

# NORGES BANK PAPERS

Central bank digital currencies

NO 1 | 2018



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## NORGES BANK

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# Preface

A number of central banks are considering whether they might in the future issue a central bank digital currency (CBDC) for general purpose users. A CBDC of this kind is a central bank liability denominated in the official unit of account and will be a supplement to cash.

Technological advances have brought this issue to the fore. A decline in cash usage has prompted us to think about whether at some future date a number of new attributes that are important for ensuring an efficient and robust payment system and confidence in the monetary system will be needed. If the answer is yes, a CBDC may be an appropriate measure for remedying weaknesses that may otherwise arise.

This report, prepared by a Norges Bank working group, provides an overview of aspects that should be given weight in assessing whether Norges Bank should issue a CBDC. A CBDC can be designed in various ways, depending on the desired aims. The working group points in particular to three possible purposes that merit further consideration:

- To ensure a public and credit risk-free alternative to deposits in private banks, in addition to cash.
- To function as an independent back-up solution for the ordinary electronic payment systems.
- To ensure the existence of suitable legal tender as a supplement to cash.

Norges Bank will continue to issue cash as long as there is demand for it. But when cash usage declines, a CBDC can be an alternative to deposit money. The primary purpose of a CBDC is to ensure confidence in money and the monetary system.

It is not Norges Bank's ambition to take over credit provision from banks. A premise underlying this work is that the existence and scope of a CBDC must not impair the ability of banks and other financial institutions to provide credit.

A CBDC raises complex issues. There is virtually no international experience to draw on. Further analysis is needed to assess the purposes of a CBDC, the types of solutions that best achieve these purposes and the benefits measured against financial and other costs. This is a long-term undertaking. The aim of publishing the working group's report is to inform the public about its work, disseminate knowledge and initiate a dialogue with stakeholders.

Øystein Olsen

# 1. Introduction and summary

A central bank digital currency (CBDC) is a digital form of central bank money denominated in the official unit of account for general purpose users. A CBDC can take several forms with different properties, depending on its purpose.

A Norges Bank working group<sup>1</sup> has completed an initial phase of a study of CBDCs. The working group's report provides an overview of the issues that it regards as relevant in an assessment of whether to introduce a CBDC in Norway.

A CBDC raises substantial and complex issues. CBDCs have not been introduced in any country with a fully developed financial system, and there is thus little experience to draw on. A number of central banks, including Sveriges Riksbank, are now considering whether a CBDC is necessary and desirable.<sup>2</sup> Technological advances and reduced cash usage are two forces that have made this issue currently relevant. From a purely technological standpoint, however, it was possible to introduce a CBDC earlier.

## ***CBDC – what and for whom?***

Introducing a CBDC in Norway – as a supplement to cash – would entail offering a digital liability on Norges Bank for use as a means of payment and store of value. A CBDC would also entail the creation of dedicated payment solutions that Norges Bank would have full or partial responsibility for, but would not necessarily operate and maintain.

A CBDC does not mean that Norges Bank will provide credit to the general public. That role will still be played by banks and other financial institutions. Depending on its design, a CBDC may entail a more active role for the central bank in providing credit to banks and in some situations in helping to fund bank lending.

The primary target group for any CBDC will be the general public in Norway: private individuals, associations, organisations, non-financial enterprises and government authorities.

## ***Why a CBDC?***

Any decision for Norges Bank to take the initiative in introducing a CBDC must be based on a socio-economic cost-benefit analysis. Important elements in such an analysis will be the impacts on the payment system, financial stability and monetary policy.

Internationally, a number of arguments have been made for introducing CBDCs. The working group finds that the relevant question for Norges Bank will primarily be whether a CBDC is necessary and desirable for ensuring an efficient and robust payment system and confidence in the monetary system. Confidence in the monetary system means that we trust that the value of money will remain stable over time. This confidence is supported by low and stable inflation, the ability to make payments safely and efficiently and the certainty that money is genuine and its issuers are solvent and will honour their commitments.

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<sup>1</sup> The working group comprised Knut Sandal (chair), Farooq Akram, Ragna Alstadheim, Lasse Ask, Tom Bernhardsen, Kathrine Stang Ottesen, Ylva Søvik, Leif Veggum, Peder Østbye, Terje Åmås and Steinar Årdal. Kjetil Heltne participated in an early phase. The project's steering group comprised Jon Nicolaisen (chair), Ida Wolden Bache, Olav Bø, Torbjørn Hægeland and Marius Ryel. Kristin Gulbrandsen participated in an early phase.

<sup>2</sup> See Skingsley (2016), Sveriges Riksbank (2017) and Ingves (2017) regarding work at the Riksbank. See CPMI (2018) for an overview of the international discussion of CBDCs. In general, countries differ in their financial structure and thus to some extent also differ in their approach to the issue of CBDCs.

The following questions must be asked:

- What characteristics do we want the payment system to have in the future?
- Is there a risk that important characteristics will disappear and confidence in the monetary system will weaken, unless Norges Bank and/or other authorities take action?
- If yes, is a CBDC the best instrument for ensuring desired characteristics?
- Will a CBDC have other, undesirable consequences?

An important trend in the payment system is a gradual decline in cash usage. Cash will be with us for many years to come. However, it is possible that, at some point, cash usage will be so low that it can no longer be considered a generally available means of payment. It is not Norges Bank's aim to eliminate cash, either with the aid of a CBDC or in some other manner. The use of cash should be determined by demand.

Cash has a number of important attributes:

- It is a credit risk-free alternative to deposit money (bank deposits). Bank deposits can readily be converted into physical cash, which in and of itself may sustain public confidence in bank deposits and the monetary system. Cash also helps sustain competition among means of payment. Credit risk-free does not mean that cash is free from risk or other costs.
- It is an independent back-up solution if electronic systems fail. Cash is not dependent on technology or a third party at the time of payment.
- It is legal tender that can be used by anyone.
- The use of cash is not traceable.

If cash is marginalised as a generally available means of payment, bank deposits will not be fully capable of ensuring that these attributes continue. Bank deposits are now the predominant means of payment and must be assumed to be virtually the only alternative if cash usage becomes very low. E-money and crypto-assets are hardly viable alternatives in the near and medium term.

It is the opinion of the working group that attributes such as credit risk-free alternative to deposit money, independent back-up solution and legal tender are the most important ones that may be lost. However, further analysis is needed to assess the usefulness of introducing a CBDC with all or at least some of these attributes.

What these attributes have in common – perhaps to some extent with the exception of back-up solution – is that users barely take note of them when choosing a means of payment. Nevertheless, these attributes may be important to society.

Cash entails some “frictions” in the form of logistics and the risk of loss and/or theft for the person holding physical cash. Thus, it is not a fully satisfactory alternative for persons who wish to withdraw bank deposits on a large scale. An important question is whether it is regarded as desirable to offer a more “frictionless” alternative to deposit money and what consequences this may have.

While the discussion of the other attributes generally concerns matters of principle, the question of an independent back-up solution is more of a practical issue. Two technically wholly independent payment systems based on bank deposits *can* conceivably serve as contingency arrangements for each other. The question is whether regulation of private financial market infrastructure (FMI) owners will ensure the existence of independent contingency arrangements and, more generally, what strategy is most appropriate for achieving this.

The need for a CBDC can also be assessed on the basis of other areas important to Norges Bank and to Norway. These include monetary policy space, the possibility of currency substitution (the use of currencies in Norway other than the Norwegian krone) and the impacts on seigniorage (a source of income for central banks and/or the public sector because cash is a “cheap loan”). The working group has not found arguments in these areas that provide an essential justification for introducing a CBDC. The impact in these areas of any CBDC should nevertheless be included in a cost-benefit analysis.

### *Primary models for CBDCs*

The work on models for CBDCs has made little headway. The assessments below should therefore be considered preliminary and can serve as a starting point for further work. In the assessment of the working group, there are primarily two relevant models for organising a CBDC system:

- In an **account-based model**, both value storage and transaction processing are centralised. Money is thus held in accounts and moves from one account to another in the system.
- In a **value-based model**, value storage and processing are decentralised. Money is thus stored locally in a payment instrument, typically a card or smart phone app. Transfers take place directly between parties, without the intermediation of a central third party.

**Hybrid variants** that combine elements of both primary models are also possible. An example is a model where money is stored locally, but transactions need to be verified by a third party with a register of all transactions and holdings.<sup>3</sup>

A third model, which can also be considered a hybrid variant, is based on **distributed ledger technology** (DLT). In a DLT system, the transaction register is distributed among all network participants, with transactions taking place directly between end users. DLT has potential, including for contingency purposes because the technology is independent and robust to the loss of individual elements. However, the working group does not consider DLT to be a relevant technology for a CBDC in the near and medium term. The technology is generally immature. This suggests proceeding with caution. The DLT systems examined so far have far lower processing capacity and speed than modern centralised payment systems. This may improve in new versions of the technology. The central bank must be able to control the CBDC system, so that if DLT is adopted, adjustments would have to be made to a purely decentralised system.

The two primary models have different strengths and weaknesses. Within each model there are a number of properties and functionalities that need to be chosen. The impacts of a CBDC will depend on its specific design. In general, the functionalities

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<sup>3</sup> Value-based and hybrid models are often grouped together under the term “token-based”, see CPMI (2018).

of a value-based model are largely similar to those of cash, while an account-based model resembles more closely ordinary bank deposits.

An account-based model:

- can be adapted to all payment methods, including those used for online shopping and paying bills,
- offers secure value storage and is suited to payments of any size,
- has the limitation that it is dependent on contact with a central third party to execute and settle payments; in isolation, this weakens its suitability for contingency purposes,
- may have adverse impacts on banks, financial stability and the implementation of monetary policy. The impacts depend on the design, including the interest paid on the CBDC and frictions in flows between bank deposits and CBDC.

A value-based model:

- is local and thus not dependent on communication with a third party for making payments. This makes the model robust and particularly well-suited for contingency purposes,
- will be able to address privacy concerns as payments are not traced or recorded in a central database,
- is not optimal for storing or paying large amounts, since the money is lost if the payment instrument is lost or damaged.

The assessment of the models depends on what is deemed to be the primary purpose of introducing a CBDC. The working group's preliminary conclusion is that a value-based system has some advantages as a back-up solution. An account-based model has some advantages in being able to offer a real risk-free alternative to deposit money as a store of value. With regard to the purpose of providing an alternative means of payment to bank money and promoting competition, both models have their strengths and weaknesses.

### ***Principles for IT architecture and costs***

The principles for IT architecture from the Agency for Public Management and eGovernment (Difi) are common guidelines for all public sector IT work. Possible solutions for a CBDC must be assessed on the basis of scalability, interoperability, accessibility, security and flexibility. Our preliminary assessment is that it will be possible to realise both primary models in line with these principles for IT architecture.

The financial costs associated with both primary models would be substantial, in terms of both establishment and operation. Costs depend, among other things, on technology, functionality and security and on organisational matters such as outsourcing and system ownership. Cost estimates will not be possible until such matters have been clarified.



### ***Norges Bank's role***

Norges Bank must have control over and primary responsibility for any CBDC system. For a value-based system, it should be considered whether this responsibility can be defined in the same way as in the cash area currently. For an account-based system, Norges Bank would probably have to have the ultimate responsibility for the core infrastructure, but not necessarily for the payment services that can be built on top of it.

None of the primary models requires Norges Bank to have direct customer contact. A number of factors possibly suggest that, operationally, Norges Bank will not have to be responsible for the technical development and daily operation of any CBDC system.

Several types of service provider are relevant. There can only be one provider of the core of the solution, since there may only be one account structure or register for a CBDC. For the services to customers, there may be a large number of providers.

### ***Public demand for CBDC***

For a payment system<sup>4</sup> to be maintained it must be widely adopted and used. The general public must be sufficiently familiar with CBDC in order to use it, for example, on the day a contingency situation arises.

Users' assessments of a CBDC compared with other means of payment – and associated payment instruments – will determine demand for and thus the volume of CBDC. Users will likely give weight to confidence in means of payment, functionality and the total costs for users themselves. This also means that demand may change considerably if situations arise that change these assessments. Demand is also affected by users' purposes for using a CBDC.

Factors that can influence demand for CBDC for **payment purposes**:

- What needs are met by the solution, what payment situations it can be used in and how widely adopted it is.
- How well it functions and whether it is perceived as attractive and secure.
- How simple and inexpensive it is to convert CBDC into bank deposits and vice-versa.
- Which operators are given access.

Factors that can influence demand for CBDC for **value storage purposes**:

- Whether there are limitations on the amount of funds it is possible to store.
- The relative return on stored amounts.
- The security of storage – operational risk/risk of theft.
- How simple and inexpensive it is to convert CBDC into bank deposits and vice-versa.

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<sup>4</sup> A payment system comprises any means, systems or instruments that can be used to execute or facilitate payments.

- Which operators are given access.
- Which other (government-issued) assets exist that are liquid and can be easily used for value storage.

### ***Consequences for banks, financial stability and monetary policy***

Transferring bank deposits to accounts with the central bank or to a rechargeable card or mobile app can affect the central bank's balance sheet and liquidity management. It can also have an impact on banks' balance sheets and funding, the structure of the banking sector and monetary policy.

