other possible objectives, on which there is much debate and little agreement at international level, relate to CBDC as a tool to improve monetary transmission and CBDC as a tool to make the financial system safer or the opposite, namely CBDC as a risk to financial stability.** Possible effects of CBDC on monetary policy, financial stability and supervision must of course be taken into account, but the positive considerations with regard to CBDC in these areas are not a reason per se for DNB to introduce CBDC. These issues are discussed in chapter 4 under the possible effects of CBDC on the duties and objectives of the central bank.<sup>13</sup>

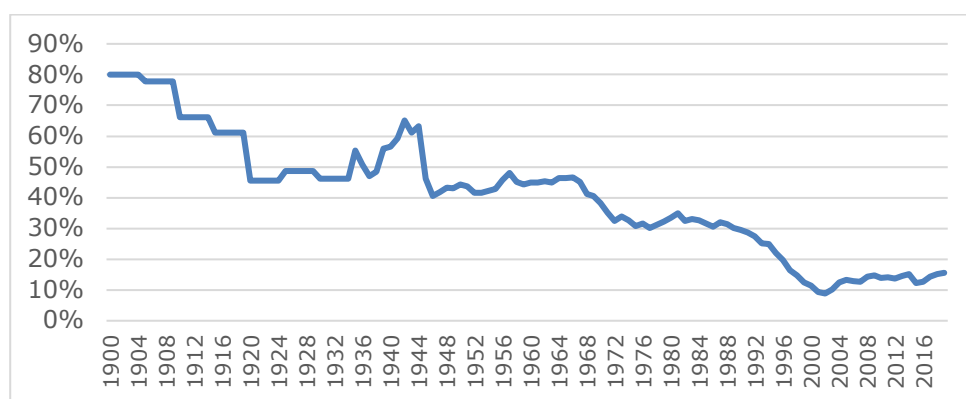
## 3.2 Retaining public money

**The debate on CBDC also bears on the question why a public form of money exists alongside private forms of money and whether it is advisable that a significant part of the population actually uses and accepts this public form.** For an increasing number of Dutch people, the use of cash is no longer a given. The digital form of money is becoming ever more user-friendly and in particular young people hardly ever use cash anymore. Figure 3 shows the long-term trend in the composition of the total money supply. Money in 1900 consisted of 80% cash (coins and banknotes). This declined to 41% directly after the Second World War. And in 2019 that percentage was 16%. The use of cash as payment means in the Netherlands has decreased further in the past years. In 2018, Dutch consumers paid 37% of their purchases in shops, bars, restaurants, hotels and similar establishments in cash (or 63% electronically), down from 65% (or 35% electronically) in 2010.<sup>14</sup> The Netherlands has the lowest percentage of payments in cash in the entire euro area (ECB, 2017).

<sup>13</sup>Generating seigniorage income is also mentioned as a possible reason to introduce CBDC, however this is not an objective in itself for central banks. Policy is motivated by public objectives such as the smooth operation of the payment system, monetary policy and financial stability. The effect of CBDC on seigniorage income depends heavily on the design, i.e. whether or not interest would be paid on CBDC. This design option is discussed in chapter 6.

<sup>14</sup> See also <https://www.dnb.nl/en/news/news-and-archive/DNBulletin2019/dnb384990.jsp>

**Figure 3.** Cash in the Netherlands, 1900-2019 as a percentage of the sum of non-cash and cash money.



Source: Statistics Netherlands and DNB. Note: the definition used for the money supply is M1, or the sum of non-cash and cash money. The erratic patterns shown before 1936 is explained by the data being available only once every five years from 1900.

**That raises the question: how important is the fungibility between public and private forms of money, for wide groups in society?** The exchange of private euros for public euros may use two channels. In the first, commercial banks can exchange their claims on other banks for balances in the reserve accounts with the central bank. This explains why balances on reserve accounts increased sharply during the credit crisis. This channel does not depend on the use of cash by the general public and continues to exist even if general purpose CBDC is not introduced. However, if this becomes the only channel, the dependency of citizens and businesses on the banking sector would increase. For that reason, the second channel is also important, namely that citizens and businesses can exchange their balances in commercial bank money for central bank money themselves. Most users see a euro amount as a euro amount, regardless of whether that is an amount in a bank account, a banknote or a handful of coins. This fungibility has become so commonplace that many people take it for granted. But in fact the link is not that straightforward. If there were no public alternative for the private euro, the value of private money would not be linked to the public euro one-to-one. If a bank were to go into liquidation there would be no public euro to fall back on, creating uncertainty about the value of the money. Let us take a look at Dutch monetary history to help clarify the importance of fungibility.

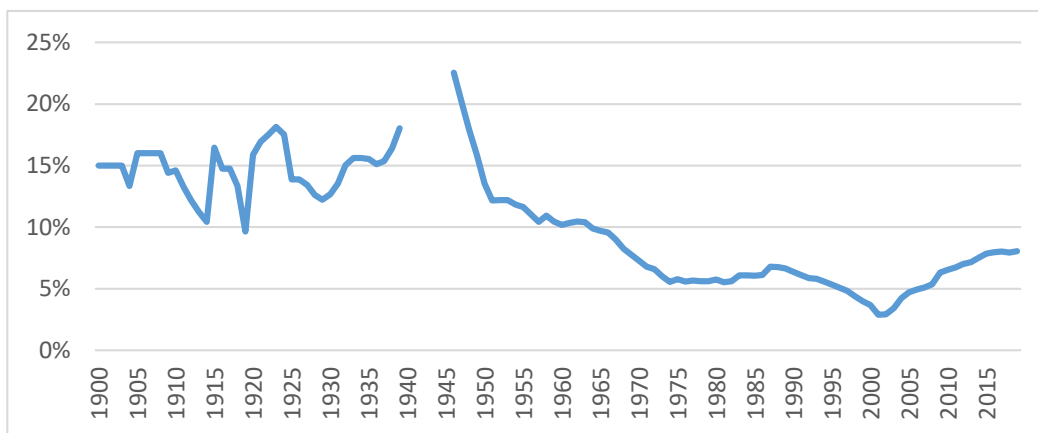
**From the very first, central banks promoted stability by exchanging cash and non-cash money in times of uncertainty.** The Amsterdam Exchange Bank (*Amsterdamse Wisselbank*), founded in 1609, is now seen as the precursor of the current central banks (Quinn and Roberds, 2014). The prevailing form of money in that era was coin and there was competition between the various coins. At the start of the 17<sup>th</sup> century there was no longer any uniform minting in the Northern and Southern Netherlands due to the war with Spain. There was also a wide variety of coins for international trade. Uncertainty about the value of money was hindering trade, which is why the Exchange Bank took in silver and gold coin, checked its quality and issued bank guilder deposit receipts in exchange. As a result, “the dismal and unstable guilder of around 1600 was replaced by an indexed and stable guilder” (Van Nieuwkerk, 2005). The bank guilder became the leading international currency of the time (Quinn and Roberds, 2014) and this chapter in history contains valuable lessons for our present time (Schnabel and Shin, 2018; Knot, 2019 and Frost, Shin and Wierds, 2020).

**In present times the fungibility between public cash money and private non-cash money remains important, in particular during periods of uncertainty such as war and financial crisis.** For precautionary reasons, the demand for safe public money continues to increase during periods of uncertainty.<sup>15</sup> As a case in point,

<sup>15</sup> Other reasons to retain money relate to the transaction and speculation motives.

the amount of cash circulating in the Netherlands increased during the crisis of the early 30s, before and after the Second World War and again during the credit crisis when it rose from 5% of GDP in 2007 to 7% of GDP in 2012 (Figure 4). Similar increases in the outstanding amount of cash money during uncertain times can also be seen globally. Since the credit crisis of 2007-2008 the amount of outstanding cash money worldwide has increased significantly and can partly be attributed to growing uncertainty (Jobst and Stix, 2017).<sup>16</sup>

**Figure 4.** Cash in the Netherlands, 1900-2019 as percentage of GDP.



Source: Statistics Netherlands and DNB. Note: the definition used for the money supply is M1, or the sum of non-cash and cash money. There are no GDP data for the period 1940-1945.

**Substitution between private and public money not only occurs during a crisis.** Whereas during the crisis the greater security of public money led to substitution of private to public money, it is now the user-friendliness of private digital money that is contributing to substitution of public money (cash) to private money, in particular for transaction reasons. This process is slower and more structural than during a crisis but ultimately leads to the same question about fungibility and balance between public and private money.