Some possible consequences, particularly with an account-based model with few frictions between bank deposits and CBDC, are:

- Large-scale withdrawals of bank deposits can occur. Such bank runs can potentially take place around the clock without limit and will be independent of geographical proximity (unlike the case today with cash).
- The introduction of a near substitute for bank deposits may motivate banks to raise deposit rates and lead to a shift from deposit funding to wholesale funding. This may also result in increased credit provision by non-bank financial institutions.
- A substantial reduction in the demand for deposits may reduce bank lending and hence economic growth, unless other participants become important providers of credit.
- If demand for CBDC becomes very high, Norges Bank runs the risk of having to fund a large proportion of banks' assets, particularly loans.
- The interest rate on CBDC may set a floor under all short-term market rates and a CBDC may also result in runs on non-bank financial institutions.
- The central bank may become a direct competitor to payment service providers. This may have impacts on the earnings of banks and other payment providers.

The bullet points above suggest choosing a model that limits the impacts on the functions performed by the banking system. These impacts can be limited if Norges Bank chooses a value-based model or an account-based model with frictions between bank deposits and CBDC.

### ***Legal matters***

An account-based CBDC solution where accounts are held in Norges Bank will require amending the provisions in the Norges Bank Act concerning which entities may hold an account with the Bank. A value-based solution will probably not require amending the Norges Bank Act, as long as the solution is within the customary or normal remit of a central bank. This will be influenced by developments at other central banks and in society at large. In any case, the working group finds that a decision to introduce a CBDC is so important that it will also involve other regulatory authorities.

### *Conclusion and the way forward*

It is too early to conclude whether Norges Bank should take the initiative in introducing a CBDC. The impacts of a CBDC – and the socio-economic cost-benefit analysis – will depend on the specific design. The design, in turn, will depend on the purpose of introducing a CBDC. The working group points in particular to three possible purposes, which require further analysis:

- A credit risk-free alternative to deposit money.
- An independent back-up solution for the ordinary electronic payment systems.
- Legal tender, if cash can no longer be regarded as “generally” available, as legal tender is normally understood to be.

On the other hand, the working group has not identified issues allowing it to conclude at present that introducing a CBDC can be ruled out. The working group has identified a number of factors that suggest caution, particularly in order to avoid conversion of bank deposits into a CBDC that is so rapid and so extensive as to impair lending.

There is thus a need to examine the purposes of a CBDC and the most relevant solutions in more detail than permitted by the scope of this study. This will also make it possible to elaborate on the impacts of a CBDC and the cost-benefit analysis. This is planned for the project’s second phase. A premise underlying this work is that the existence and scope of a CBDC must not impair the ability of banks and other financial institutions to provide credit.

## 2. Why a CBDC?

### 2.1. About money and means of payment

#### *Money*

Money has three basic functions:

- First, money is a **means of payment** that can be used to transfer value between parties, for example in connection with the purchase of a good or service.
- Second, money is a practical **store of value**.
- Third, money is a **unit of accounting** that facilitates comparison of the value of different goods and services. Norway's units of accounting are the *øre* and the *krone*.

A CBDC must fulfil all three of these functions. The working group has proceeded on the basis that a CBDC must be denominated in the Norwegian krone and have the same value as other means of payment denominated in the Norwegian krone.

The money we currently use has no significant “physical” value. Rather, it represents a receivable from the issuer. Potential issuers include central government (central banks) and private enterprises. The value of money depends on public confidence that money will function as intended, i.e. that it will fulfil the basic functions. If money can only be used in a small selection of stores, its function as a means of payment will be weakened. If there is a risk that money may lose its value, for example due to issuer insolvency or high inflation, confidence in money as a store of value will be undermined.

#### *Means of payment and payment instruments*

Different means of payment represent receivables from different operators. Means of payment are utilised through payment instruments. At present, the public's primary available means of payment are cash, bank deposits and E-money; see Table 1. A further means is private crypto-assets (also referred to as “cryptocurrencies”, “digital currencies” or “virtual currencies”), such as Bitcoin. These do not represent a receivable from any party, and constitute separate units of account.<sup>5</sup>

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<sup>5</sup> See chapter 2.5.2 for a brief discussion of how well crypto-assets function as money and payment systems.

**Table 1. Means of payment and payment instruments**

Means of payment	Receivable from	Payment instrument
Cash	Central bank	Cash
Bank deposits (deposit money)	Private bank	Online giro, card, card via smart phone app, ...
E-money	E-money institution	Rechargeable card, PayPal online payment, ...
Crypto assets such as Bitcoin	No-one	Digital wallet

The proportion of money supply that is available for payment transactions is quantified by the narrow money-supply indicator (M1).<sup>6</sup> At year-end 2017, cash (physical notes and coins) accounted for 2.3 percent of M1 money, while private deposit money accounted for the rest.

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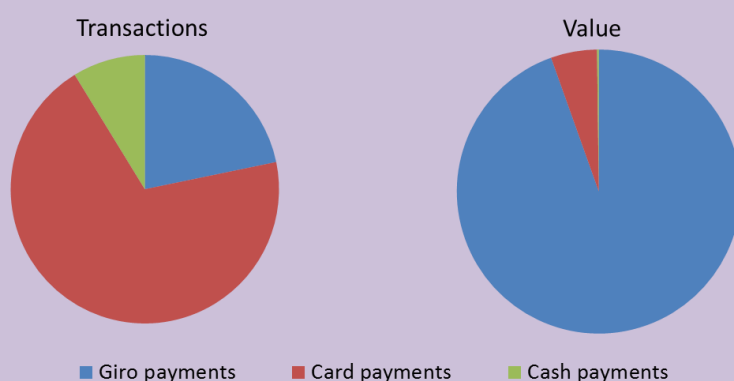
<sup>6</sup> M1 comprises the public's total holding of cash and balances in negotiable order of withdrawal bank accounts. The public's E-money and crypto-asset holdings are not included in the money supply statistics, and are assumed to constitute only a small proportion of money held by the public.

### Box 1: How do we make payments?

We primarily make payments using three different payment instruments:

- **Cash** is generally used when the payer and payee meet physically. This may include purchases in physical stores and payments between private individuals.
- **Payment cards** are used for both purchases in physical stores and distance purchases, for example of goods and services via the internet. Mobile telephones are not a payment instrument, but rather a payment solution. Most mobile payments, for example through the Vipps service, involve the charging of a payment card. Recently, the Vipps service has also begun offering immediate account-to-account settlement.
- **Giros** are used to pay bills and make transfers, and are usually actioned in an online or mobile banking solution. Some use is also made of giros to pay for online purchases.

Figure 1. Use of different payment instruments. 2016



In 2016, some 3.1 billion transactions were actioned via the three payment instruments.<sup>7</sup> Almost 70 percent of payments were card payments; see Figure 1. Giro payments accounted for just over 20 percent of the total, and cash payments just under 10 percent. The estimated scope of cash transactions is based on questionnaires, and some uncertainty attaches to the figures. Cash and card payments largely relate to purchases of goods and services. The average card payment value is far smaller than the average giro payment. Giro payments accounted for 95 percent of the total value of payments made in 2016.

<sup>7</sup> Norges Bank (2017b).

Our payment habits are changing:

- Cash usage is declining in terms of the overall number of cash transactions, the proportion of total payments made and the value of completed payments.
- Card usage is increasing:
  - Card payments are replacing cash in in-store transactions and payments between private individuals (private payments via smart phone apps that use a card as the underlying payment instrument).
  - A steadily increasing proportion of good and service purchases are being made online. Online purchases cannot be settled in cash, and the primary method used is payment by card.
- Immediate account-to-account settlement has recently been introduced. Volumes are small at present, but are expected to increase.
- The introduction of the Revised Payment Services Directive (PSD2) as of 2018 will also facilitate an increase in non-card account-to-account payments.
- Further, PSD2 will open the payment market to new operators, who will no longer have to partner with banks to offer payment services. Examples include:
  - new fintech companies,
  - major global platform operators like Apple, Samsung, Google and Facebook Messenger,
  - major global operators like AliPay and Amazon, who can offer combined purchase and payment solutions for goods and services,
  - more traditional retail chains in Norway.

The entry of major global companies may increase competition in the payment market, at least in the short term. In the longer term, there is a risk that major global operators will exploit their large customer networks and ownership of popular technological platforms to reduce competition. This may necessitate a response by regulatory authorities.

## 2.2. Desired attributes of the payment system

The payment system must be efficient. Payment system efficiency means that payments can be made quickly, securely, at a low cost and in line with user needs (Norges Bank, 2017a). The factors which determine payment system efficiency include the following:

- Means of payment and payment instruments must cover a range of different needs, as payments are made in many different situations and users may have differing priorities.
- The attributes of the different solutions must be known to users. As long as prices quoted to users reflect the differing costs associated with the solutions, users will make a socio-economically efficient choice of payment solution based on personal preference.
- A generally available payment solution must be available that can be used if a payer and payee cannot agree which means of payment or payment instrument to use.
- There must be real competition between different payment solutions/means of payment and their providers.
- Back-up solutions must be available that can operate effectively in the event of a service stoppage.

Norges Bank is of the view that the Norwegian payment system is currently efficient; see Norges Bank (2017a). Cash contributes to the efficiency of the Norwegian payment system.

However, technological advances and changing user expectations mean that currently acceptable solutions will not necessarily also be adequate in future. Developments may also undermine functions of importance to society.

The following questions must be asked:

- What characteristics do we want the payment system to have in the future?
- Is there a risk that important characteristics will disappear and that confidence in the monetary system will decline unless Norges Bank and/or other authorities take action?
- If yes, is a CBDC the best instrument for ensuring desired characteristics?
- Will a CBDC have other, undesirable consequences?



## 2.3. Attributes of cash

An important trend in the payment system is a gradual decline in cash usage, which now totals around 10 to 15 percent of payments for which cash could be used. Cash will be with us for many years to come. However, it is possible that, at some point, cash usage will be so low that it can no longer be considered a generally available means of payment. It is not Norges Bank's aim to eliminate cash, either with the aid of a CBDC or in some other manner. The use of cash should be determined by demand.

Bank deposits are now the predominant means of payment and must be assumed to be virtually the only alternative if cash usage declines further. E-money (receivables from E-money institutions) and crypto-assets such as Bitcoin are hardly viable alternatives for a broad user group in the near and medium term.

Consideration must therefore be given to which desirable attributes of the payment system will be lost if cash is no longer generally available, and how these could be compensated for. An overview of the most important attributes of cash as a means of payment and payment instrument follows.

### *Credit risk-free alternative*

Cash provides an alternative to bank deposits, and is credit risk-free for the holder. Confidence that deposit money can be quickly and simply converted into a corresponding sum of central bank money is (along with deposit protection and bank regulation) important for confidence in deposit money as a generally available means of payment. A financial crisis often weakens confidence in substantial segments of the banking system. In such circumstances, it is insufficient that the public can switch from one bank to another. The option of conversion into central bank-issued money is thus important for confidence in a monetary system dominated by privately issued money.

The existence of an alternative to provide bank money also means competition for banks. Competition has a disciplinary effect compared to a situation where banks have a monopoly on the issuance of money and/or means of payment, and may additionally promote innovation and the development of efficient payment methods.

Banks deposits with private institutions cannot offer these attributes. In the absence of a public guarantee covering all deposits, bank deposits will not be entirely credit risk-free for issuers.<sup>8</sup>

### *Direct, final settlement free of third-party involvement and technological dependence*

Cash permits direct, final settlement between payer and payee. When cash changes hands, final payment is made there and then, and the payer and payee are thus not dependent on a third party payment facilitator. This distinguishes cash from private deposit money.

In future, immediate-payment solutions may provide direct, final settlement between parties, but a third-party facilitator will be involved. Moreover, cash payments are technologically independent.<sup>9</sup>

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<sup>8</sup> One possible CBDC variant could involve users making deposits in a national bank or postal service bank. This would offer a credit risk-free alternative to ordinary bank deposits.

### ***Back-up solution***

Independence of technology and third parties at the moment of payment indicates that cash can function as a back-up solution when banks' ordinary electronic payment solutions are non-functional.<sup>10</sup>

Two technically wholly independent payment systems based on bank deposits can conceivably serve as contingency arrangements for each other. No such solution exists at present. The question is whether regulation of private financial market infrastructure (FMI) owners will ensure the existence of independent contingency arrangements and, more generally, what strategy is most appropriate for achieving this. This is a far broader question than that of a CBDC, but the answer influences whether back-up functionality is a motivating factor in the CBDC context.

### ***Legal tender***

Legal tender status is an important statutory characteristic of cash. Such status means that a party to a payment may demand cash settlement unless the parties agree otherwise. Further, the fact that cash (central bank money) is the mandatory means of payment promotes public confidence in bank deposits – the public knows that the available credit risk-free alternative is also a generally accepted means of payment.

If bank deposits were to become legal tender, some credit risk would arise for issuers of mandatory means of payment. Moreover, it would be necessary to decide which payment instruments may be used. This is a complicating factor in relation to cash, which is both a means of payment and a payment instrument.

### ***Anonymity***

Cash offers anonymity as it leaves no electronic traces. This safeguards user privacy. Payments based on bank deposits cannot offer anonymity. Electronic payment solutions can offer varying degrees of privacy, determined by regulatory restrictions on the use of payment information. Any increase in international ownership of infrastructure for Norwegian payments may make it more difficult to control the use of payment information.<sup>11</sup> On the other hand, lack of traceability can make it more difficult to discover certain crimes.