**DNB welcomes the continued use of a public form of money and therefore has a favourable attitude towards CBDC.** Uncertain times can lead to an increased demand for public money. That should be a euro that is exchangeable 1:1 for private money. That fungibility bolsters confidence in the monetary system when it is most needed: in periods of uncertainty including war, a financial crisis, the rise of a government mistrusted by the population or a disruption of private payments.<sup>17</sup> For that reason, DNB has for many years been committed to useful, reliable, accessible and affordable cash money (DNB, 2018). Looking to the future this can be worded more broadly as follows: DNB is committed to useful, reliable, accessible and affordable *public* money. The principle is timeless whereas the form could adapt to changes in technology and user demand.

<sup>16</sup> See also Cusbert and Rohling (2013) for a case study of the rise in demand for cash during the financial crisis in Australia.

<sup>17</sup> This is the reason that the Norwegian central bank continues to value cash money.

# 4 Effects on the central bank's tasks

**The introduction of a new form of public money would have wide-ranging implications for the tasks and objectives of DNB and the ECB.** This chapter comprises an initial analysis of possible effects: on the smooth operation of the payment system (4.1), monetary policy (4.2), financial stability (4.3) and supervision (4.4).

## 4.1 Smooth operation of the payment system

**Most of the possible objectives in Figure 2 relate to the smooth operation of the payment system.** Two aspects are highlighted in current debates. Firstly, a possible role for CBDC as a back-up for the volume of non-cash payments in light of the risk of digital disruption mentioned above. Secondly, the prospect of new forms of cryptocurrency being introduced by BigTech companies which came to the attention of central banks worldwide and which has led to the publicly expressed demand for CBDC as a public alternative. We will discuss both aspects in more detail below.

### CBDC as a back-up

**In the Netherlands, payments<sup>18</sup> are considered part of the critical infrastructure** (DNB, 2017). This means that any failure or disruption of that infrastructure could lead to severe societal disruption and pose a threat to national security.

**At present, cash is the fall-back option for private digital money.** The different steps in a payment transaction form payment chains.<sup>19</sup> The availability of retail payments depends on the following: (1) the availability of the different payment chains; (2) the degree of overlap of links in the payment chains, and (3) the degree to which one payment chain can replace the other. The cash chain is less suitable as a substitute for the electronic chain if fewer people have cash on them, ATMs disappear and fewer shops accept coins and banknotes.

**CBDC would mean introducing an extra alternative: public digital money.** That could increase the robustness of the retail payment system. CBDC's value as a back-up would depend on its availability, ability to act as substitute for private non-cash chains and its overlap with other chains. Of course, a CBDC would have to be available almost all the time. Key conditions for CBDC to function as a substitute for the current private and public chains are that it must be widely held and broadly accepted. However, of particular importance for the robustness of payments is the overlap of a CBDC with other chains. Basically there should be no overlap at all, otherwise a malfunction (or hack) in the overlapping section would take out both chains.

**CBDC has particular value as a back-up in payments if it minimises the use of private non-cash chain components.** Any link that is a *point of failure* for both the private and the public digital chains, would be a *single point of failure* for digital payments. Using as little private infrastructure as possible such as that of commercial banks, schemes<sup>20</sup> and processors could contribute to robustness. In the event of an emergency, people would still be able to make debit card payments using central bank money and exchange non-cash central bank money for cash at ATMs.

**Creating different options to deal with negative shocks can increase the resilience of complex systems, as described in more detail in Box 1.** CBDC's value as a back-up would depend to a considerable degree on its

<sup>18</sup> Payments comprise point-of-sale (POS) payments and electronic payments. POS payments include cash payments, withdrawal of cash, electronic payments with debit cards and credit card payments. Credit transfers, direct debits and standing orders are part of the non-cash payment system.

<sup>19</sup> See DNB's video clip explaining the payment chain <https://www.youtube.com/watch?v=zadZluonWR0>.

<sup>20</sup> Examples of widely used schemes in the Netherlands are V Pay and Maestro.

availability, ability to act as substitute for commercial bank money and cash and its overlap with commercial bank money and cash.

**In the debate on the robustness of payments and CBDC, the topic of off-line payments regularly comes up.** These are digital payments not requiring an internet connection. They are also an option to make current non-cash payments more robust. For example *store-and-forward* mechanisms in a CBDC design could reduce the dependence on a continuous internet connection. Examples of these are *merchant approved transactions* where the retailer takes the risk that the customer may not have sufficient funds. In the case of commercial bank money this mechanism is used on aircraft, for example, where in-flight transactions are forwarded to the processor after landing. Collecting this transaction history at a central point is important as otherwise the large-scale use of off-line payments would open up a range of new possibilities for fraud and weaken central supervision of the system. In consequence, off-line payments are not a solution to long-term system-wide malfunctions.

**As applies to many electronic systems, in the design of CBDC this also means a trade-off between efficiency when all payment chains function properly and resilience in emergencies.** In the normal situation, economies of scale can be achieved by using the existing infrastructure. The use of and interoperability with existing infrastructure also drive the demand for CBDC. If retailers were to need separate debit card terminals for CBDC, it would entail costs to society. At the same time, CBDC would become dependent on this existing infrastructure. The resilience to emergencies would decrease for example if the debit card terminals failed to work properly. For that reason we have included this point in the design options in chapter 6.



### Box 1: Resilience in complex systems

**Complex systems as a whole display properties that cannot be derived from the constituent parts.** Take ant colonies for example or the nervous system, forms of telecommunication and the financial system. Because complex systems are not linear, a relatively small deviation can quickly lead to a totally different result. This is known as the butterfly effect, illustrated by Edward Lorenz' remark that the wings of a butterfly in Brazil could cause a tornado in Texas a few months later. This concept is also relevant to the financial sector as a complex system. The first signs indicated that the losses were limited to the *subprime* market. It only emerged later that contagion was worldwide (Laeven and Valencia, 2010).

**A key point in Taleb's work (2012) is that economic agents can combat unpredictability by creating options.** He provides examples citing a wide range of different systems, such as the fact that people have two kidneys where one would suffice to keep that person alive. The second kidney is a fall-back option for a vital function of the organism. He goes on to argue that a market economy is similarly more robust than a centralised economy: by giving economic agents a choice in different suppliers, some suppliers can go into liquidation without this adversely affecting the service in the economy.

**These lessons for complex systems in uncertainty are also relevant to the payment system, given the established uncertainties regarding digital disruption of the critical infrastructure.** The WRR (2019b) emphasises uncertainty about the causes of shocks to the digital infrastructure: "*although cyberattacks are a main cause of incidents, human error, defective servers, software problems or external factors such as cable ruptures or power outages could have a great impact on the operation of digital infrastructure*". Both CBDC and the private payment infrastructure can be affected by any one of those and could also be affected simultaneously. However, the chance of the latter happening is less likely if they operate independently of one another.

**Option-driven policy can make the payment system (and perhaps even society as a whole) more agile and robust, but that does involve cost.** Using existing infrastructure for CBDC is probably cheaper than building parallel payment chains. These trade-offs can also be observed at macro level, between efficiency if all goes well and resilience if it does not. In times of prosperity diversity often means fragmentation and emergency scenarios can be forgotten. Therefore it is important to weigh the social costs and benefits.

### CBDC in response to cryptocurrencies

**Global interest in CBDC has grown since the announced introduction of new forms of cryptocurrency** (OMFIF, 2020). With that in mind we will discuss the current risks of cryptocurrency and their supervision, the current international debate on the risks of new forms of cryptocurrency and the possible role for CBDC seen from this perspective.

**Providers of crypto services must apply for registration with DNB.** DNB and the AFM point out that cryptocurrencies are vulnerable to financial crime (DNB and AFM, 2018). Supervision is currently aimed at combating money laundering and terrorist financing, in accordance with the revision of the Fourth Anti-Money Laundering Directive. The duty to register applies to providers of services for the exchange between virtual and regular currencies and the providers of custodian wallets for virtual currencies.<sup>21</sup>

**The announced introduction of new forms of cryptocurrency has sparked international debate about extending the scope of supervision to those new forms.** The BIS (2018b) and DNB/AFM (2018) do not regard cryptocurrency as money because they do not function as a medium of exchange, store of value or unit of account. However, with the BigTech companies announcing that they will introduce their own cryptocurrencies whose value will be backed by assets, the possibility exists that these cryptocurrencies will in future operate, at least in part, as a means of payment. For that reason, the G7 (2019) pointed out that although this offers opportunities for the efficiency of cross-border payments, it also leads to emerging risks, including smooth operation of the payment system, financial stability, monetary policy, competition and privacy. In the summer of 2020, the Financial Stability Board will therefore publish a report on the necessary extension of supervision of new forms of cryptocurrency.

**Even countries where cash is still in widespread use are showing an interest in the possibility of introducing CBDC in response to private cryptocurrencies.** Respondents in a global survey held by OMFIF (2020) indicated that they would have most confidence in digital money issued by the monetary authorities. The respondents from developed economies in particular indicated placing little faith in cryptocurrency issued by technology or credit card companies.