### ***“Everyone” can use it***

The use of cash requires no technological knowledge, and the risk associated with loss or theft is limited to the face value of notes and coins. These factors make it easier to send money via children, for example.

Private operators are developing user-friendly solutions, including for special groups such as children and young people. The working group anticipates that the technological maturity of the population will increase over time as new generations grow up. However, there is a risk that technological developments will outpace parts of the population, and that those affected may then find that they no longer have access to payment services that satisfactorily meet their needs.

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<sup>9</sup> Independent of technology at the moment of payment. Technology and third parties may be required to procure cash. Bank notes also incorporate technology.

<sup>10</sup> Reductions in banks' cash services have a negative impact on this back-up solution. Pursuant to section 16-4 of the Financial Institutions Act, banks must offer cash services in accordance with customer expectations and needs.

<sup>11</sup> In the EU/EEA, the new General Data Protection Regulation (GDPR) has established a common data protection standard.

### *Other attributes of cash*

The physical attributes of cash entail frictions, or limitations:

- Cash can be lost, damaged or stolen, and is therefore unsuitable as a store of substantial value.
- There are inherent volume restrictions and delays in the cash distribution system. This has potential advantages for banks and in terms of financial stability, as deposits cannot be exchanged into cash on an unlimited scale over a very short period of time.
- Cash payment necessarily entails physical transfer, and thus geographical proximity between the parties.

## 2.4. Are private means of payment sufficient on their own?

Although cash will continue to be used for many years to come, cash usage is falling steadily. If, at some point in the future, cash usage declines so much that cash can no longer be regarded as a generally available means of payment, this development may – in view of the discussion above – well be negative for the overall efficiency and robustness of the payment system.

Three particular factors require further analysis in the context of any general non-availability of cash:

- The need for a credit risk-free alternative to deposit money.
- An independent back-up solution for ordinary electronic payment systems.
- The legal tender function.

Further, it can be questioned whether overall efficiency will improve if the public gains better opportunities for the conversion of private money into central bank money than those offered by cash. Although it is currently in principle possible to convert all money deposited in a bank account into cash, doing so is associated with costs and/or frictions linked to physical logistics and loss risk, such that this option is unlikely to be realistic in practice.

The assessment of these factors will indicate whether private electronic means of payment alone can provide an efficient payment system and secure confidence in the monetary system.

## 2.5. Other arguments for a CBDC

In this chapter, we discuss a number of other potential arguments for a CBDC that are not related to the promotion of an efficient and robust payment system. The working group's primary conclusion is that none of these arguments provide decisive grounds for introducing a CBDC. Nevertheless, these issues may be affected by the introduction of a CBDC, and such effects should be taken into account in a cost-benefit assessment.

### 2.5.1. Monetary policy space and other macro-economic grounds

Monetary policy is implemented through the key policy rate, and is independent of the volume of notes and coins<sup>12</sup> and the payment system.<sup>13</sup> Even though notes and coins play no role in the implementation of monetary policy, they do constitute an investment alternative for the public in their capacity as a store of value. The existence of notes and coins thus implies a lower limit on market interest rates. In practice, the lower key policy rate threshold is believed to be somewhat lower than zero, since cash handling costs and the risk associated with storing large sums mean that the public will not wish to hold significant volumes of cash (instead of electronic receivables) until the nominal rate falls somewhat below zero.

Based on the assumption that a CBDC can have an interest rate below zero, some<sup>14</sup> have concluded that it would be advantageous to eliminate physical cash and replace it with a digital currency. The unavailability of cash is a critical factor in the removal of the lower key policy rate threshold. Accordingly, to the extent that a CBDC would help eliminate cash as a real payment and investment alternative, increased monetary policy space may be an argument for introducing a CBDC. In the working group's view, however, this argument provides insufficient support for a change as radical as introducing a CBDC.

Barrdear and Kumhof (2016) have taken the view that a CBDC can influence the real economy, not least by affecting real interest rates. The advantages they have identified are based on the assumption that interest rates on public debt may fall if some debt is replaced by a CBDC. This would give public authorities room to cut taxes. Since taxes often have a distorting effect, an efficiency gain could be achieved. In this regard, the working group has assumed that any CBDC would be limited in volume terms. Moreover, since the Norwegian public sector has net financial receivables, this argument holds little relevance for Norway.

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<sup>12</sup> For a discussion of the implementation of monetary policy and a description of its independence from money supply, see Disyatat (2008) and Disyatat (2011). In practice, the interest rate has always been a decision variable and a monetary policy instrument in Norway; see Klovland og Øksendal (2017).

<sup>13</sup> In line with this, Woodford (2003) has stated that central banks do not need to play any role in the payment system in order to implement monetary policy. Woodford (also) cited the trend towards a cashless economy as a motivation for his study of the interest rate as a monetary policy instrument. He stated that, "It is possible to imagine that in the coming century the development of electronic payment systems could not only substitute for the use of currency in transactions, but also eliminate any advantage of clearing payments through accounts held at the central bank." He pointed out that Wicksell (1898) already defined, "A state of affairs in which money does not actually circulate at all, neither in the form of coin (except perhaps as small change) nor in the form of notes, but where all domestic payments are effected by means of...bookkeeping transfers" (p. 70).

<sup>14</sup> See Rogoff (2015).

## 2.5.2. Currency competition

A further question is whether competition from crypto-assets like Bitcoin and other national currencies offering CBDCs could threaten the position of the Norwegian krone in the payment system in Norway. The IMF (2016)<sup>15</sup> has stated that volatility in the value of crypto-assets probably indicates that such currencies are not only unsuitable as a unit of measurement, but also pose no threat to national currencies in countries where there is confidence in national monetary policy. The working group shares this view. It is possible that new generations of crypto-assets may become more attractive as means of payment or payment solutions due to greater processing capacity, lower costs, increased speed and more user locations. However, crypto-assets have a long way to go to become more efficient than robust centralised payment solutions.

In the long term, the possibility cannot be excluded that payment solutions based on means of payment other than the Norwegian krone (for example receivables from large international companies in US dollars or other globally used currencies) will grow in scope and thus have a greater impact on the Norwegian payment system and use of the Norwegian krone. Further, “shadow banks” may emerge that employ means of payment that are in widespread international use and can easily and cheaply be converted into Norwegian kroner when needed.

According to macro-economic literature, it is monetary policy and robust macro-economic stabilisation policy – along with sustainable government finances – that safeguard the value of money and protect against currency substitution, not the efficiency of the payment system. Further, the effects of national monetary policy depend on use of the local currency in pricing and in contracts; they do not depend directly on which currency is used to settle payments.

It is possible that other countries’ currencies will become more widely used in pricing and contracts in Norway if the payment services linked to these currencies are robust and the associated currency risk is deemed to be manageable. Such substitution away from the Norwegian krone may be countered by introducing a CBDC in Norway. However, a prerequisite is that the CBDC helps keep Norway’s payment system linked to the Norwegian krone more competitive than it would otherwise have been. This question is not examined further in the present report.

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<sup>15</sup> See also Carney (2018), Carstens (2018) and Mersch (2018), who have argued that digital money does not fulfil the fundamental functions of money.

### 2.5.3. Could a CBDC result in higher seigniorage and, if so, is this important?

Seigniorage<sup>16</sup> is an important source of income for many central banks, and ultimately benefits the public sector through transfers from the banks. A shift away from cash towards other forms of money will reduce central bank revenues. A sufficiently large shift may reduce a central bank's balance sheet, and may thus in principle restrict the use of policy instruments (BIS 2015). Introducing a CBDC can be a means of limiting any drop in seigniorage. The resulting effects will depend on several factors, including whether the public receives interest on central bank deposits and how the introduction of the CBDC is funded.

On the other hand, the consideration of central bank income has never guided the use of policy instruments or the design of payment systems in Norway. Socio-economic efficiency generally implies that a central bank should not accumulate significant seigniorage. Norges Bank's payments policy has always been based on socio-economic assessments, even though this has reduced the bank's revenues.<sup>17</sup> Further, Norges Bank is insulated against income fluctuation by transfers to and from the Ministry of Finance. Finally, central banks can, if necessary, operate with a negative equity balance for several years without this necessarily impacting on their use of policy instruments (Buiters 2008; Stella 2005). The opportunity to earn higher seigniorage is therefore not an argument for the introduction of a CBDC in Norway.

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<sup>16</sup> There are several definitions of seigniorage. One current and commonly used definition is the added value a central bank generates by investing income from "sales" of notes and coins in interest-bearing assets such as national government bonds and foreign securities (Veggum, 2010). The central bank balance sheet then shows notes and coins in circulation as a liability and a corresponding asset entry comprising the interest-bearing asset investments (typically foreign securities).

<sup>17</sup> See Veggum (2010).

## 3. How?

### 3.1. Primary models

Thus far, not much progress has been made on the development of organisational models for CBDCs. Accordingly, the discussion below must be considered preliminary, but may function as a starting point for further work.

The working group's current assessment is that there are two primary potential models for the organisation of a CBDC system: *account-based* and *value-based*.

- An **account-based model** is characterised by the fact that both value storage and transaction processing are centralised.
- A **value-based model** is characterised by decentralised storage and decentralised processing.

#### 3.1.1. Account-based model

In an account-based model, assets and other data are stored in a central account structure/database.<sup>18</sup>

Assets are accessed using software and hardware. Examples of such software include smart phone applications and online banking solutions, while examples of hardware include cards, telephones, watches and armbands.

No actual assets are stored in either the software or the hardware. Rather, they provide access to a balance stored in a centralised database, through identification or the specification of a reference. Transactions are implemented by entering a payment instruction in a smart phone application or on a website, or using a payment card or other unit together with a terminal. The instruction is verified through a centralised system. Transaction implementation is conditional on network access and availability of the centralised system.<sup>19</sup>

This model allows the public to keep an account with the central bank or in a system controlled by the central bank. At present, it is generally only banks that hold accounts directly with the central bank. Banks use these accounts to settle payments between their respective customers.

In practice, such a system will generally function like the account systems most consumers already know from their personal banking arrangements. However, an important and fundamental difference is that CBDC payments can be settled immediately and directly between the payer and the payee, since both have accounts in the same account system. This can be compared to payments between customers of the same bank.

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<sup>18</sup> A further potential solution does not involve one centralised account structure, but rather individual customer CBDC accounts with private banks. Each bank would have to hold corresponding CBDC sums on the asset side of the balance sheet. (In other words, each bank would have to procure CBDC.) This equates to "full reserve banking". The further discussion focuses primarily on a centralised account structure.

<sup>19</sup> Offline transactions without coverage control could provide a back-up solution for shorter time periods and defined risks (for example a maximum number of transactions below a certain value threshold).

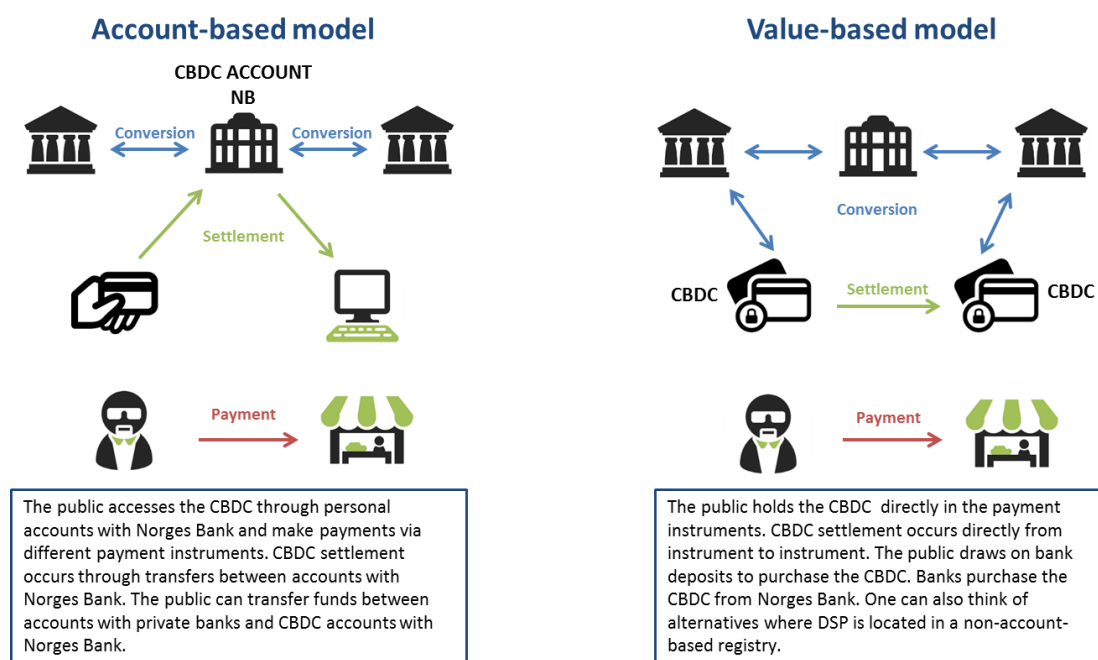


Balances held in the account system represent receivables from Norges Bank, and thus central bank liabilities. However, this does not prevent outsourcing of the daily operation of core infrastructure to other operators. Infrastructure, or some other system, is also required for the transfer of money between the private bank account system and the CBDC system.