**CBDC and cryptocurrency have distinct profiles.** Table 2 compares in outline the possible effects of public money (including CBDC), private money and new forms of cryptocurrency on different aspects of the smooth operation of the payment system: security, reliability and efficiency. On the one hand cryptocurrency does offer opportunities to improve the efficiency of international payments, but on the other, cryptocurrency does not fall under the deposit guarantee scheme (DGS) and as a result it is less secure than CBDC, payment data are sometimes used as part of the business model, and there could be network effects and dominant market power. It is important that the convenience of CBDC matches that of private money (see chapter 6, design).

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<sup>21</sup> See <https://www.toezicht.dnb.nl/2/50-237993.jsp>.

**Table 2.** Money, cryptocurrency and the smooth operation of the payment system

	Money issues			Crypto
	Cash, public	Non-cash money, private by banks	Central Bank Digital Currency, public	BigTech digital cryptocurrency, asset-backed, private <sup>22</sup>
<b>1. Security</b> <i>Credit risk</i>	Claim on central bank	Claim on private bank insured under DGS	Claim on central bank	Claim on BigTech, not under DGS. Risk of losing trust.
<i>Theft</i>	Risk of physical theft	Risk of digital theft	Risk of digital theft	Risk of digital theft
<i>Use of data</i>	Generally anonymous	Account in holder's name. Customer approval required to share data (PSD2)	In all likelihood in customer's name. Anonymity depends on design	Commercial use of payment data; privacy risks
<b>2. Reliability:</b> <i>Infrastructure</i>	Robust cash infrastructure	Reliable critical digital infrastructure for the private sector. But remember the risk of digital disruption (WRR, 2019b)	Reliable critical digital infrastructure for the public sector. But remember the risk of digital disruption (WRR, 2019b)  Resilience increases in parallel public and private infrastructures.	Critical infrastructure dependent on BigTechs. Security as yet unknown, but remember risk of digital disruption (WRR, 2019b).
<b>3. Efficiency</b> <i>Costs and market power</i>	Costs of logistics; distribution via banks	Retail payment system secure and efficient by tailoring to customer needs. But power concentrated in major Dutch banks (WRR, 2019a)	Costs of public infrastructure; issuance possible through private intermediaries catering to customer needs	Probably efficient, notably across borders due to new infrastructure and global scale. But market power concentrated in BigTechs

## 4.2 Monetary policy

**Introducing CBDC would impact the central bank and the monetary system in a variety of ways.** Access to non-cash money with the central banks is currently reserved for banks and a small circle of governments, foreign central banks, supranational institutions and market infrastructure providers. The issuance of CBDC would open that access up to the general public.

### Impact on the central bank

**CBDC could be a substitute for cash.** Except for equity capital, the liabilities side of the central bank balance sheet consist almost entirely of central bank money (Figure 5). Suppose that citizens and businesses exchange a sum of money CBDC1 in banknotes for CBDC at the central bank. In that case CBDC substitutes part of the outstanding amount of banknotes on the central bank balance sheet. The amount of central bank money remains the same but changes in configuration. This is illustrated in Figure 5 by the decrease in banknotes with CBDC1 and the increase in the balance sheet item CBDC for the same amount.

**CBDC could also be a substitute for commercial bank money.** Suppose that citizens transfer a sum of money CBDC2 from their commercial bank account to their account with the central bank. Depending on the state of monetary policy, the central bank can be forced to extend the asset side of the central bank balance sheet. This extension would result in an increase in the amount of central bank money. How this works is explained below.

<sup>22</sup> In addition, payments already exist with commercial bank money that are made on BigTech platforms not visible to banks.

**Figure 5.** Central bank balance sheet with excess reserves

Assets		Liabilities	
Gold and foreign currency reserves	15	Equity capital	10
Own euro-denominated investments	15	Banknotes	20 -CBDC1
Loans	30	Minimum reserves	30
Monetary portfolios	40	Excess reserves	40 -CBDC2
		CBDC	+CBDC1 +CBDC2

**The potential necessity in the event of substitution of commercial bank money by CBDC to extend the asset side of the central bank balance sheet follows from the way in which the central bank steers short-term interest rates.** This is done through the compensation on “central bank reserves” (reserves). Reserves are money that commercial banks keep in their reserve accounts with the central bank. Banks use these sums to make payments amongst themselves, for example. As such reserves contribute to the smooth operation of the payment system. But steering interest rates is also done through reserves. Interest paid on reserves thus has a dominant influence on how much banks in financial markets wish to pay in order to lend or borrow money for a single day. The expectations about the interest rate on reserves in the future have a dominant influence on long-term interest rates in financial markets. Banks pass on these interests rates to their customers. But for this mechanism to work, banks need sufficient reserves at their disposal. Only then will the interest rate on reserves be a dominant factor for the interest-rate pass through to customers and financial markets. The central bank therefore has to ensure a sufficient amount of reserves.

**The demand for banknotes and CBDC lowers the amount of reserves in banks.** Banks use the money in their reserve accounts to buy banknotes from the central bank to stock up the ATMs. Banks could also see their reserves with the central bank decreasing if their customers transfer funds to CBDC accounts with the central bank. Greater demand for banknotes and CBDC therefore leads to fewer reserves. With current monetary policy, banks need more reserves than required to steer the interest rates (excess reserves). Substitution from commercial bank money to CBDC does not give rise to any action by the central bank as long as it is not greater than the sum of the surplus. The central bank balance sheet only alters in composition, as illustrated with **CBDC2** in Figure 5.

**When monetary policy normalises, banks will operate with the minimum amount of reserve required to execute the monetary policy** (the item minimum reserves in figures 5 and 6). In this case the central bank must actively counterbalance the greater demand for CBDC by bringing new reserves into the system. The central bank can do so by extending its assets, in which it can choose between a) gold and foreign currency reserves, b) own euro-denominated investments<sup>23</sup>, c) loans against sufficient and adequate collateral to banks and d) monetary portfolios existing of bonds denominated in euros. By bringing new reserves into the system, the central bank increases its balance sheet. In Figure 6 **CBDC2** illustrates the substitution of commercial bank money to CBDC. The

<sup>23</sup> As part of its own investments, DNB now also invests in foreign (non-euro-denominated) bonds (investment grade and high-yield).

minimum reserves decrease with CBDC2 by this substitution and subsequently increase by the same amount because the central bank increases its monetary portfolio with CBDC2.

**Figure 6.** Central bank balance sheet in normalisation of monetary policy

Assets		Liabilities	
Gold and foreign currency reserves	15	Equity capital	10
Own euro-denominated investments	15	Banknotes	20
Loans	20	Minimum reserves	30
Monetary portfolios	10 +CBDC2	CBDC	+CBDC2

**Any social cost of a longer central bank balance sheet as a result of CBDC being issued must be weighed against the social benefits of CBDC.** Should the demand for CBDC increase and the central bank wish to accommodate that demand, the central bank must decide which assets to keep as counterparts. In that event, the central bank will purchase government bonds, for example, and as these become less available, perhaps even securities issued by private operators. That means that the central bank would be more involved in financial intermediation.<sup>24</sup> As far as this is at the expense of the efficient use of information at a decentralised level, it could well lead to a less effective allocation of means (BIS, 2018, p. 14 and Houben and Reijnders, 2019). If that were the case, the social costs would need to be weighed against the social benefits of the central bank’s policy. Those benefits could relate to the issuance of CBDC but also to other policy objectives for which the central bank uses its balance sheet, including for example unconventional monetary policy (which could also lead to an expansion of the central bank’s balance sheet).

**Control measures for the amount of CBDC in circulation can be devised through quantity and price.** The central bank may charge an unattractive fee if the amount of central bank digital currency per person, household or business exceeds what is considered advisable. Beyond that threshold, price-sensitive citizens will deposit their liquid assets with commercial banks or other financial institutions such as money market funds. Under normal circumstances this could keep the growth of the central bank balance sheet within reasonable limits (Bindseil, 2020). More far-reaching control measures are a possibility as well in order to prevent interference of private financial intermediation, even in times of crisis. An absolute ceiling can be put in place or advance notice given that such a ceiling beyond the advised amount of CBDC could be one of the options, should circumstances so dictate.

**It is a trade-off between the required degree of access for the general public to the central bank balance sheet and the desired role of the central bank in the financial system.** To achieve most objectives, CBDC would have to be used and be sufficiently attractive to the user. However, were CBDC to become overly attractive compared with private money, the central bank’s role in the financial system would grow. Section 6.2 therefore discusses in more detail the possible control measures for the amount of CBDC in circulation.

<sup>24</sup> If the central bank were to funnel CBDC back to banks through loans, the influence of the central bank on credit intermediation of the private sector could also increase. In that way, banks would be financed for the greater part by central banks instead of by the market. In contrast to the market, the central bank does not take into account the bank’s risk profile in this type of funding. All banks pay the same rate and can lend against the same collateral, regardless of their creditworthiness (as long as they are financially sound).

### Monetary transmission

**The introduction of CBDC could in principle affect the transmission of monetary policy to the interest rates of money markets, capital markets and banks and the possibility of unconventional monetary policy.** Should the central bank view CBDC as an alternative for cash, an interest rate of 0% could be considered. Should CBDC be interest-bearing, then how CBDC influences the monetary transmission depends among other things on i) the amount of CBDC in circulation and ii) the compensation paid on CBDC balances.

**Interest-bearing CBDC could increase the central bank's control over risk-free interest rates, although it is already strong at present.** Should CBDC be interest-bearing, the central bank will determine the rate. In so far as this central bank money is a full alternative for money in deposit accounts, its availability makes it harder for banks to vary their deposit interest rates with the interest rate established by the central bank. Suppose that the central bank were to increase all policy interest rates, including the interest rate on CBDC. If a bank was slow, or failed, to pass this on as higher deposit interest rates, consumers could switch to CBDC. A caveat applies to all this, as it is still unclear whether monetary transmission would improve to any significant extent. Although there is much debate about the pass-through of monetary policy to the real economy and inflation, the first step in the monetary transmission policy - transmission of policy interest rates to deposit and money market interest rates - generally functions well (Potter, 2017; BIS, 2018a).

**Widespread availability of CBDC could strengthen the grip on money market interest rates during major monetary policy adjustments.** At present, money market interest rates are usually lower than the policy interest rate set by the central bank. This is due to institutional investors' need to safely deposit their money as they have no access of their own to the central bank balance sheet. The central bank still retains sufficient control over the interest rates as long as these move with any adjustment in policy rate. Major fluctuations in the state of monetary policy could lead to the risk that an adjustment of the policy interest rate fails to have a direct effect on money market interest rates. In situations of that kind, CBDC could lay a floor in the money market and mitigate that risk.

**Depending on the chosen objective and design, CBDC could also impact the degree to which policy interest rates can become negative.** One of the reasons interest rates cannot go too far into negative territory is the zero interest rate on banknotes. If CBDC were to replace banknotes in particular and be awarded an interest rate that could fall below zero, this would increase the options for negative policy rates. Conversely, if CBDC were to be designed with a fixed zero interest rate or at least without being able to fall below zero for the publicly desired amount (see also the elaboration in section 6.2), this would limit the capacity for negative policy rates.

## 4.3 Financial stability

**The introduction of central bank digital currency could have implications for the stability of the financial system.** CBDC is an alternative for money in accounts with commercial banks and as such influences the funding base of the banking sector. A distinction can be made between substitution in normal times and substitution in times of financial crises, both of which are discussed below. Generally speaking, substitution depends on the appeal of CBDC compared with commercial bank money. It is important therefore how CBDC and commercial bank money

relate to one another in the baseline situation and how central banks and commercial banks would respond if they observe unwanted substitution.

**CBDC should be designed in such a way that it encourages substitution up to the publicly desired amount of CBDC and discourages any substitution above that.** In normal times, substitution will depend on all factors that make the use of money appealing to the user. That includes factors such as convenience of CBDC as compared with commercial bank money and any interest payment, caps or other measures to discourage retaining high or excessive amounts of CBDC. Because CBDC does not as yet exist and because the behavioural response by the central bank and commercial banks is hard to anticipate, the uncertainty about the expected substitution is considerable. It therefore makes sense to introduce CBDC gradually, allowing time to gain knowledge on the extent to which CBDC operates in practice as an alternative for commercial bank money and to adjust the design and conditions if the demand for CBDC were to be either too low or too high.

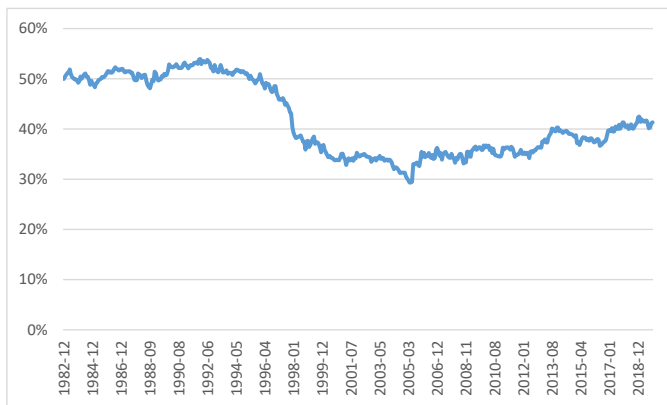
**This uncertainty about the effects of substitution leaves room for differences in opinions on the impact that CBDC will ultimately have on the banking sector.** On the one hand there is a risk that CBDC will narrow the banks' funding base (section 4.4), as deposits are a key source of funding for banks (Figure 7). To compensate an erosion of the deposit base, banks could consider tapping other sources of funding, and there is a chance that they will take more risks. On the other hand the argument has been made that the creation of a safe alternative for commercial bank money could have a disciplining effect (WRR, 2019a).<sup>25</sup> From that point of view, banks may actually be stimulated to look for more responsible funding and take fewer risks. The resolvability of systemically important banks could also improve if CBDC were to provide an alternative for critical payment features of the banks (Kumhof, 2016).

**The gradual introduction of central bank digital currency should go hand in hand with control measures to prevent unwanted substitution between CBDC and bank deposits.** Central banks and the commercial banking sector each have their own role in the financial system. Providing loans to the private sector is one of the tasks of the banking sector, and the central bank is the bank of banks. The introduction of CBDC could lead to a longer central bank balance sheet and as a result the central bank would have a larger footprint in the financial system. In as much as control measures restrict the amount of CBDC, it would result in the trade-off mentioned above: between the level of public access to the central bank balance sheet and the level in which risks to monetary policy and the financial stability are controlled.

**Figure 7.** Bank deposits of Dutch banks as a percentage of the balance sheet total

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<sup>25</sup> Andolfatto (2018) analyses the impact of CBDC in a model with a concentrated banking sector, with market power. In his model, central bank digital currency increases the pressure on banks to keep their deposit interest rates competitive. When CBDC is introduced, banks would increase the deposit interest rate to attract deposits. In his model that leads to lower interest rate margins and larger amounts of deposits and lending. Loans to the private sector could even increase in this model.



Note: data taken from table 5.2, Balance sheet of the Monetary and Financial institutions (MFIs) established in the Netherlands (excluding DNB) on DNB's statistics website. Deposits refer to private sector and non-government deposits. This data source does not break down by deposits of the private sector only for the MFIs established in the Netherlands.

**The risks posed by CBDC for financial stability must be mitigated, because CBDC could accelerate a bank run.** The demand for a public and secure form of money generally increases in times of uncertainty for precautionary reasons. The existence of a secure public form of money reinforces trust in the financial system (section 3.2). During a financial crisis, that substitution may happen too fast and consequently banks see their funding slip away and the risks to stability increase. That effect is also a factor where it concerns cash but with CBDC that substitution could well be much faster because it does not have the physical restrictions of withdrawing and storing it. This is another reason to include control measures upfront when designing CBDC.

#### **CBDC and the deposit guarantee scheme (DGS) protect citizens and businesses against bank defaults.<sup>26</sup>**

The DGS plays a key role in preventing bank runs by depositors referred to above and does so by backing the deposits to a maximum of EUR 100,000. When CBDC is introduced, the DGS will constrain substitution of bank balances to CBDC, as the DGS likewise now constrains substitution of bank balances to cash. However, the DGS also has its disadvantages, for example because it reduces depositors' incentive to monitor the banks (Ketcha, 2007). The DGS can also be viewed as an uncertain factor because recent history has shown that backing under the DGS can quickly be adjusted during a financial crisis. Some therefore see the introduction of CBDC as a part of a fundamental reform of the financial system. (Ordóñez, 2018). By introducing CBDC as secure public money, existing implicit and explicit guarantees can be eliminated in this view, such as the DGS and liquidity support to banks in trouble. Whether the introduction of CBDC would in fact bring about that result remains to be seen. In the short term, the simultaneous introduction of CBDC and elimination of the DGS would lead to an increased risk of unrestricted substitution between bank balances and CBDC. A gradual introduction of CBDC would mean an introduction within the current financial structure including the DGS.

<sup>26</sup> The Deposit Guarantee Scheme (DGS) is a set of rules that guarantees the deposits of bank account holders. Should a bank go into liquidation, the scheme guarantees the balances (deposits) of both consumers and businesses (except - in short- financial institutions and governments) up to EUR 100,000.



## 4.4 Supervision

**The introduction of CBDC has implications for the supervision of financial institutions.** The existence of CBDC can have consequences for the banks' business model and profitability. There are also institutional questions relating to the gatekeeper role of banks. Both aspects are discussed below.