The public must be able to access funds in CBDC accounts with the central bank. Some form of online banking solution is probably required to facilitate the payment of bills and other larger account-to-account payments. Instruments are also needed for payments at user locations and transfers between private individuals. Payment cards and payment applications for mobile telephones could be suitable instruments in this regard. Moreover, as regards payments at user locations, it is necessary to investigate whether existing infrastructure (card terminals, etc.) can be used or whether it is necessary or desirable (for example in the interests of back-up capacity) to develop parallel, independent payment infrastructure.

The scope of Norges Bank's role in such a system needs to be decided, with respect to both development of the actual systems and subsequent operation and maintenance. One potential solution is for Norges Bank to provide the account structure, and possibly also the basic underlying customer infrastructure, while other operators are permitted to develop their own customer-oriented solutions based on and connected to the central bank's core system. Figure 1 compares the structures of account-based and value-based models.

Figure 1





### 3.1.2. Value-based models

In a value-based model, assets (money) are stored locally in an electronic unit, for example a pre-paid card or a sim card in a mobile telephone. Assets are stored in the hardware (a chip), and can only be changed using a cryptographic key. There is no need to contact a central database to verify the assets stored in hardware, or to implement a transaction. Payment is made through the direct transfer of funds from a payer's electronic unit to the payee's electronic unit. The balance in the payee's hardware increases by the same amount as the balance in the payer's hardware is reduced.

Payments in a purely value-based system require both the payer and the payee to be physically present or otherwise directly connected at the moment of payment. A value-based system is therefore unlikely to be suitable for distance payments, as in the case of online shopping and bill payment. The technical possibilities should be investigated further.

As in the case of cash, payments are settled immediately in a purely value-based system. Moreover, payment can be made anonymously. However, identification is likely to be required when loading and transferring money onto/from electronic units.

If an electronic unit is lost, the money held in the unit will also be lost, just as in the case of cash. Individuals are therefore likely to limit the volume of money they store in such units.

When money is stored locally, it is unlikely that interest can be paid on it. Accordingly, value-based models are no more suitable for saving and the storage of substantial value than cash.

A value-based system also requires extensive infrastructure. Norges Bank will have to decide the extent of its role in the development, operation and maintenance of the system, as well as customer contact. Electronic units have to be provided, as does functionality for loading and transferring money onto/from the electronic units (account-based central bank money or private bank money). User locations require payment terminals capable of accepting such payments.

In a purely value-based system, there is no ongoing centralised verification of ownership of issued money. It is therefore vital that security solutions are implemented to prevent both counterfeiting and use of the same money for multiple payments.

The Octopus payment system used in Hong Kong and the Oyster Card system used in London are examples of purely value-based models. Both Octopus and Oyster started life as travel-payment systems, but the Octopus system has been expanded to include payments in stores and restaurants. These systems have been linked to central transaction registers to ensure that users can be reimbursed for lost assets (transaction data from local card readers are transferred to the central registers several times a day). However, asset storage and transfer both occur locally and directly between the payer and payee.

In addition to purely value-based models, there are also various solutions that make greater or lesser use of elements from account-based models. These solutions also store assets locally with individual users. However, unlike the hardware-based storage approach adopted by purely value-based systems, storage in such systems is software-based.

Assets are typically stored in an application on a mobile telephone, in the form of so-called digital certificates. Since no secure technology has as yet been developed to prevent copying of digital certificates, and thus so-called “double spending”, transactions have to be routed through a central unit that receives the certificate and issues a new certificate to the payee. The Australian Digicash<sup>20</sup> system is one example of a system that works in this way.

### **Box 2: Model based on decentralised technology**

A third alternative is a model based on decentralised technology (Distributed Ledger Technology, or DLT); see for example Bech and Garratt (2017), Kaminska (2017), Broadbent (2016) and Carney (2018). Existing financial infrastructure is extensively based on a number of key systems through which all transactions pass (for example clearing houses and central bank settlement systems).

In a DLT system, the transaction register is disseminated among all the members of the network, and transactions occur directly between end users. This may give DLT systems some advantages in terms of back-up functionality, compared to centralised models featuring “single points of failure”.

One possible authentication/security mechanism involves amalgamating new transactions into blocks and entering these into the account system through some form of approval, for example network consensus (as in the case of open networks like Bitcoin, although such an organisational structure is not a prerequisite). Such blocks of transactions are then linked in a chronologically fixed order, producing a blockchain.<sup>21</sup>

Such systems present some challenges:

- The technology is generally immature.
- The systems, or at least those we have examined to date, offer far lower processing capacity and speed than modern centralised payment systems. New versions of the technology may offer improvements, but there is some way to go.
- Open networks based on consensus through “proof of work” consume a disproportionate amount of energy, resulting in very high system costs. It is likely that this task could be performed more efficiently by a system incorporating a central administrator/owner. (In the case of a CBDC, this would be the central bank or an operator appointed by the central bank.)
- Current solutions have already presented a range of security challenges, as electronic wallets have been stolen and assets lost due to technical errors. The risk of theft is, in principle, the same as in the case of cash.

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<sup>20</sup> www.digi.cash

<sup>21</sup> Wandhöfer (2017) has proposed, at the theoretical level, a DLT solution for digital Euros in which the central banks in the Euro system function as validating nodes, banks supply their customers with digital money purchased from the central bank and the system permits anonymous small payments.

- One particular challenge linked to the use of DLT for CBDC purposes is that the central bank must be able to control the system. This necessitates a number of adjustments compared to a purely decentralised system.

DLT in general offers considerable potential. Solutions and pilot projects have already been developed in some areas, for example gold and diamond sales, loan syndication, trade financing, securities trading and settlement infrastructure, international payments, know-your-customer systems and other processing and sharing of information. These areas feature fewer, but more complicated, transactions (with a greater informational content) than payment services for the general public, and the solutions typically involve closed networks.

Payment systems for the general public probably do not represent the simplest application of DLT.<sup>22</sup> In this area, DLT has to compete with modern decentralised systems that, at present, are far more efficient and offer more mature technology. Accordingly, the working group does not regard DLT as a relevant CBDC model/technology for the near and medium term.

Several central banks have investigated whether DLT can be used in their central settlement systems (a far narrower issue than CBDC). Among others, the central banks of the United Kingdom, Canada, Singapore, Brazil and the ECB/Japan (joint project) have examined available opportunities in-depth.<sup>23</sup> Attractive characteristics of DLT are its absolute independence from existing technology and the fact that the network survives even if members fall away. Internationally, the consensus appears to be that DLT holds potential for settlement systems, particularly in conjunction with other financial infrastructure (securities settlement, currency settlement) involving central bank settlement. However, the technology is currently considered to be too immature. In addition, challenges have arisen with respect to adapting DLT to keep settlement transactions private from all but the involved parties (and the central bank) without reintroducing central “single points of failure”. Several of the central banks plan to analyse the opportunities further, but to date none of them have decided to adopt DLT. The Bank of England’s future settlement system is to be compatible with potential DLT-based securities settlement systems; see Carney (2018).

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<sup>22</sup> For a different perspective, see the DLT-based “Fedcoin” proposal in Andolfatto (2015) and Koning (2016).

<sup>23</sup> See Bech and Garratt (2017) for an overview.

### 3.1.3. Comparison of the attributes of the two primary models

As payment systems, the two primary models have differing strengths and weaknesses. Generally speaking, a value-based model has very similar functionality to cash, while an account-based model is broader and more closely resembles systems based on deposits in private banks.

#### **An account-based model:**

- can be adapted to all payment methods, including those used for online shopping and paying bills,
- offers secure value storage and is suited to payments of any size,
- has the limitation that it is dependent on contact with a central third party to execute and settle payments; this entails greater dependency on functioning electronic systems,
- may have substantial adverse impacts/side-effects on banks, financial stability and monetary policy, and may offer arbitrage opportunities for large operators. The impacts depend on the design.

#### **A value-based model:**

- is local and thus not dependent on communication with a third party. This makes the model operationally robust and particularly well-suited for contingency purposes,
- will be able to address privacy concerns satisfactorily, as payments are not traced or recorded in a central database,
- is not optimal for storing or paying large amounts, since value is stored locally by the user on a card or in an application. This alternative thus features some of the limitations/frictions (such as geographical location) inherent in physical cash. These frictions will be lost if an account-based model is chosen. A purely value-based model is probably also unsuitable for online shopping and bill payment, as the payer and payee have to meet or be directly connected at the moment of payment.

It is difficult to comment on utility and costs in greater detail without further specification of individual solutions.

### 3.1.4. Norges Bank's role

Irrespective of the model chosen, Norges Bank must have control over and primary responsibility for any Norwegian CBDC system. However, Norges Bank's role may differ under the two models.

In the case of a **value-based system**, it should be considered whether this responsibility can be defined in the same way as in the cash area currently. In other words, Norges Bank would take responsibility for money and related security, as well as the supply of CBDC to banks/private recipients. Banks are responsible for passing cash on to their own customers. This could entail, for example, making Norges Bank responsible for provided technical solutions while banks take responsibility for passing instruments on to their own customers and for the systems used by customers to transfer money between their personal bank accounts and their CBDC instruments (cards, smart phone apps). Norges Bank would probably have to be responsible for the development of instruments and payment terminals used in such a system.

In the case of an **account-based system**, Norges Bank would probably have to have the ultimate responsibility for the core infrastructure, but not necessarily all the payment services that are built on top of it; see below. This does not prevent the outsourcing of tasks; see chapter 5.3.

The working group sees several arguments why Norges Bank should not be responsible for technical development and daily operation of any CBDC system. These include:

- Other operators possess greater expertise in fields like product development, technical customer interfacing, etc.
- Other operators possess greater expertise, and can specialise, in customer service and compliance with regulations relating to matters such as know your customer, anti-money laundering and anti-terrorist financing.

Even if tasks are outsourced, Norges Bank will still bear ultimate responsibility. Norges Bank must therefore have the expertise and capacity required to handle non-conformances, orders, and monitoring of services delivered by providers.

None of the primary models require Norges Bank to have direct customer contact. One possibility is to outsource customer contact to a single operator, for example the operator engaged to operate the system on Norges Bank's behalf, if this solution is chosen.

An account-based system can be organised as an infrastructure to which various banks and payment service providers have access. This solution facilitates competition and innovation "on top" of the system. In other words, banks and/or payment service providers will develop and deliver customer-oriented services based on a shared account system that they do not control. Such a solution is most consistent with the intentions behind the EU regulatory framework for payment services, and mirrors the structure of the Norwegian electricity market, in which grid and customer service operations are separated and price-setting occurs "on top" of the underlying structure.

If customers instead hold CBDC accounts with individual banks (rather than in a central account system), each bank will have to ensure that its CBDC holdings match its customer deposits – i.e. a "full reserve", rather than "fractional", banking system.

## 3.2. Design principles

The attributes and functionality of a CBDC are highly determinative of the architectural design and technical solution chosen. The overarching principles for IT architecture formulated by the Agency for Public Management and eGovernment (Difi)<sup>24</sup> are common guidelines for all public sector IT work, and constitute a foundation for all future efforts. Possible solutions for a CBDC must be assessed by reference to the following IT architecture principles:

- **Scalability:** The CBDC solution must be scalable in response to changes in use, whether in terms of number of users, user group composition, volume or response times, throughout the operating life of the solution. The solution must be modularised in such a way that it is possible to upscale and downscale both the entire solution and individual components.
- **Inter-operability:** The CBDC solution must be usable without restriction across all unit types and user operating systems, and must insofar as possible be adaptable to future technological changes. The solution must employ publicly approved standards and formats to ensure promotion of cooperation, innovation and information exchange.
- **Accessibility:** The CBDC solution must provide services that are: available when users need them, easy to find, user-friendly and universally designed. The CBDC must be available to all relevant user groups irrespective of age and functional ability, to ensure that no user groups are discriminated against. The solution must be available 24 hours a day, 365 days a year.
- **Security:** The CBDC IT solution must comply with risk-based requirements related to operational security, protection against breaches of confidentiality, integrity and accessibility, as well as protection against cyberattacks. The solution must comply with all statutory requirements, such as those in the Security Act and the Personal Data Act, and with applicable international guidelines and standards.
- **Flexibility:** The design of the CBDC solution must not limit changes to functionality, organisational structure, ownership and infrastructure. The design must take into account the possibility of changes in the supplier market, amendment of laws and regulations relevant to responsibility and ownership, and updates of information-exchange standards.

Work on a CBDC solution is at an early stage. Based on an overall technical assessment, it appears possible to achieve both an account-based and a value-based CBDC solution based on the IT architecture principles referred to above. Further work on the attributes and functionality of the CBDC solution will provide a basis for defining concrete solution options.

The financial costs associated with both primary models would be substantial, in terms of both establishment and operation. Costs depend, among other things, on technology, functionality and security and on organisational matters such as outsourcing and system ownership. Cost estimates will not be possible until such matters have been clarified.

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<sup>24</sup> <https://www.difi.no/fagomrader-og-tjenester/digitalisering-og-samordning/nasjonale-arkitektur-prinsipper>. See also Scorer (2017) for a discussion of the principles for IT architecture from the Bank of England's perspective.