**CBDC, as an alternative for deposits and payment account balances, affects the funding base of banks.**

CBDC could be an alternative for cash and bank deposits (section 4.2). Substitution for bank deposits could lead to the situation that banks become more dependent on market funding compared with the more stable deposits. In the current environment where negative market interest rates are lower than deposit interest rates, banks have an incentive to replace more expensive deposit funding with cheaper market financing. That is how they increase their profitability. CBDC may make it easier for banks to switch to increased market funding, as their depositors would have CBDC as an alternative. A stronger dependence on market funding makes banks more vulnerable to unexpected changes in market conditions. There are degrees to this effect, of course, e.g. it could be mitigated in case banks replace deposits with long-term market funding.

**The competition that CBDC poses with commercial bank money affects the banks' profitability.** The payment account is a product that many banks use as an anchor to offer and grant higher-margin products such as mortgages and personal loans. If customers were to switch to CBDC entirely, it would make this type of cross-selling harder for banks, which in turn puts pressure on their profitability. In a positive interest rate environment CBDC could also put pressure on the banks' interest rate margin. Structural pressure on profitability could ultimately jeopardise the banks' prudential obligations. The part that banks play in the economy by providing and intermediating loans could suffer as a result.

**Depending on the design of CBDC, payment data belonging to households could well fall into the hands of operators in which they have less confidence at that time.** If non-banking operators are permitted to intermediate in CBDC, they will gain access to the payment data of households that is currently restricted to banks. In surveys, households indicate they have less confidence in non-banking operators such as BigTech firms where it concerns management and use of their data.<sup>27</sup> This shows that it is important to design CBDC in line with the social objectives deemed appropriate, such as privacy.

**Introducing CBDC can have consequences for the gatekeeper role that banks have in preventing money laundering and terrorist financing** (see also section 5.2 on the legal framework). Depending on CBDC's design, that gatekeeper role could shift to non-banking operators. These new operators must also comply with the obligations ensuing from this legislation for transactions in CBDC.

**The above implications could lead to changes in DNB's supervision and may require additional supervisory legislation and supervision of activities.** Further internationally coordinated rules on liquidity and solvency may perhaps be necessary to keep the banks' funding and lending activities stable. As a result of the introduction of CBDC, changing market relations reinforce the importance of supervisory authorities focusing on

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<sup>27</sup> DNB (2020), 'Transformation for trust. Lending, saving and paying in the data age.'

activities alongside entities. The cost of these additional supervisory measures and this supervisory capacity must be included in the cost-benefit analysis of the introduction of CBDC.

# 5 Preconditions

**Some specific choices need to be made in order to conduct a more concrete debate on the design of CBDC: What are DNB's main preconditions to introducing CBDC?** This chapter provides the first steps in that direction. Remember these are not carved in stone - the topic is relatively new and insights are continually evolving. This chapter discusses the following preconditions:

- (1) Demand and supply must be aligned, within the boundaries set by the central bank's tasks:
  - a. demand: clarity about the objective beforehand, so that the design of CBDC can be tailored to the objective, and sufficient demand for CBDC can be generated to achieve that objective.
  - b. supply: accommodating the demand for CBDC to achieve the chosen objective and introducing control measures to reduce or halt the demand for CBDC beyond that.
- (2) There must be a robust legal and institutional base for the introduction of CBDC or an amendment of the Treaty on the Functioning of the European Union (TFEU) or other legislation that would prove necessary.

The remainder of this chapter discusses these preconditions.

## 5.1 Sufficient supply and demand given the objective

**Given the chosen objective, CBDC should be attractive enough to generate sufficient demand, so that the intended objectives can indeed be achieved.** A number of studies predict a rather low demand for CBDC based on the demand for cash.<sup>28</sup> But these studies implicitly assume that the chosen version of CBDC would be one without strong digital innovation and without payment of interest. In that scenario, the convenience of CBDC would be unable to match the current or future private digital alternatives. To generate demand therefore, the technical design of CBDC must be a good fit with new forms of payment.

**Risks to financial stability must be adequately managed.** The amount of CBDC roughly needed for the chosen objective must be estimated and what that would mean for the central bank balance sheet. DNB feels strongly that control measures should be designed in such a way that the central bank's footprint in the financial system does not become overly large.

**The introduction of CBDC must fit in with the structure of the financial system, with the central bank as the bank of professional operators.** The public and private sector must focus on their own comparative advantages within their own mandate. The central bank focuses on public objectives and is not a consumer bank.

## 5.2 Institutional and legal framework

### Institutional framework

**In all likelihood the introduction of CBDC will fall under the tasks and responsibilities of the European System of Central Banks (ESCB).** The ECB and national central banks are bound by the Treaty on the Functioning of the European Union of which the Statute of the European System of Central Banks and of the European Central Bank ("the Statute") forms part as Protocol no. 4.<sup>29</sup> It follows from the TFEU that the Euro system has exclusive competence to introduce the monetary policy of the European Union in the euro area.<sup>30</sup> CBDC could influence the main objective of the ESCB, i.e. maintaining price stability. CBDC could also have implications for monetary transmission and the stability of the financial system.

<sup>28</sup> Khaionarong and Humphrey (2018) and Riksbank (2018).

<sup>29</sup> The Statute is part of the TFEU, but certain articles, including Articles 17 and 22, could be amended by the European Parliament according to normal legislative procedure based on Article 129(3) of the TFEU.

<sup>30</sup> Section 3(1)(c), Sections 127(2) and 282 of the TFEU

**CBDC could contribute to the smooth operation of the payment system.** The ESCB's fundamental tasks include promoting the smooth operation of the payment system.<sup>31</sup> Introducing CBDC can help to facilitate cross-border payments and settle them in central bank money. In addition, CBDC could in part replace cash. Should the introduction of CBDC fall under the mandate of the ESCB, DNB will naturally continue to be involved, as part of the ESCB.

**The TFEU will in all likelihood provide little scope for national central banks to offer CBDC independently.** Based on Article 14.4 of the Statute, national central banks may in principle not serve any function other than those described in the Statute, unless the ECB's Governing Council establishes by a two-third majority of the vote cast that these functions are at odds with the objectives and tasks of the ESCB. The introduction of CBDC will likely fall under the duties and responsibilities of the ESCB so that no 'other function' as described in the Statute will apply, and on that basis, Article 14.4 of the Statute provides no room for national central banks to independently introduce CBDC. Should the introduction of CBDC qualify as "other function", it is up to the ECB's Governing Council to determine whether it thwarts the ESCB's objective and duties (in particular price stability and monetary policy).

**Whether the issuance of CBDC can be viewed as the issuance of banknotes in the sense of the TFEU and current Statute is the question and the answer depends in part on the design choices.** Based on Section 128 of the TFEU and Article 16 of the Statute, the ECB and national central banks may issue banknotes. If Article 16 of the Statute is taken as a basis to introduce CBDC, the term 'banknote' would need to be defined more broadly, to include not only tangible banknotes but also digital ones. The design and development of banknotes is versatile and CBDC could be viewed as a further upgrade in that process. If it is to qualify as banknote, CBDC would have to be as close an approximation to existing banknotes as possible. That follows from the concluding sentence in Article 16 of the Statute which determines that the ECB honours the existing customs where possible when designing and issuing banknotes.

**The ESCB could make use of intermediaries to introduce account-based CBDC.** Article 17 of the Statute determines that the ECB and national central banks, in order to perform their work, are entitled to open accounts for credit institutions, public bodies and other market operators. CBDC may perhaps be described as the provision of 'accounts' as described in Article 17 of the Statute. Similar to the accounts that the ECB and national central banks provide to monetary counterparties, CBDC would create an account at the central bank with which payments may be made. Households and businesses are generally speaking not credit institutions nor public bodies. Whether they can be qualified as 'other market operators' seems unlikely, but for CBDC the question arises if the term 'other market operators' could be interpreted more broadly. If Article 17 of the Statute was taken as a basis and CBDC was designated as providing 'accounts' while households and businesses cannot be qualified as 'other market operators', to prevent an amendment of Article 17 of the Statute, one solution could be to opt for a form of CBDC in which accounts are provided to households and businesses through intermediaries that are credit institutions or market operators (see section 6.1, design option 3 about the point of contact for the user). It remains an open question whether this interpretation would hold because CBDC would still be a liability for the central bank, even if the customer had a different point of contact (chapter 2).

**Pursuant to Article 20 of the Statute, the ESCB may use other instruments of monetary policy.** CBDC could be based on that Article, if it is primarily intended for monetary policy. However, it should be noted that this Article is generally viewed as a catch-all clause, only to be applied when the conventional measures for monetary policy have been exhausted.<sup>32</sup> If CBDC involves obligations for third parties, additional legislation is required from

<sup>31</sup> Section 127(2) of the TFEU and Article 3.1 of the Statute.