### 3.3. What will influence demand for a CBDC?

Some use is required in order for a CBDC system to be sustainable. The required usage volume is probably smallest when the primary purpose of the CBDC is to function as a back-up solution. However, even in such cases there will be a need for at least some use in order for the general public to be sufficiently familiar with the system when an emergency situation does in fact arise. We therefore need to understand which factors may influence CBDC demand.

Demand at any given time is determined by how users assess the CBDC compared to other means of payment (and associated payment instruments). In principle, the authorities can make the CBDC mandatory for certain types of (public) payments. Doing so may give the CBDC an advantage over private means of payment. However, it is not given that the authorities should impose such requirements.

Users are likely to prioritise confidence in the means of payment, functionality in accordance with their own preferences and overall cost (including risk). Accordingly, demand may fluctuate considerably if circumstances arise that affect these attributes. Further crucial attributes are the respective returns on the CBDC and bank deposits and regulations relevant to confidence in bank deposits; see below.

As discussed elsewhere in the report, it may become necessary to influence the CBDC volume by introducing frictions into the conversion process between bank deposits and the CBDC. In designing attributes, it is important to ensure that the CBDC is considered “sufficiently attractive” by the public.

We have distinguished between *payment purposes* and *value storage purposes* in our analysis of factors that may influence CBDC demand. The assessment as to which factors are most important will vary depending on the primary intended purpose for which the money is to be used.

#### ***A CBDC for payment purposes***

Internationally, many private operators have made unsuccessful attempts to develop customer-oriented payment solutions.<sup>25</sup> Predicting which solutions will become popular and achieve a sufficient number of users and advantages of scale – and which will not – is difficult. However, it is possible to identify some factors with a probable influence on demand:

- What needs are met by the solution.
- How well it functions and whether it is perceived as attractive and secure.
- What payment situations it can be used in. Can it be used at physical user locations, for online shopping, to pay bills and for friend payments?
- How widely adopted the solution is. Can it be used for payments at most user locations and to businesses and private individuals?

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<sup>25</sup> One example is the UK-based Mondex rechargeable payment card.

- How simple and inexpensive it is to convert CBDC into bank deposits and vice-versa.
- Which agents are given access.

***A CBDC for value storage purposes***

If the most important driver of CBDC demand is value storage, a different set of factors will determine the volume of demand:

- Whether there are limitations on the amount of funds it is possible to store.
- The relative return on stored amounts.
- The security of storage – credit risk (to which deposit protection is relevant) and operational risk/risk of theft.
- How simple and inexpensive it is to convert CBDC into bank deposits and vice-versa.
- Which agents are given access.
- Which other government-issued securities/assets exist that are liquid and can be easily used for value storage.



## 4. Consequences

In this chapter, we assess the consequences of introducing a CBDC for the payment system (chapter 4.1), for Norges Bank's liquidity management, bank functions, financial stability and monetary policy (chapter 4.2) and for other regulatory authorities (chapter 4.3).

### 4.1. Consequences for the payment system

#### 4.1.1. Competition and innovation in the payment market

The introduction of an entirely new, electronic means of payment and related payment instruments may improve the efficiency of the payment system, both through the new products and services on offer and through intensified competition in the market and a resulting increase in innovation among established operators.

On the other hand, introducing a CBDC may reduce important payment service revenue for established operators. This may reduce their incentives to invest in innovation and product and service development. However, the opposite trend has been observable in the payment market in recent years, with existing operators regarding the payment market as far more important for strategic positioning than previously. They have therefore been willing to invest even though earnings in the payment market have been weak. The development of the Vipps service is one example of this. We otherwise refer to the discussion of the payment market in chapter 2.

#### 4.1.2. Socio-economic costs associated with the payment system

One argument made in favour of electronic central bank money for general purpose users is that it would improve the cost efficiency of the payment system. This argument is based on the view that electronic payments are much cheaper than cash (or cheque) payments. The working group has found no arguments or calculations in support of the proposition that CBDC payments are cheaper than other electronic payments.<sup>26</sup>

Previous surveys conducted by Norges Bank evidence considerable differences in the costs associated with different payment types. The most recent survey, carried out in 2013, found that the social costs of cash payments at user locations were more than 50 percent higher than in the case of card payments.<sup>27</sup> However, cash usage in Norway is relatively low. Surveys indicate that cash payments account for approximately 10 to 15 percent of all payments for which cash can be used. Cheque usage is extremely limited. Accordingly, compared to many other countries, the potential for cost savings through further digitisation of the payment system is relatively limited in Norway. The working group has therefore concluded that the cost argument for introducing a CBDC in Norway is not decisive. However, this does not preclude positive side effects.

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<sup>26</sup> See for example Barrdear and Kumhof (2016) and Chiu and Wong (2015). Similarly, Andolfatto (2015) has argued that introducing a "FedCoin" could reduce cash usage in the USA, which could result in efficiency gains. Similar arguments have been made by Bordo and Levin (2017), Raskin and Yermack (2016) and Cochrane (2016). The conclusions in these papers are based on apparently plausible assumptions as to potential efficiency gains in payment services. However, these are undocumented, and it is therefore difficult to evaluate their reasonableness. None of the referenced papers have estimated CBDC demand.

<sup>27</sup> See Norges Bank (2014b).

### 4.1.3. Public/private role allocation in the payment market

Norges Bank has traditionally performed the central payment settlement function and acted as a wholesaler of cash. The introduction of a CBDC may influence the public/private role allocation in the payment market. Norges Bank – like most central banks in modern economies – does not currently provide payment services directly to the general public. According to CPSS (2003)<sup>28</sup>:

*“While central banks encourage or require the use of central bank money in systemically important payment systems, they limit access to it for other purposes. One form of central bank money – namely banknotes – is, of course, universally available. However, central bank accounts are typically available only to a limited range of entities, mainly banks. This reflects the fact that while central bank money plays a key role as a settlement asset in payment systems, central banks do not in general want to compete with commercial banks in providing banking services to the public. Because of this, central banks typically open accounts only where there are good public policy reasons for doing so, for example where the use of central bank money helps to eliminate exposures arising within the payment process that could give rise to systemic risk.”*

The impact on the payment market will depend on the design of the CBDC. If the central bank only provides underlying infrastructure while private operators develop and sell payment services to the public, the change in roles will be smaller than if the central bank provides payment services directly to the public.

Kahn, Quinn and Roberds (2016) have studied a cost-risk pay-off spectrum in the payment system. Different payment instruments offer different combinations of costs and risks. Changes that bring the spectrum of payment instruments closer to the origin – i.e. to lower costs and lower risk – increase welfare. Kahn et al. have argued that the role of central banks is to provide payment instruments/means of payment with low or negligible risk. However, these carry relatively high costs. Private operators can move along the cost-risk payoff spectrum, offering the public lower costs at the expense of higher risk. Public payment instruments can constitute “anchors”, or the backbone of the system, and may move the entire spectrum inwards when there are innovations in central bank money.

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<sup>28</sup> CPSS (2003) is a report by the “Committee on Payment and Settlement Systems”, a central bank committee with a secretariat in BIS. The committee was renamed the “Committee on Payments and Market Infrastructures” (CPMI) in 2014.

# 4.2. Consequences for the macro-economy: bank and central bank balance sheets, financial stability and monetary policy

## 4.2.1. Bank and central bank balance sheets

A CBDC gives the general public (households and businesses) a digital claim against the central bank. At present, notes and coins represent the only claim the public can have against the central bank. The conversion of bank deposits into CBDC units may have consequences for central bank balance sheets, bank financing and balance sheets, the structure of the banking sector and monetary policy.

Bank assets primarily consist of loans to the public, securities of various types and deposits with (or other receivables from) the central bank. Banks fund their assets through deposits from the public, different types of commercial paper, central bank loans and equity (together referred to as “liabilities”); see Table 2.

Money and credit creation by banks is a cornerstone of any modern economy featuring deposit money. Money is created when banks make loans to customers that are then deposited in a bank account.<sup>29</sup> Such loans increase the loan total on the asset side of the balance sheet and the deposit total on the liabilities side equally. Accordingly, banks are in the unique position of being able to create money, i.e. their own financing.<sup>30</sup> Transactions between members of the public, e.g. households and businesses, do not alter money supply. Transactions between such parties simply involve the transfer of deposits from one bank to another. Collectively, therefore, banks can assume that deposits from the public, which they themselves create, are a fairly stable source of funding.

**Table 2. Bank and central bank balance sheets**

Banks		Central bank	
Assets	Liabilities	Assets	Liabilities
Loans to the public	Deposits by the public	Securities	Deposits by banks (reserves)
Securities	Commercial paper	Foreign exchange reserves	Notes and coins
Deposits with the central bank	Loans from the central bank	Loans to banks	Deposits by government
	Equity		CBDC
			Equity

<sup>29</sup> Money is also created when banks purchase securities from non-banking actors. This occurs because banks pay by granting the seller of a security a bank deposit. Similarly, money is destroyed when the public repays debt to banks, and when banks sell securities or issue commercial paper and shares to non-banking actors.

<sup>30</sup> Although in purely technical terms this means that banks can issue an unlimited volume of money and credit, there are factors that influence and govern bank lending. Three overarching factors are important: (i) demand for loans by the public, which in turn is dependent on interest rates; (ii) regulatory requirements; and (iii) risk and profitability considerations for banks.

The liabilities side of the central bank balance sheet includes the items notes/coins, deposits by banks, deposits by the Norwegian State and equity. A CBDC in the form of deposits by the public or a rechargeable card/smart phone app will also be shown on the liabilities side of the central bank balance sheet; see Table 2. Central bank assets comprise securities, foreign exchange reserves and loans to banks. Banks' deposits with the central bank are synonymously referred to as central bank reserves, reserves or bank liquidity.<sup>31</sup>

A CBDC may have an impact on bank and central bank balance sheets. If the CBDC takes the form of an **account-based solution**, any transfer by a participant from a bank to the central bank requires the affected bank to transfer reserves from its central bank account to the central bank account of the participant. (If the transaction had been between two banks, the bank losing the customer deposit would have had to transfer reserves to the other bank's central bank account.) If there are few reserves in the banking system, banks must borrow reserves from the central bank. On the liabilities side of bank balance sheets, customer deposits will be replaced with central bank financing. On the liabilities side of the central bank balance sheet, public deposits (CBDC) will increase, while on the asset side loans to banks will increase. Alternatively, the central bank may first inject reserves into the banking system by purchasing securities from the public. In such case banks will have reserves to be drawn on when the public transfers deposits to the central bank.<sup>32</sup>

If the CBDC takes the form of a **value-based solution** such as a rechargeable card or an app, the card or app will be charged by drawing on a bank deposit. The bank that loses the deposit will have to reduce its central bank deposits proportionately. For a given volume of CBDC demand, the effect on bank and central bank balance sheets will be precisely the same as when the CBDC is account-based.

### *A CBDC is a different autonomous factor*

Like notes, coins and state accounts, a CBDC is an autonomous factor in the central bank balance sheet. "Autonomous factor" means an item in the central bank balance sheet that influences the volume of reserves in the banking system but is beyond central bank control. The central bank counteracts autonomous factors through market operations.<sup>33</sup> This is an important element in the central bank's liquidity management.<sup>34</sup> However, there are some differences between a CBDC and other autonomous factors.

If the public is permitted to hold accounts with the central bank, bank deposits can be transferred from banks to the central bank quickly. This is because the public is likely

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<sup>31</sup> Banks primarily maintain central bank deposits (reserves) for the purpose of payment settlement. When a bank deposit is transferred from Bank A to Bank B, it is settled through the transfer of reserves from Bank A's central bank account to Bank B's central bank account. For further discussion of money and credit creation by banks and the links between monetary aggregates such as money and central bank reserves, see McLeay, Radia and Thomas (2014), Nicolaisen (2017) and Bernhardsen, Kloster and Syrstad (2016).

<sup>32</sup> If the volume of reserves in the banking system is high (for example because the central bank has purchased securities, due to QE, etc.), banks will not necessarily be dependent on central bank loans or central bank purchases of securities in the market.

<sup>33</sup> State accounts are an autonomous factor in central bank balance sheets because transactions involving state accounts influence banks' deposits with the central bank (reserves). Payments from the public to the State (for example tax) reduce bank deposits with the central bank and increase the State's deposits. As central banks often have a target figure for banking system reserves, this will be offset by offering banks new reserves, for example through secured loans. Similarly, when the State makes payments to the public, this increases banks' central bank deposits, which can be offset by offering banks time deposits. Increased demand for notes and coins reduces central bank reserves because banks pay for notes and coins by drawing on their central bank deposits.