<sup>32</sup> R. Smits, *The European Central Bank. Institutional Aspects*, The Hague: Kluwer 1997, p. 283-284.

the EU's Ecofin Council based on the second paragraph of that Article. Depending on the design of CBDC there may be obligations for third parties and therefore additional legislation required. If this basis is applied, it remains the question how this relates to Article 17 of the Statute.

**Under Article 22 of the Statute, the ESCB may set up a payment system that uses CBDC.** As explained above it remains the question whether accounts can be offered to households and businesses for that CBDC payment system. On the one hand the CBDC payment system needs those accounts in order to operate. On the other, it could be stated that Article 17 of the Statute remains in full force, and the above possibly constitutes an act in contravention of that Article.<sup>33</sup>

### Legal framework

**In order to establish which regulatory framework applies to the issuance of CBDC and execution of transactions using CBDC, the technical design of CBDC must first be clarified.** The technical design influences the question whether CBDC should be regarded as non-cash money, electronic money or a different, unique figure. Depending on the question how CBDC is to be categorised in legal terms, certain legal frameworks will either apply or not. Legal frameworks relevant in this case include regulations relating to the issuance of electronic money, the provision of payment services and the Dutch Civil Code. Once the applicable legal framework has been established, the next step is to examine to what extent applying it is advisable, given the special nature of CBDC.

**When determining the boundaries within which CBDC can be held, the free movement of goods, services and capital within the EU should be taken into account.** The EU has an internal market which allows for the free movement of goods, services and capital between the Member States. Any barriers that to the internal market are not permitted under the TFEU. Another question relates to retaining CBDC by residents and/or non-residents (see design option 6, section 6.2).

**The current deposit guarantee scheme does not apply to CBDC issued by DNB.** The current DGS guarantees deposits retained by commercial banks. CBDC is retained by a central bank and consequently does not fall under the DGS. The added value of expanding the scope of DGS to include CBDC seems limited because CBDC would be seen as secure money.

**Finally, sanction regulations and legislation preventing money laundering and terrorist financing merit particular attention in the context of CBDC.** Sanctions regulations oblige institutions to check whether sanctions apply to their customers. These sanctions are intended to prevent undesirable transactions (embargoes) and to combat terrorism. Sanctions regulations would apply to the issuance of and transactions with CBDC. For the Netherlands, legislation to prevent money laundering and terrorist financing is incorporated in the Anti-Money Laundering and Anti-Terrorist Financing Act (*Wet ter voorkoming van witwassen en financieren van terrorisme – Wwft*), a key element of which is customer due diligence. The depth of the screening can be aligned to the risk posed by a certain type of customer, relationship, product or transaction. In addition, the institutions must continually monitor the risk profile and transaction pattern and any unusual transactions must be reported, in the Netherlands to the Financial Intelligence Unit. Obligations arising from the *Wwft*, such as customer due diligence, monitoring and reporting unusual transactions would also merit particular attention for transactions in CBDC (BIS, 2018a).

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<sup>33</sup> Provision of accounts in TARGET2 by the Eurosystem is based on both Article 17 and Article 22 of the Statute.

# 6 Design options

**This chapter introduces specific design options for CBDC.** Chapter 3 gave a *top-down* analysis of CBDC by starting with the objectives. This chapter will discuss CBDC starting from specific design options, i.e. *bottom-up*. Ultimately both approaches should be combined. Once the preferred objectives are clear from the public debate, the design can be made to fit accordingly. For now, any such *fine-tuning* is premature. However we can sketch the considerations and illustrate those with a reference design for CBDC that we consider reasonable with the current information available. Other justifiable choices can be made in many respects, and the insights may also change, given the debates yet to come. This tentative reference design is intended mainly as an illustration.

**Each design option for CBDC will be compared with the choices made for existing forms of money and cryptocurrency.** The design options relate to innovation in technology, customer service, privacy and monetary design. By way of comparison we show how that choice has turned out for three other forms of money: cash, commercial bank money and central bank reserves.<sup>34</sup> We also demonstrate two cryptocurrencies. We have opted to use Bitcoin (BTC) as the first, most well-known and currently most highly valued cryptocurrency. We will also demonstrate the position of Libra, where known.<sup>35</sup> Libra is what is known as an *asset-backed crypto*, the announcement of which has led to a worldwide increased interest in CBDC (OMFIF, 2020).

## 6.1 Technology, payment services and privacy

### Technological innovation

**After a decade of experimenting with private cryptocurrency the question arises whether some technologies have adequate added value to be used in CBDC.** Possibilities to consider include programmable money, how transactions are validated and the application of cryptographical techniques to ensure anonymity (Ali and Narula, 2019).

**In the range of options, design option 1 can be found between simple payments on one end and full application of *smart contracts* using complex logic on the other.** One advantage of only offering simple payments is that it is easier to operate such a CBDC ecosystem with the current infrastructure. In addition, it is probably cheaper and simpler to develop and easier to secure because the system is less complex. On the other hand, a system for *smart contracts* with complex logic potentially increases the demand for CBDC and offers the opportunity to lower transaction costs. In that way it could contribute to the diversity and innovation of the payment market. It is also *future proof*: it keeps all options open to incorporate new technologies in future.

**We have opted for a CBDC reference design that uses proven technology and innovations mature enough to be applied.** Cash allows for physical payment here and now, and with direct settlement. Commercial bank money offers options such as scheduling payment orders. In central bank reserves, complex queue mechanisms and liquidity saving systems are used. In essence, Bitcoin is a programmable asset with limited options for developers. Libra offers a wider range of features. Technological innovation has the potential to lower transaction costs and thus drive the demand for CBDC. Sufficient demand for CBDC is a condition for many potential examples of CBDC, in particular as a means of retaining public money and as a back-up function. Given the great importance of keeping central bank money secure, we will not go as far as Libra.

### Example for design option 1: Technical possibilities

<sup>34</sup> Any assets that cannot be shown in the range of options in a meaningful way have been excluded.

<sup>35</sup> See the Libra Association (2019).



**A following choice is that between centralised and decentralised validation of transactions.** In principle, CBDC can be introduced through a system of traditional accounts, where the account supplier (usually a bank) validates the transactions. But this can also be done through *Distributed Ledger Technology* (DLT), which is a form of decentralised validation of transactions using a consensus mechanism (as for example in Bitcoin).

**The introduction of CBDC does not require the use of DLT** (DNB, 2018; Ali and Narula, 2019). One advantage of a centralised party that validates transactions compared with DLT is that it significantly increases the potential transaction volume.<sup>36</sup> The excessive use of electricity as is the case in Bitcoin does not apply to centralised consensus (BIS, 2018). Validation by a trusted party such as the central bank makes clear who manages the system and is responsible to act in case of a failure. For example, Bitcoin’s fully decentralised solution with its decentralised validation was partly driven by ideological reasons: its creators wanted a system with no banks. The advantage of a decentralised validating system is that it is not dependent on a single database. A ‘trusted’ party is not required for the system to operate but this also means that it is unclear who will act should the trust in decentralised consensus evaporate (Carstens, 2019).

**Opting for CBDC implies trust in the central bank, which is why we have chosen a reference design with a centralised consensus mechanism.** DLT is of great value if a system lacks a centralised party that is sufficiently trusted by all participants to accurately record the transaction history. However, this is at the expense of the system’s potential transaction volume and can lead to inefficient use of electricity. In addition decentralised consensus means it is harder to act quickly if things go wrong. It would seem that these sacrifices are not necessary in the case of CBDC.

**Example for design option 2: Validation of transactions: consensus mechanism**



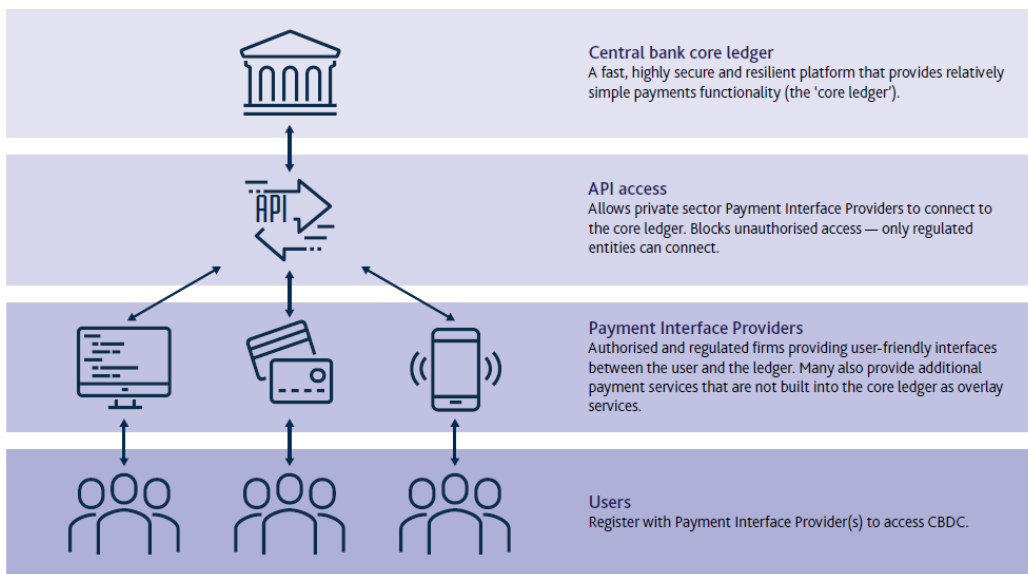
**Payment services**

**An important question is who or what will be the point of contact for users of CBDC?** The central bank is not set up as a consumer bank. Cash is distributed in part through intermediaries subject to supervision. Distribution of CBDC through intermediaries subject to supervision would imply that the current structure remains in place in that respect, with the central bank as the bank of professional operators.

**That raises the question what the business model would be of the private operators distributing CBDC.** CBDC may provide private intermediaries with the opportunity to integrate payment services more effectively with their existing technical infrastructure. Thus distribution through private intermediaries (including payment institutions) could stimulate innovation. The central bank manages the infrastructure and determines the preconditions relating to standards, security and solidity, within which the private sector can innovate. Essential payment functions such as identification, authentication and validation would be performed, as now, by the private

<sup>36</sup> For example, the Bitcoin network can process about 7 transactions per second (TPS) whereas the centralised systems of VISA and MasterCard can achieve up to 10,000 TPS.

sector. However, access through a central bank app only is easier to secure and would increase the control that the central bank has. But a hybrid system is also a possibility. The central bank could, for example, provide an *Application Programming Interface* (API) with which citizens and businesses could gain direct access to their CBDC balances. The Bank of England has created an illustration of this type of system, which is presented below.



Source: Bank of England (2020)

**In our reference design, transactions from CBDC accounts may only be initiated by regulated operators so that the role of the central bank as the bank of professional operators is guaranteed.** This access mechanism is comparable with access to a payment account by third party operators as currently regulated in the revised Payment Services Directive (PSD2). This allows the private sector to compete for CBDC convenience and drive the demand for that payment means. In addition, we thus also partly address the security risks involved in advanced technical options of design option 1. Requirements may be set on licenses to initiate transactions.

**Example for design option 3: Initiation of CBDC transactions**



**A related debate concerns a possible design of CBDC as a back-up in the payment system.** Roughly 7 out of 10 retail transactions in the Netherlands take place in commercial bank money, with the other 3 being made in cash. The dominance of non-cash transactions in commercial bank money has increased the past years. This increases the social dependence on the infrastructure for commercial bank money. CBDC could offer a possible fall back option.

**A design of CBDC that has the fewest overlaps with the infrastructure for payments in commercial bank money is most valuable as fall back option** (see section 4.1). But this option is also probably the most expensive. Sufficient demand and ownership of CBDC is a key precondition for CBDC to work as a fall back option in the payment system. In contrast, the implementation of CBDC would in all likelihood be cheaper if the existing infrastructure was used.



**There is a great difference for existing forms of money and cryptocurrency in the amount of overlap in the infrastructure for payments in commercial bank money.** Commercial bank money and central bank reserves are both dependent on the high-quality payment system between banks. Both depend, like crypto assets, on the availability of electricity and telecommunication. Cash is less dependent on those but an adequately functioning infrastructure for payments in commercial bank money remains necessary for withdrawals from ATMs.

**This requires greater understanding of the costs for a parallel payment infrastructure for CBDC, which would hardly overlap with that for commercial bank money.** In accordance with the analysis in section 4.1, the social benefits of increased resilience must be weighed against the cost. To prevent limiting the demand for CBDC too much and avoid driving up costs for market operators unnecessarily, using existing debit card terminals (or the next generation) could be worth considering. That requires further research into how to design secure off-line payments.

**Example for design option 4:** Degree of overlap with the infrastructure for commercial bank money



### Privacy

**The degree of privacy when holding balances and executing transactions is an important design choice.**

On the one hand, users may have a strong desire to protect their privacy. On the other, supervisory authorities, from the perspective of their public role, will want to have insight into those balances. And for private operators the use of that data could be part of their business model.

**The degree of openness about the transaction history differs strongly between the current forms of money and cryptocurrency.** Cash is the most anonymous means of payment, as no aggregated transaction overview exists. That is followed by central bank reserves and commercial bank money. Shifting to the right is the permitted DLT-based infrastructure of Libra and on the far right end of the scale is Bitcoin, whose transaction history is public.<sup>37</sup>

**CBDC provides an opportunity to align the degree of privacy to the objectives.** As a digital form of money, CBDC would not be able to achieve a similar degree of anonymity as cash. But anonymity would probably be easier to safeguard than for private forms of money, because the central bank does not have a commercial incentive to profit from the use of data (for example through targeted advertising). This does not detract from the fact that the supervisory authorities, given their public role, will sometimes have to examine transactions. It would seem that it is necessary to make agreements about access to data for specific supervisory authorities given their public role, such as monitoring money-laundering, terrorist financing and other illegal activities.

**Given that protecting privacy is one of the key objectives for CBDC, the central bank in our reference design would not use information about balances and transactions for commercial purposes.** At the same time licensed service providers will see the data from their own customers, as is the case now, and naturally within the prevailing privacy legislation. A distinction may be made between balances and transactions. The balances are only held by the central bank and in principle are only known to the central bank. The intermediary need merely

<sup>37</sup> In contrast, in the case of Bitcoin it is unclear who is behind the addresses with balances. Banks perform extensive Know-Your-Customer (KYC) checks to identify account holders. That does not happen in the bitcoin network. Bitcoin holders are therefore pseudonyms and holders of commercial bank money are identified.

have the transactions it initiates, and does not need to know about the transactions it receives. Another point worth considering is giving users access themselves to their balances through a simple central bank (smartphone) app or by enabling them to transfer their own CBDC balances via the central bank API.

#### Example for design option 5: The degree of privacy for users



## 6.2 Monetary design

**There is a trade-off between the required degree of access for the general public to the central bank balance sheet and the central bank's footprint in the financial system** (see section 4.2). If the design of CBDC is attractive to the user, many users will want to have access. The first question when choosing the design is who has access. The range of choice is broad, offering widespread access including the entire world population on the far end of the spectrum and on the other only a narrowly defined set of financial institutions, as is the case with wholesale CBDC. One the one hand, broad international access can make international payments more efficient, contribute to financial inclusion and provide opportunities for the euro as a global reserve currency (which is a relevant consideration of the Eurosystem in the context of the availability of cash). On the other, widespread access increases the central bank's footprint in the financial system, as stated above. If that is viewed as unwelcome beyond a certain point, the access may be restricted, for example to residents of the euro area and possibly non-residents with a nationality from within the euro area. A further decision to be made concerns the type of individuals and entities permitted access. If access is only given to households, it would imply that businesses, financial institutions and governments would be excluded, which would for example create restrictions in the role of CBDC as means of payment.

**For the time being, we opt for a reference design that offers access to natural and legal entities within the euro area, and for natural persons who have the nationality of one of the countries within the euro area, even if they live abroad.** That scope coincides as much as possible with the jurisdiction of the ECB. A broader scope is worth considering in connection with the role of the euro as international reserve currency. Therefore the reference design for general purpose CBDC assumes access for households, businesses (including financial institutions) and governments. Widespread access fits in with the design of cash, that is also intended for general purpose. But given the ease with which private forms of money and other assets could be converted into CBDC, it makes sense to build in additional restrictions in the reference design, not least because of the central bank's wish to limit its footprint in the financial system.