<sup>34</sup> Norway's liquidity management system is further described on the Norges Bank website; see <https://www.norges-bank.no/en/Liquidity-and-markets/The-liquidity-management-system/>. See also Aamodt, Strøm-Fjære, Lerbak and Tafjord (2016) and Norges Bank (2014a). For further discussion of liquidity management systems in general, see Bindseil (2014), Bernhardsen, Kloster and Syrstad (2016), Bernhardsen and Kloster (2010) and Syrstad (2011).

to regard bank deposits and central bank deposits as close substitutes. It is therefore possible that a CBDC incorporating a (central bank) account-based solution will result in significantly larger changes in autonomous factors in the central bank balance sheet than notes and coins, particularly if the public can hold unlimited amounts of the CBDC. A CBDC incorporating a value-based solution – such as a rechargeable card or app – is likely to be a poorer substitute for bank deposits than central bank deposits, and movements are therefore likely to be smaller. However, a distinction can still be made from cash, as banks have to hold cash before they can sell it on to the public. In contrast, the public can transfer deposit money from a private bank account and purchase CBDC without the private bank first having to hold the corresponding amount of central bank reserves.

A CBDC may also have an impact on the risk inherent in the central bank balance sheet. When the central bank counteracts changes in autonomous factors through market operations and by injecting reserves into banks in the form of loans, these transactions are always secured. If the CBDC incorporates an account-based solution without restrictions of any kind – meaning that large bank deposits can quickly be transferred to central bank accounts – the central bank may be forced to make large loans to banks. Depending on the security banks can provide, the central bank may have to accept security carrying a higher credit risk. If the CBDC incorporates a value-based solution (card/app), or an account-based model featuring frictions between bank deposits and the CBDC, the movements between the CBDC and bank deposits are likely to be smaller, meaning that the risk inherent in the central bank balance sheet will also be smaller.

#### 4.2.2. Effect on banks

Deposits are the most important form of funding for Norwegian banks, and smaller banks in particular. Generally, deposits are also a cheaper funding source for banks than wholesale funding. Accordingly, high CBDC demand may have considerable consequences for bank funding and activity, and for the structure of the banking sector.

It is difficult to forecast future CBDC demand. As discussed in chapter 3.3, demand depends on factors such as the perceived user-friendliness of the CBDC, the perceived security of bank deposits, the interest rate on bank deposits relative to the CBDC interest rate (see discussion of interest rates below) and any usage fees.

Several interest rate-setting alternatives are discussed in chapter 4.2.3. The analysis there is most relevant to an account-based model. It is worth noting that:

- The CBDC interest rate may become a floor for bank deposit rates. If bank deposit rates drop below the CBDC rate, members of the public can quickly convert bank deposits into CBDC, particularly if they are permitted to hold central bank accounts. Moreover, such deposit transfers may occur even if the CBDC takes the form of a rechargeable card or app.
- Introducing a CBDC may boost interest rates on bank deposits due to the introduction of a new, more competitive means of payment than cash. If the CBDC interest rate is negative, the effect on bank interest rates is likely to be minimal, at least under normal conditions.
- Over 60 percent of all deposits are protected by the deposit guarantee scheme. Accordingly, if the public considers such deposits to be almost as secure as CBDC holdings, it is unlikely that protected deposits will be notably affected, as long as the CBDC rate is lower than the key policy rate.

- Bank turbulence and a zero or low interest differential between the CBDC and bank deposits may result in high, unpredictable CBDC demand.

These effects may reduce lending via banks in the economy. However, if the lending rates charged by banks increase substantially, other operators may take over some bank lending, and this may reduce the effects somewhat. The scale of these changes is very difficult to forecast, and should be investigated with respect to different CBDC models.

A high CBDC volume may lead banks to opt for wholesale funding as the primary funding source for their activities. In practice, this would mean the introduction of a so-called narrow-bank system in Norway; see Box 3.

If it becomes easier and cheaper for the public to convert bank deposits into CBDC than to convert bank deposits into cash, bank deposit levels may become more volatile. The risk of large withdrawals will be particularly acute if the public is concerned about access to funds in bank accounts. To some degree, this can be countered by the development of a different bank funding structure than at present, with more wholesale funding and a larger share of high-rate bank deposits.

### **Box 3: What are narrow banks, and what are the potential advantages and disadvantages of such a system?**

In a narrow-bank system, deposits do not fund lending or other risky investments. All deposits are invested in secure, liquid instruments such as central bank reserves or government paper. This equates to a 100 percent reserve requirement for banks. Such deposits banks are referred to as narrow banks. Previously, many postal service banks operated with such a model. Loans and other risky assets currently found in bank balance sheets would therefore have to be funded by means of wholesale funding.

A similar situation will result if newly introduced CBDC replaces *all* bank deposits (i.e. the CBDC system becomes a narrow bank), and existing banks thereafter obtain all their funding in the market.

Such a structural differentiation of deposits from loans insulates the payment system against the risk borne by lending banks. This eliminates the need for deposit protection and reduces the need for other regulation of lending banks. Since lending bank losses will have no impact on society's ability to make payments, fewer problems will be raised by the insolvency of such banks, and the market can be given greater leeway to determine lending-bank requirements.

Narrow banks were proposed in response to the Great Depression in the USA, with Chicago-based economists like Irving Fisher, Henry Simons and Milton Friedman<sup>35</sup> in particular being strong proponents of a 100 percent reserve requirement. Others, including James Tobin, subsequently made similar proposals. A reserve requirement (albeit not totalling 100 percent) was introduced in the USA through the Banking Act of 1935. The Glass-Steagall Act of 1933 limited banks' opportunities to invest in securities, but not their

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<sup>35</sup> See <http://www.narrowbanking.org/> for more detailed literature references.



lending activities.

The most important cost associated with a narrow-bank system is a likely reduction in lending in the economy.<sup>36</sup> First, banks' funding costs will increase, and loan interest rates will follow. Second, the information banks possess about their customers will be reduced because customers no longer hold bank deposits – such deposits provide valuable information on customers' savings, liquidity and risk. Reduced customer information may inflate the risk taken on by banks when making loans, and thus reduce lending activity.

Since the financial crisis, various proposals have been made to reduce the risk exposure of banks that accept deposits. These proposals have primarily involved limiting banks' opportunities to make risky securities investments, as under the Glass-Steagall Act.<sup>37</sup> No specific proposals have been put forward by political bodies to limit banks' opportunities to fund lending with deposits.

#### 4.2.3. Significance of a CBDC for monetary policy<sup>38</sup>

The introduction of a CBDC may have consequences for monetary policy. This applies particularly to the selection of an account-based model with few frictions between the CBDC and bank deposits. Based on a stylised model, the working group has identified some key links between a CBDC and monetary policy; see annex. The following tentative conclusions can be drawn:

- The CBDC interest rate may function as a floor for the key policy rate and the interest rate on deposit money in an account-based model.
- A CBDC with a fixed low interest rate (e.g. zero) may reduce the impact of monetary policy and present a new dilemma in the setting of interest rates under turbulent conditions. This is because the lower the key policy rate, the more attractive a fixed-rate CBDC will appear to be relative to other investments (i.e. the interest loss associated with holding CBDC instead of other assets is reduced). CBDC volume may thus increase when the key policy rate is cut. Expansionary monetary policy may thus trigger the loss of bank deposits, higher bank demand for wholesale funding and increased risk premiums.
- On the other hand, a fixed, adequately large *margin* between the key policy rate and the CBDC interest rate is likely to insulate monetary policy fairly effectively against the introduction of a CBDC, including under an account-based model. This is because a fixed margin disconnects CBDC demand from monetary policy decisions: if the CBDC interest rate tracks both rises and falls in the key policy rate, the interest loss (cost) associated with investing money in the CBDC will not change when the key policy rate is adjusted. The CBDC volume will be more stable than discussed in the previous bullet point, and

<sup>36</sup> It is not given that the scale of lending is optimal at present, but this will not be discussed further in this report.

<sup>37</sup> See [Independent Commission on Banking](#) for proposals in the United Kingdom, the [Volcker Rule](#) in the USA and the [Liikanen report](#) in the EU. The USA repealed the Glass-Steagall Act in 1999.

<sup>38</sup> Discussion of interaction between a CBDC and monetary policy is most relevant if the CBDC is account-based. If CBDC demand is not clearly dependent on interest differentials between the CBDC and other investment alternatives and the CBDC instead has similarities with cash, the discussion in this section is likely to be less relevant. See also the discussion of CBDC demand in chapter 3.3.

demand may remain consistently *low* if the fixed interest margin is sufficiently high. In such a scenario, it is likely that bank access to deposit funding will be more stable and remain unaffected by the CBDC under normal conditions.

- In extraordinary situations featuring turbulent conditions, setting an unusually low CBDC interest rate (greater margin) may be an instrument for restricting competition between the CBDC and bank deposits.
- However, a CBDC with an interest rate *close or equal to* the key policy rate (small interest margin) will intensify competition between the CBDC and other investment forms – given either a high or a low key policy rate level – since the return on the CBDC relative to other investments will be relatively equal under all conditions. On the one hand, this may reinforce the impact of monetary policy because the CBDC interest rate may establish a floor for other rates. On the other hand, a small margin between the key policy rate and the CBDC rate may have major consequences for bank funding. A model in which the CBDC interest rate is set close to the key policy rate thus appears to be of limited practical relevance.

### ***Monetary policy space and a CBDC***

It has been argued that introducing a CBDC may eliminate the lower bound on interest rates. This will only be the case *if the CBDC gradually leads to the elimination of physical cash* as a real investment alternative, and if the CBDC rate can be set below zero.<sup>39</sup> Due to the handling costs associated with physical money, the effective lower bound (or ELB) on the key policy rate – i.e. the point at which the public is indifferent about holding secure (electronic) receivables or physical money – is presumably already somewhat lower than zero for many operators. If the existence of a CBDC results in reduced cash usage, its introduction is likely to reduce the ELB and increase monetary policy space.

When both physical money and a CBDC are present in the economy, *the lower bound on the key policy rate* will be the higher of the ELB and the CBDC interest rate. If the CBDC rate is always zero or higher, therefore, it is likely that the effective lower bound on the interest rate will rise.<sup>40</sup> Increased policy space thus requires that the CBDC interest rate is permitted to be negative.

However, introducing a CBDC may also raise risk premiums in the market. In isolation, this will *reduce* monetary policy space. Higher risk premiums may result from an increased need to pledge securities (due to a stronger need to borrow from the central bank when the public demands CBDC). This is likely to boost the interest rates charged on wholesale funding available to banks because when the proportion of pledged assets rises, the interest rate on unsecured funding also rises. Similarly, it has been observed that higher liquidity requirements for banks can influence risk premiums, as discussed in a separate box in Norges Bank (2016).<sup>41</sup> Risk premiums may also be pushed up if banks try to secure more wholesale funding to replace deposit money instead of increasing their central bank borrowings.

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<sup>39</sup> Agarwal and Kimball (2015) have pointed out that the lower threshold for the interest rate can theoretically be eliminated if breach of parity is permitted for paper money, not just if paper money is eliminated. Digital currency must then take over as the unit of measurement in the economy.

<sup>40</sup> In recent years, the key policy rate has been negative in the Euro area, Switzerland, Sweden, Japan and Denmark, but this has not increased demand for cash. However, the deposit rates available to households and businesses have largely remained above zero.

<sup>41</sup> See also Lund, Tafjord and Øwre-Johnsen (2016).



The size of the effect on risk premiums will depend on the size of the CBDC volume, and on what the central bank accepts as collateral. A larger volume will put more pressure on risk premiums. The CBDC volume is in turn determined by the drivers of CBDC demand, and by any interest rate paid on the CBDC. For example, a CBDC interest rate of zero and higher risk premiums than at present may cause the key policy rate to hit its lower bound more frequently with an account-based CBDC than without such a CBDC.<sup>42</sup>

### ***Response to major shifts in CBDC demand***

It is conceivable that sudden shifts in CBDC demand and large volume increases would lead to a lowering of the CBDC interest rate (relative to the key policy rate) by the central bank. This could dampen demand for conversion of bank deposits into CBDC; see also the discussion in the annex.

It would also be possible to introduce an absolute limit (quota) on the CBDC volume that the central bank may supply. The main problem with an absolute volume restriction (fixed quota) is that it could result in a breach of parity with other money. In principle, the result could be different prices measured in “CBDC money” and other money. Moreover, a cut in the key policy rate (while the CBDC interest rate is kept unchanged, for example at zero) could make CBDC money relatively more valuable (due to higher demand), and monetary policy decisions could then in principle influence this new “exchange rate”. However, if the Norwegian krone has several different values, it will no longer be suitable as a unit of account. In practice, the risk of a breach of parity will presumably depend on the adopted CBDC design, and may be greatest in the case of an account-based CBDC solution.

## **4.3. Consequences for other regulatory authorities**

The areas of responsibility of several government authorities may be affected by the introduction of a CBDC and related payment instruments. This applies, among other things, to the Ministry of Finance, the Financial Supervisory Authority of Norway, the Norwegian Competition Authority, the Data Protection Authority, the tax authorities and the consumer protection authorities.

However, we cannot see that a CBDC will introduce any new tasks or roles for any of these authorities. For example, the Financial Supervisory Authority may have to evaluate payment services and service providers that build on any CBDC infrastructure. Equally, a CBDC may alter competition in the payment market, and thus affect the Competition Authority’s analyses. However, in principle this is no different from other evaluations the Financial Supervisory Authority and the Competition Authority have to undertake, for example pursuant to PSD2. The Data Protection Authority may have views on whether the CBDC system is consistent with data protection rules, and may impose sanctions in relevant cases, but this does not raise any new matters of principle.