#### Example for design option 6: CBDC ownership



**Virtually frictionless access to CBDC is possible in theory but unwelcome from our point of view.** Access for households, businesses and government to central bank digital currency can be designed to be virtually frictionless. In that case, the central bank would supply any amount of CBDC demanded and adapt its balance sheet accordingly. We consider this approach too hazardous for the central bank's footprint in the financial system, and

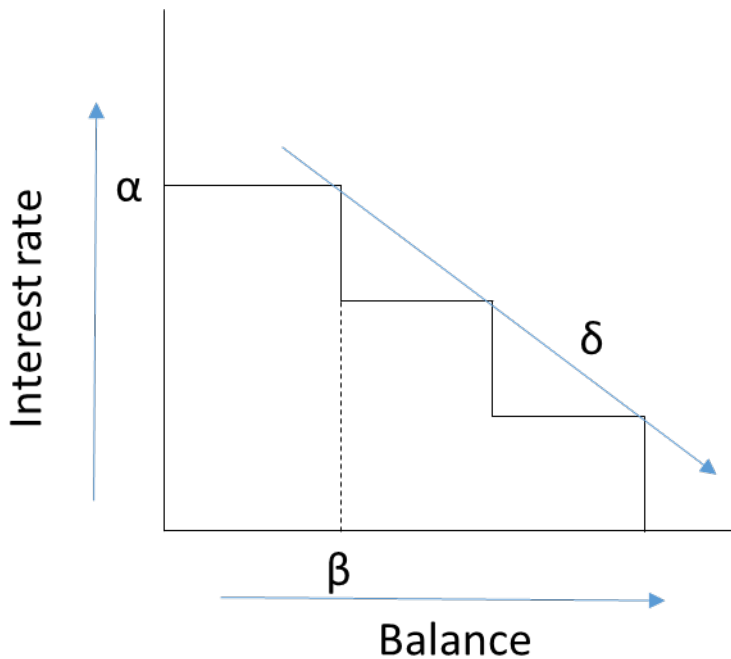
for impact of that footprint on financial intermediation in the private sector. Nor would this be in line with the policy for existing forms of central bank money, reserves and cash, for which explicit and implicit frictions apply (see section 4.2).

**Over the preceding years a number of control measures for CBDC have been proposed; all have their advantages and disadvantages.**

1. The **first option** is an absolute ceiling. The Danish central bank discussed this option (Gürtler *et al.*, 2017). The advantage is that the quantity of CBDC can be steered directly. The disadvantage, according to the authors, is that an absolute ceiling could hinder payments because only payments below the ceiling would be transacted.
2. A **second option** is that the central banks only issue CBDC against government bonds as counterparts, which must be supplied by the party receiving CBDC (Kumhof and Noone, 2018). One advantage of this is perhaps that it indirectly limits the quantity of CBDC because the amount of available government bonds decreases as the demand for CBDC rises. An adjustment in the interest rate on CBDC would ensure a balance between supply and demand. For this system to operate, the exchangeability of CBDC for central bank reserves and commercial bank money would not be guaranteed. The downside of this proposed option is that the fungibility between the various forms of euro is lost (see also section 3.2 on the importance of fungibility and Bindseil, 2020). Moreover, this proposal is complex and could result in strong fluctuations in the interest rate if CBDC became scarce. Therefore this proposal lacks international support among central bankers.
3. A **third option** is using a combination of a price and quantity scheme known as the *two tier remuneration system* (Bindseil, 2020). The desired amount of CBDC in the system is then translated to a desired amount per holder (the base part) and the compensation for it provides an incentive to retain CBDC for that part. For higher amounts that incentive will be set in such a way that retaining CBDC becomes unattractive. One advantage is that this aligns with control measures currently in use by central banks and that users can be sure that the interest rate on the base part will not suddenly become very negative. However, the disadvantage is that it may not provide sufficient incentive to prevent substitution regarding CBDC beyond the base part under all circumstances. In particular during a financial crisis, users will be prepared to accept a negative interest rate in exchange for safety.

**For the time being, our reference design for CBDC is based on the third option, i.e. the two tier remuneration system, supplemented with the possibility of an absolute ceiling.** This is shown graphically in Figure 8 below. The interest rate level of the first tranche is indicated by  $\alpha$ .  $\beta$  is the balance that falls within this tranche, or the length of the first bracket. The steepness of the interest rate decreasing as the balance increases is indicated by  $\delta$ . For that reason we will discuss the design options for a possible interest rate structure and the first indications for the amount of CBDC in circulation. Already noted in section 4.2 was the additional option of an absolute ceiling for amounts above the base part, if the circumstances required it, for example, during a financial crisis.

**Figure 8:** Design options for control measures



**We would use the policy interest rate and the average interest rate on commercial bank money as a reference point for interest payment over the base part** (design option 7). This is because if the interest rate on CBDC is higher than the interest rate on commercial bank money, it could distort competition. And if the interest rate was significantly lower, there would probably be little demand for CBDC. By way of comparison: at the time of writing the interest rate for main refinancing operations is 0% and only slightly positive interest rates or no interest rate are paid on payment accounts in commercial bank money. No interest rate is paid on cash. The interest rate on the rest of the discussed crypto assets is nil in the first tranche. Consequently, the interest rate over the base part could be considerably lower to discourage its use (design option 8: step tier progression). By allowing the interest rate to decrease sharply as the balance increases, any use over and above the base part is discouraged.

**Design option 7:** The interest rate on CBDC in the base part ( $\alpha$ )



**Design option 8:** The steepness of the tier from the first tranche ( $\delta$ )



**The length of the base part could lie anywhere between EUR 1,000 and EUR 7,000 per capita with the mid-section ranging between EUR 3,000 and EUR 4,000.** A sum of EUR 3,000 to EUR 4,000 should be enough

for the majority of Dutch people to live on per month while retaining a buffer for unforeseen expenses. In the unlikely scenario that all citizens retain a maximum balance, it would result in a central bank footprint comparable to that of cash in 2019. The amount of cash per capita in the Netherlands in 2019 amounted to EUR 3,781, or 8% of GDP.<sup>38</sup> It is an open question what amount of CBDC could be retained by legal entities and what the interest rate structure would look like for them. Further research is necessary to make that assessment and to relate this to, for example, the extent of business activities in the euro area.

**The available scope for CBDC issuance in each euro area country could be made contingent on the decrease of cash use.** According to that proposal, the amount of CBDC could increase to 15-16% of GDP in the hypothetical situation that cash were to disappear entirely from the Netherlands. That would correspond with the amount of cash in circulation at the beginning of the 20<sup>th</sup> century, i.e. before the structural substitution to private non-cash money (see also Figure 4 in chapter 3)<sup>39</sup> and would mean that the central bank's footprint for issuing cash - that has been in structural decline since the beginning of the 20<sup>th</sup> century - would have been fully compensated by the issuance of CBDC. If we transpose that to present times, it would mean an upper limit of just over EUR 7,000 per capita. A possible lower limit which can be used for example to gradually introduce CBDC can be obtained by considering low-denomination notes in particular (5 euro, 10 euro, 20 euro and 50 euro notes) which are most frequently used for payment purposes. That would result in over EUR 1,000 in central bank digital currency for each of the over 340 million residents of the euro area.

**Design option 9: Length of the first tranche ( $\beta$ )**



<sup>38</sup> Source: calculations based on data from Statistics Netherlands and DNB. See also Figure 4 in chapter 3. Bindseil (ECB, 2020) lists an indicative sum of EUR 3,000 based on the outstanding amount of cash in the euro area (just below the amount of cash per capita of about EUR 3,500).

<sup>39</sup> By way of comparison: at the end of 2019 the consolidated sum of deposits of the Monetary and Financial Institutions established in the Netherlands to the private sector and decentralised government amounted to EUR 1,031 billion, or 127% of GDP. See table 5.2, Balance sheet of the Monetary and Financial Institutions (MFIs) established in the Netherlands (excluding DNB) on DNB's statistics website. This data source does not break down by deposits of the private sector only for the MFIs established in the Netherlands.

## 7 Conclusion

**The introduction of CBDC would involve a structural reform of the monetary system.** We therefore urge to view this debate on a long horizon. What is the long-term trend in the use of cash and what will saving and payments look like in the future? What role should public money have in a society where digital technology is becoming increasingly important? Our conclusion is clear in that respect: it would be a good thing if a public form of money continued to exist for general use. In order to be used, that new form of money would have to meet the preferences of users. That means we would have to think the design through so that it fits within the objectives and tasks of central banks and adequately mitigates the risks, which is why we compare possible CBDC designs to existing forms of money and crypto assets.

**Firstly a more in-depth policy discussion is required, both within the Europeans System of Central Banks and in the Netherlands.** In the Netherlands, the topic of CBDC has currently garnered more public attention than in a number of other countries within the euro area, because of the ongoing digitalisation in our country. It is important that the issue is also debated in the wider context of the euro area because the debate on CBDC falls within the European System of Central Banks' mandate and additional European legislation may be required as a result. DNB will therefore use this study to contribute to the policy debate and plans to take an active part in that policy debate and its further elaboration.

**If the ECB subsequently decides to experiment with specific forms of CBDC, DNB is prepared to play a leading role.** CBDC does not yet exist and not all effects can be thought through in advance. For that reason, a gradual introduction makes sense. Once the policy debate has taken shape and sufficient support has been amassed within the European System of Central Banks, a logical next step would be to develop and experiment with prototypes. That would enable us to measure the effects more accurately. The experiments could be conducted in a controlled setting but may include issuance of CBDC to the general public. Due to the evolving digitisation in the Netherlands, our country would make good testing ground.

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