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<sup>42</sup> If CBDC contributes to a lower real rate of interest, see Barrdear and Kumhof (2016), this would exacerbate the problem.

### 5.1. Regulatory framework for Norges Bank

Norges Bank's jurisdiction and policy space are governed by the Norges Bank Act. The overarching question discussed below is whether the current Norges Bank Act and the draft new act proposed in Official Norwegian Report (NOU) (2017) permit Norges Bank to issue a CBDC, and what statutory amendments would be necessary. Key factors in this regard are whether a CBDC is reconcilable with the role and purpose of the central bank, whether a CBDC could qualify as legal tender and the impact of the Financial Contracts Act,<sup>43</sup> which extensively regulates the right of consumers to use means of payment. Many of the issues discussed below are applicable regardless of the CBDC model adopted. However, the applicability of the legislation may vary from model to model.

#### 5.1.1. The purpose of the central bank and public access

A CBDC may have consequences for monetary policy, for the banking system and for financial stability. One important question is therefore whether issuing a CBDC is consistent with Norges Bank's statutory purpose and role. This is relevant to its role as the issuer of money, as well as its role as a market operator.

Section 1 of the Norges Bank Act provides that the bank “shall issue banknotes and coin, promote an efficient payment system domestically as well as vis-à-vis other countries...”

Similar provisions are found in the draft new Norges Bank Act; see Official Norwegian Report (NOU) (2017). Section 1-2 of the draft act states, “The purpose of Norges Bank's functions is to maintain monetary stability and promote stability of the financial system and an efficient and secure payment system.” The draft section 1-3 states, “Norges Bank shall issue banknotes and coins, promote the central settlement system and oversee the payment system.”

Section 1, second paragraph, of the Norges Bank Act states that Norges Bank may “implement any measures customarily or ordinarily taken by a central bank.” It has been proposed that this provision be retained in section 1-3 of the new act. Depending on factors such as international developments and practice, as well as other adjustments to the act,<sup>44</sup> it is conceivable that issuing a CBDC to the public will gradually become a customary or ordinary measure taken by a central bank.<sup>45</sup>

Under section 13 of the current Norges Bank Act, Norges Bank has the exclusive right to issue notes and coins, and the bank's notes and coins are mandatory means of payment; see section 14. It has also been proposed that these provisions be retained, in sections 3-4 and 3-5 of the new act. In principle, this exclusive right will not prevent Norges Bank from also issuing a CBDC denominated in Norwegian kroner parallel to notes and coins. However, this type of central bank money will not be a mandatory means of payment (under either the current act or the draft new act), unless statutory amendments are made.<sup>46</sup>

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<sup>43</sup> The Act of 25 June 1999 No. 46 relating to financial contracts and financial assignments.

<sup>44</sup> See the discussion below concerning, among other things, the provision of accounts to the public.

<sup>45</sup> Official Norwegian Report (NOU) (2017), chapter 23.6.

<sup>46</sup> Official Norwegian Report (NOU) (2017), chapter 23.6.

### 5.1.2. Public access to a CBDC

At present, generally only banks may hold electronic receivables from and take up electronic debt to the central bank; see sections 19 and 20 of the Norges Bank Act. While section 22 of the current act permits Norges Bank to accept deposits from institutions other than banks in “special circumstances”, the preparatory works refer to cases where other legislation requires such deposits,<sup>47</sup> and situations where refusal to accept deposits could exacerbate a crisis of confidence.<sup>48</sup> Issuing a CBDC to the public is unlikely to constitute such a special case, assuming the proper functioning of deposit mechanisms in the private banking sector. However, this possibility cannot be precluded when a CBDC is to be used solely as a back-up solution.

The draft new section 3-1 of the Norges Bank Act states that only banks and other undertakings in the financial sector may hold accounts with Norge Bank. In other words, neither the current nor the proposed new rules authorise Norges Bank to permit the public to hold digital currency in central bank accounts.

A value-based solution has similarities with cash in terms of both usage and risk. Accordingly, it does not involve a “deposit” within the meaning of the current sections 19 and 22, nor an “account” within the meaning of the proposed new section 3-1. However, a value-based solution will not constitute legal tender under current law. Nevertheless, based on social considerations, such a solution must be deemed to fall within the customary activities of a central bank.

### 5.1.3. A CBDC as legal tender

Supplying legal tender is a common statutory obligation of central banks. It is also an exclusive right of Norges Bank; see section 3 and section 14 of the Norges Bank Act.<sup>49</sup> Further, the bank “shall” issue notes and coins; see section 1. The core of the term “legal tender” as defined in section 14 of the act is that a debtor must be able to use mandatory means of payment to discharge financial obligations in the state in which the means of payment are valid. In addition, a creditor is entitled to demand payment of monetary claims in this manner. Accordingly, legal tender is considered to provide predictability with respect to the mechanisms for definitive legal settlement of financial obligations within a jurisdiction. The legal tender provision in section 14 of the Norges Bank Act is declaratory, i.e. can be waived by agreement.<sup>50</sup> It is central bank notes and coins that are legal tender in Norway; see section 14 of the Norges Bank Act.

The rules on notes and coins in the Norges Bank Act are supplemented by other provisions. Section 16-4 of the Financial Institutions Act contains rules intended to ensure that account holders have access to notes and coins held by banks. Section 38 of the act lays down special rules on monetary settlement in consumer and non-consumer transactions. The third paragraph of section 38 provides that consumers are always entitled to make payment to the payee using notes and coins.

In other words, the central bank has jurisdiction and a duty to issue mandatory means of payment, but this is limited to notes and coins. Under the current and draft new Norges Bank Act, a CBDC cannot function as legal tender. A statutory amendment will thus be required if a CBDC is to be introduced.

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<sup>47</sup> For example the Deposit Act.

<sup>48</sup> Official Norwegian Report (NOU) (1983), page 330.

<sup>49</sup> The bank’s exclusive right is also apparent from the provisions in the Penal Code on currency counterfeiting (see sections 367–369 of the Penal Code 2005).

<sup>50</sup> Proposition to the Odelsting (1984–1985), page 91, states that, “The proposed rules on obligatory means of payment in the draft do not prevent the agreement of settlement in a foreign currency with performance in Norway. This is also the position under current law.”

## 5.2. Consumer protection and competition issues linked to a CBDC

### 5.2.1. PSD2

The Payment Services Directive regulates different aspects of the provision of payment services, and has been implemented in Norwegian law through various pieces of legislation, including the Financial Institutions Act, the Financial Contracts Act and the Payment Systems Act. The Revised Payment Services Directive<sup>51</sup> (PSD2) retains much of the content of the first Payment Services Directive, but also introduces some significant changes. Among other things, PSD2 facilitates innovation and competition in the payment services sector by regulating access to payment accounts.

#### Box 4: PSD2

PSD2 paves the way for two new types of payment service:

- **Payment initiation services**, which involve granting a payment initiation service provider the right to initiate a payment from a customer's payment account. An example of such a provider is a company that delivers a smart phone payment application either independently or as part of its general service range.
- **Account information services**, which involve granting an account information service provider access to a customer's account information so that the provider can give the customer a complete digital overview of all the customer's payment accounts with different providers. An example of such a service is a smart phone application that provides the customer with a complete overview of financial balance with different financial institutions. This can be combined with a payment application, marketing and advisory services.<sup>52</sup>

One PSD2-related question that arises in the case of an account-based CBDC is whether the CBDC account is a payment account subject to the provisions of the directive on the granting of access to providers of new payment services. Article 1 of PSD2 restricts the scope of the directive with respect to different payment service providers. Pursuant to Article 1(1)(e) of the directive, national central banks are deemed to be payment service providers "when not acting in their capacity as monetary authority or other public authorities". This may mean that the PSD2 requirements concerning the granting of access to a CBDC payment account will be inapplicable in certain cases. However, permitting third parties to deliver services on top of an account-based CBDC is considered to be sensible in principle, as doing so may help to ensure CBDC take-up and the development of innovative services that utilise the CBDC.

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<sup>51</sup> Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU, and repealing Directive 2007/64/EC.

<sup>52</sup> The service provider will then be both a payment initiation service provider and an account information service provider.

## 5.2.2. Data protection

Depending on the organisational structure chosen, Norges Bank may have duties under data protection legislation in connection with the administration of a CBDC. Work on implementing the EU General Data Protection Regulation (GDPR) into Norwegian law is continuing. Personal data means any information relating to an identified or identifiable natural person. An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier (name, ID number, etc.) Any payment data that can be linked to an identifiable natural person will constitute personal data covered by the rules. Under the coming data protection rules, data protection must be incorporated into all solutions, systems and services (“privacy by design”). The Data Protection Authority has prepared special guidelines on software development with data protection by design and by default.<sup>53</sup> It may be sensible to utilise these in the design of a technical CBDC solution.

## 5.2.3. Consumer protection under the Financial Contracts Act

The Financial Contracts Act regulates a number of matters between an issuer of a payment instrument and customers, including responsibility for misuse of the payment instrument; see chapter 5 of the Financial Contracts Act. Among other things, the act lays down detailed rules as to who must cover losses linked to payments a customer denies having made. Such cases often involve situations where an authorised payment has been made by someone other than the customer. Further consideration must be given to Norges Bank’s responsibilities under the Financial Contracts Act in connection with the administration of a CBDC.

## 5.2.4. EEA and competition law

The EEA Agreement rests on fundamental principles establishing the free movement of goods, services, capital and transactions. Any CBDC solution must be designed to comply with these four freedoms. This may mean, for example, that the design of applications and account infrastructure must not give Norwegian suppliers of goods and services an unnecessary advantage with respect to the receipt of payments. Such requirements will in any event often follow from secondary legislation (such as PSD2).

## 5.3. Responsibility for customer due diligence

Different CBDC solutions offer varying potential to utilise existing infrastructure and customer service procedures. One possible solution is cooperation with private banks in the supply of CBDC to the public. This has some similarities with the current cash distribution system. An agency solution (defined as a CBDC model under which the central bank issues CBDC but private banks are responsible for supply, system operation and administration of customer relationships) necessitates a clear division of responsibilities. The overarching question discussed below is whether responsibility for customer due diligence (know your customer) and anti-money laundering and anti-terrorist financing – referred to collectively as customer due diligence – can be outsourced to private banks that administer a CBDC solution.

### 5.3.1. Outsourcing of customer due diligence

Since Norges Bank may enter into a customer relationship within the meaning of the Money Laundering Act<sup>54</sup> with end users in connection with the issue of a CBDC, the

<sup>53</sup> <https://www.datatilsynet.no/en/regulations-and-tools/guidelines/data-protection-by-design-and-by-default/>

<sup>54</sup> Act of 6 March 2009 No. 11 relating to measures to combat money laundering and the financing of terrorism.

bank will in principle be required to conduct customer due diligence for all end users in accordance with chapter 2 of the act. At present, only banks (undertakings in the financial sector) are permitted to engage in regular borrowing and deposit transactions with Norges Bank; see sections 19 and 20 of the Norges Bank Act. As a result, the central bank's only counterparties/customers are licensed undertakings that themselves have a reporting obligation under the Money Laundering Act. Accordingly, a CBDC may impose a far greater operational and legal burden on Norges Bank in its capacity as issuer. In part, this issue can be resolved by tasking private banks with the administration of customer relationships, and thus also customer due diligence. Private banks already have procedures in place for their existing customer relationships.

One important question is therefore whether Norges Bank, in its capacity as an entity with a reporting obligation under the Money Laundering Act, is permitted to outsource responsibility for CBDC-related customer due diligence to private banks.

### 5.3.2. Operational outsourcing

Section 12 of the Money Laundering Act provides that “[e]ntities with a reporting obligation may enter into written contracts with service providers concerning outsourcing of the application of customer due diligence measures”. Pursuant to the act, service providers are “entities with a reporting obligation, with the exception of trust and company service providers as referred to in section 4, second paragraph (6)” and “licensed postal operators”. The definition of “entity with a reporting obligation” includes financial institutions, E-money institutions, undertakings engaged in foreign exchange business, undertakings operating activities consisting of transfer of money or financial claims, postal operators in connection with provision of insured mail services, etc.; see section 4(1) of the Money Laundering Act.

In order for an activity to be covered by the outsourcing provision, the service provider (i.e. the private bank/operator that undertakes customer administration in connection with the CBDC) must be considered to be an integrated part of the business of the entity with the reporting obligation when customer due diligence is conducted.<sup>55</sup> Any private bank/institution that conducts customer due diligence on Norges Bank's behalf pursuant to a contract is likely to be deemed to be an integrated part of the business of the entity with the reporting obligation for CBDC purposes.

Further, section 9 of the Money Laundering Regulations provides that, “In addition to the natural and legal persons who, pursuant to section 12 of the Money Laundering Act, may function as contractors, entities with a reporting obligation may enter into written agreements concerning outsourcing of execution of customer due diligence measures with undertakings and persons who perform such services for or on behalf of entities with a reporting obligation when such entities are part of the distribution system of the entities with a reporting obligation.” Private banks will generally be members of Norges Bank's CBDC distribution system. Norges Bank is therefore likely to be permitted to outsource the operational aspects of customer due diligence.

### 5.3.3. Outsourcing of responsibility?

It is especially important to clarify responsibility in connection with outsourcing. This is because contravention of obligations under the Money Laundering Act by an entity with a reporting obligation is subject to public-law penalties pursuant to chapter 6 of the act, in the form of orders and enforcement measures (including daily penalty

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<sup>55</sup> See Proposition to the Odelsting (2008–2009), page 80 onwards and page 121 onwards.



charges)<sup>56</sup> and criminal penalties.<sup>57</sup> Even if customer due diligence is outsourced pursuant to section 12(1) of the Money Laundering Act, section 12(2) provides that the entity with the reporting obligation has a responsibility to ensure that customer due diligence is conducted in accordance with applicable laws and regulations, and that proper procedures are established and necessary measures taken in accordance with section 23 (on control and communication procedures). In other words, it is “[t]he “entity with the primary reporting obligation” [that] has responsibility for ensuring that identification checks are conducted properly in accordance with laws and regulations.”<sup>58</sup> Norges Bank will thus be responsible for ensuring that customer due diligence is carried out in accordance with laws and regulations, that proper procedures are established and that necessary measures are taken.

## 5.4. A CBDC and the Settlement Finality Directive

The provisions of the Settlement Finality Directive<sup>59</sup> have been implemented in chapter 4 of the Payment Systems Act. The directive and act make it clear that interbank systems are permitted to enter into settlement agreements with their participants that are also binding in insolvency proceedings. Settlement agreements that are entered in the system prior to the commencement of insolvency proceedings are enforceable even if a party goes bankrupt, irrespective of any provisions on setting-aside and set-off under the bankruptcy laws of the relevant country.

Chapter 4 of the act applies to interbank systems authorised by Norges Bank, and to securities settlement systems approved by the Financial Supervisory Authority of Norway. Chapter 4 only applies if such systems have at least three participants in addition to the operator/settlement bank/central counterparty/clearing house. Further requirements are that the system has agreed that its operations are governed by Norwegian law and that the system has been notified to the EFTA Surveillance Authority.

As worded, the act and the directive do not apply to CBDC transfers between physical persons. The same applies to CBDC transfers between physical persons and companies, and between different companies.

The Settlement Finality Directive does not specify whether it is a minimum harmonisation directive or a total harmonisation directive.<sup>60</sup> This is also not discussed in the preamble to the directive or the Norwegian preparatory works. Corresponding rules on legal protection of CBDC payments will not influence the provisions in the directive on legal protection and security for participants in interbank and asset settlement systems. The working group has therefore concluded that the directive does not restrict the power to issue Norwegian rules on legal protection of CBDC payments.<sup>61</sup>

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<sup>56</sup> Section 27 of the Money Laundering Act.

<sup>57</sup> See section 28 of the Money Laundering Act – the culpability requirement is intentional or grossly negligent contravention.

<sup>58</sup> See Proposition to the Odelsting No. 3 (2008–2009), chapter 4.8.2, page 121.

<sup>59</sup> Directive 98/26/EC on settlement finality in payment and securities settlement systems (the Settlement Finality Directive).

<sup>60</sup> Minimum harmonisation means that the member states are permitted to adopt stricter rules than those laid down in the directive. Total harmonisation means that the directive sets an absolute standard as to the rules to be introduced, and that states may not have rules deviating from this standard.

<sup>61</sup> It is possible that decentralised technology can be exploited for CBDC purposes. Both CBDC technology and the legal framework applicable to CBDC solutions are under development. Decentralised technology raises a number of specific legal questions that require further consideration. These include what liability network participants should bear both under relevant regulations and with regard to other network participants.

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# Annex: Monetary policy and demand for CBDCs

*The effect of two possible alternatives for the interest rate on a CBDC: fixed interest rate on CBDC or fixed margin between the key policy rate and the CBDC interest rate.*

The cost to households and businesses of holding CBDC is the interest income lost due to not holding deposit money, i.e. the *difference* between the interest rate on deposit money and the CBDC interest rate. For simplicity, we may here assume that the deposit interest rate equals the folio rate (the key policy rate).<sup>62</sup> We can assume that the volume CBDC demanded will rise when the opportunity cost (the difference between the folio rate and the CBDC rate) falls, as illustrated by the demand curve in Figure A.<sup>63</sup>

**A fixed CBDC interest rate equal to zero** implies that adjustments to the folio rate will entail a one-to-one change in the cost of holding CBDC. A policy interest rate reduction will thus trigger increased CBDC demand from households and businesses. In Figure A, an interest rate reduction will shift the blue “supply curve” down. CBDC becomes relatively more attractive compared to deposit money when the market interest rate drops and the difference between the rates falls ( $\Delta i$  has fallen). *This may lead to a less effective monetary policy because banks have to replace deposits with more expensive wholesale funding when the interest rate is cut.*

During turbulent periods featuring failing confidence in banks and increasing risk premiums – and resulting transfers of deposits from banks to CBDC for *that reason* – interest rate cuts may exacerbate an already difficult situation faced by banks. Upward pressure on risk premiums may intensify due to increased demand for collateral and wholesale funding as the interest rate is cut and CBDC demand increases further. Monetary policy will then face a dilemma and, as discussed in chapter 4, the existence of a CBDC is likely to increase the need for the central bank to supply liquidity during turbulent times.

If, on the other hand, **the CBDC interest rate is also reduced when the folio rate is reduced** (i.e. the CBDC interest rate is cut by 0.25 percentage points if the folio rate is reduced by 0.25 percentage points), the CBDC volume will not be directly impacted by monetary policy decisions. In this case, the margin between the CBDC rate and the alternative interest rate will remain constant (for example at  $\Delta i^*$ ) when the key policy rate is adjusted. In Figure A, this is illustrated by the fact that the blue “supply curve” remains constant (even when the folio rate is adjusted) because the margin ( $\Delta i$ ) is now constant.

*The decision as to the size of the (fixed) margin between the key policy rate and the CBDC rate is at the same time an implicit decision on the CBDC volume, which is then disconnected from the key policy rate decision.* All else being equal, a larger fixed margin produces a lower volume. A smaller or zero margin, i.e. when the CBDC interest rate is equal to the folio rate and the blue curve lies on the x-axis, may

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<sup>62</sup> The interest rate on deposit money will normally be somewhat lower than the key policy rate, but the qualitative effect of different CBDC interest-setting forms will be same as in this simplified example.

<sup>63</sup> Many different demand curve shapes are possible. An L-formed demand curve may be relevant if a CBDC is given functionality similar to cash: vertical (interest inelastic) when the key policy rate is positive and horizontal (highly elastic and undetermined CBDC demand) when the key policy rate reaches zero (or slightly below) and is equal to the (effective) interest rate on cash.

produce a very large CBDC volume. The floor for all interest rates in the economy will then be equal to the key policy rate, and monetary policy can thus more directly influence a broader set of interest rates than at present.<sup>64</sup>

Figure A. CBDC supply and demand

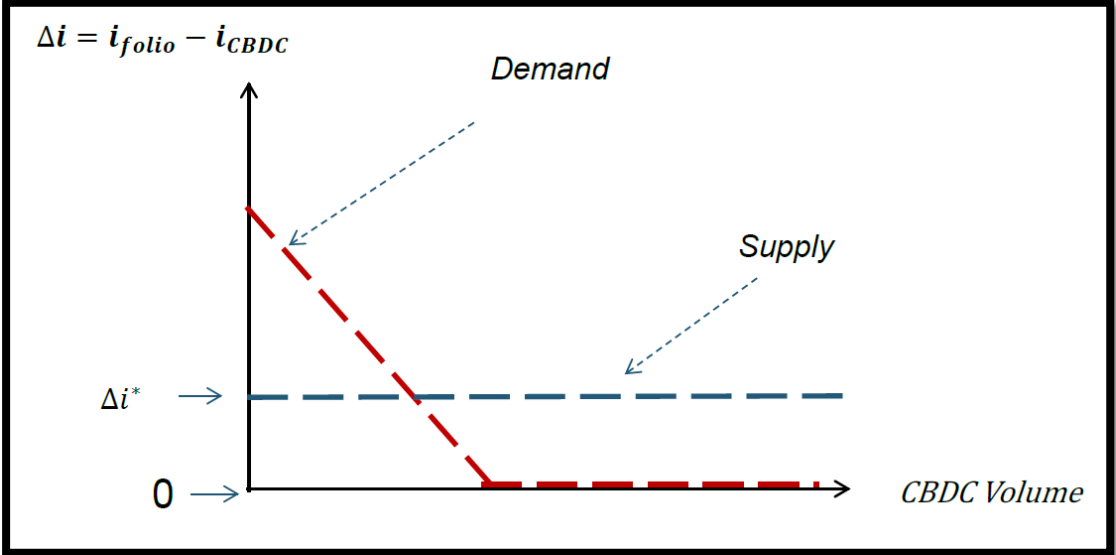
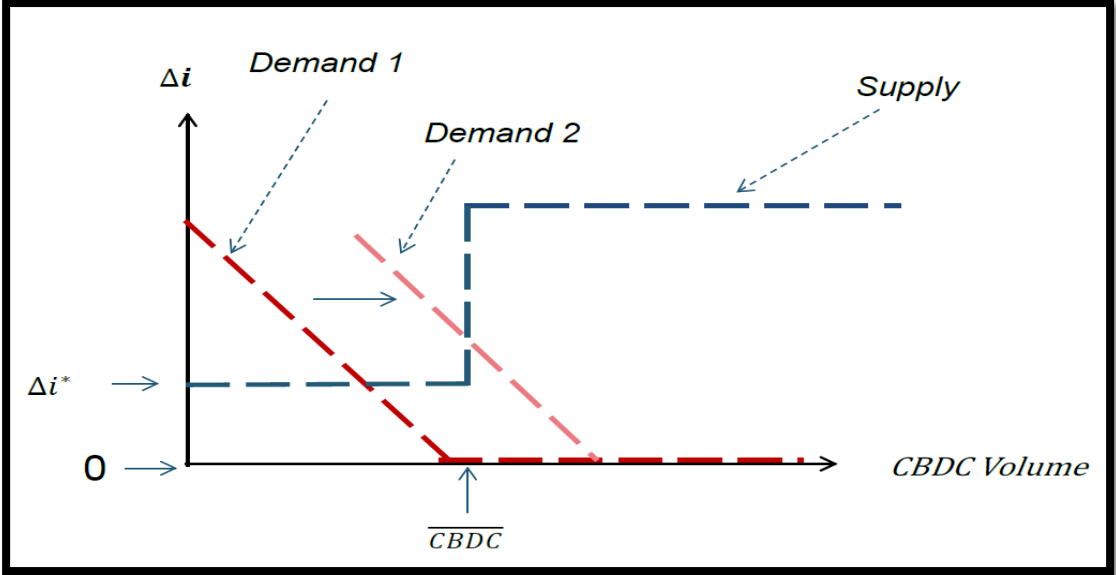


Figure B: Change in CBDC demand in connection with market turbulence, and limitation of supply



<sup>64</sup> See also the discussion in CPMI (2018).

***High demand for CBDC can in principle be met by adjusting the margin between the key policy rate and the CBDC rate<sup>65</sup>***

The spread between the folio interest rate (market rate) and the CBDC interest rate, indicated by  $\Delta i^*$  in Figure A, can be regarded as a potential (but probably highly uncertain) instrument for CBDC management.<sup>66</sup> If CBDC demand is “too low”, the central bank can reduce the margin between the folio rate and the CBDC rate by *raising* the CBDC rate. This will shift the blue curve down.

The central bank can also restrict CBDC supply by increasing the interest margin  $\Delta i$  when the CBDC volume reaches a certain level, for example  $\overline{CBDC}$  in Figure B. This can be done by *reducing* the CBDC interest rate to a lower level (relative to the folio rate) when the CBDC volume reaches  $\overline{CBDC}$ , as illustrated by the supply curve in Figure B.

A rule specifying a threshold for the margin between the CBDC interest rate and the folio interest rate may limit increases in CBDC volume, for example in the event of market turbulence. The CBDC volume will not rise above  $\overline{CBDC}$  even if demand shifts out (i.e. demand increases from curve 1 to curve 2 in Figure B), since the central bank will in such case allow the interest margin to increase in order to make the CBDC less attractive. In this way, the system can be made more robust in the face of unpredictable shifts in demand. However, the size of the required cut in the CBDC interest rate is uncertain. As illustrated by Figure B, a sufficiently large shift in demand may still increase the CBDC volume, even though the public achieves a very low return on CBDC. One solution in such circumstances may be to add a further step to the blue supply curve where an even lower return is achieved.

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<sup>65</sup> This assumes that the CBDC volume is sensitive to the interest rate compared to other investments. If CBDC demand is interest inelastic, the interest rate margin will have no effect on the volume.

<sup>66</sup> Barrdear and Kumhof (2016) have discussed CBDC as a separate monetary policy instrument. Under this approach, it is the interest rate margin against other investment alternatives that determines the CBDC volume. Alternatively, a CBDC quota can be set, and the interest rate margin can be left to endogenous determination by demand. However, this presupposes that there is a market for CBDC that decides the interest rate. Bordo and Levin (2017) have discussed replacement of the key policy rate with the CBDC interest rate. In practice, this would entail the CBDC rate equalling the folio rate, and a very high or indeterminate demanded CBDC volume. The blue supply curve in Figure A would follow the x-axis in that case, and the interest differential would be zero.



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