

# Norges Bank Papers

Central bank digital currency - final report for project Phase 4

REPORT FROM A WORKING GROUP

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## Foreword by the Governor

Norges Bank and a number of other central banks are researching the introduction of a central bank digital currency (CBDC). For Norges Bank, the paramount question is whether introducing such money is an appropriate measure for ensuring that it will be secure, efficient and attractive to pay in Norwegian kroner also in future.

Introducing a CBDC can be a way to ensure access to a means of settlement trusted by all, also in new payment arenas, and can also facilitate responsible innovation and improved payment contingency arrangements. At the same time, we must consider what can be achieved by the use of other measures.

This report from a Norges Bank working group summarises Phase 4 of the research project. This phase has consisted of experimental testing of technical solutions, analysis of scenarios for the payment system, evaluation of consequences for liquidity management and monetary policy and a review of the legislative changes necessary to permit the introduction of a CBDC.

The assessment of a CBDC raises complex issues, and the current payment system in Norway functions well, which is why we should not proceed with undue haste. Nevertheless, against the backdrop of falling cash usage, the emergence of new forms of money and payment platforms and work on CBDCs in other countries, introducing a CBDC is more relevant now than when the Bank's research into this issue began in 2016.

The research project will therefore continue in a new phase until the end of 2025. We will analyse the possibilities afforded by, and the impact of, introducing a CBDC and test candidate solutions. In addition to researching a CBDC intended for general purpose users, we will research new forms of settlement in central bank money that can facilitate innovation related to bank deposits and financial assets in a tokenised format. To obtain knowledge and contribute to international standardisation and cooperation, we will work with other central banks and international organisations.

The purpose of publishing this report – and other material from the research project – is to provide information about this work, disseminate knowledge and foster dialogue.

Ida Wolden Bache

## 1. Introduction

A working group<sup>1</sup> at Norges Bank has conducted a fourth phase of a study project on central bank digital currency (CBDC). The work builds on the reports from the first three phases (see Norges Bank (2018), (2019) and (2021)). This is the final report from the fourth phase. Material from some sub-projects is also published (see information below).

### *What is CBDC?*

CBDC is electronic money issued by the central bank in the official unit of account. Internationally, two main variants of CBDC are being studied: a retail CBDC for end users such as consumers and businesses and wholesale CBDC for settlement between banks and other financial actors.

Retail CBDC is generally accessible to the public on a par with cash and bank deposits. Banks and other third parties will have the possibility to develop and offer payment services to private individuals, companies and the public sector using CBDC as their underlying means of payment. Unless otherwise mentioned or indicated by context, it is the retail variant of CBDC that is discussed in the report.

Wholesale CBDC is central bank reserves in tokenised form.<sup>2</sup> Wholesale CBDC would only be available to banks and some other financial actors with an account in the central bank. It will be possible to use such CBDC for payment settlements in the same way as the current interbank settlements at Norges Bank are used, but in a different technological form.

### *International developments*

Many central banks are exploring CBDC. A survey<sup>3</sup> by the Bank for International Settlements (BIS) towards the end of 2022 shows that 93 percent of a wide range of central banks are studying CBDC. Of these, almost three-quarters investigated both retail CBDC and wholesale CBDC, while a good quarter only examined a retail CBDC. The European Central Bank (ECB)/Eurosystem, the Riksbank, the Bank of England, the Federal Reserve and the Bank of Japan are among the central banks that are investigating CBDC. So far, only a few central banks in other parts of the world have introduced (retail) CBDC.<sup>4</sup>

International organisations, such as the International Monetary Fund (IMF) and BIS, are investing considerable resources into the analysis of various CBDC-related issues. The BIS Innovation Hub (BISIH) has been established to experiment with how new technology can strengthen the financial system, and CBDC is a central topic. See Section 3 and *Norges Bank (2023)* for further details on work on CBDC internationally.

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<sup>1</sup> The working group was composed of Knut Sandal (leader), Ragna Alstadheim, Tom Bernhardsen, Espen Gjøs, Arne Kloster, Suela Kristiansen, Helge Syrstad, Kjetil Watne, Peder Østbye and Terje Åmås. At the end of the project phase, the steering group was composed of Torbjørn Hægeland (chair), Ole Christian Bech-Moen, Gaute Langeland, Kasper Roszbach and Marius Ryel. Olav Bø and Ketil Rakkestad were members of the steering committee in parts of Phase 4. In the sub-project on experimental testing of technical solutions, Lasse Meholm from the company Finansit has participated as external project coordinator and four Norwegian IT companies have been engaged, see Section 3 and Norges Bank (2023c).

<sup>2</sup> See box with explanation of terms at the end of the report.

<sup>3</sup> The survey is documented in Kosse and Mattei (2023).

<sup>4</sup> The Bahamas, Nigeria, the Eastern Caribbean and Jamaica have introduced CBDC, while China, India, Ghana and Uruguay have or have had pilot projects with real payments.

### *Norges Bank's research*

The purpose of the Bank's research project is to assess whether the introduction of CBDC is appropriate to ensure that it is secure, efficient and attractive to pay with NOK also in the future. The project is to provide a basis for decision-making and a recommendation as to whether Norges Bank should work to introduce CBDC and, if so, in what form and manner its introduction can be implemented.

Falling cash use, new technological opportunities, the emergence of new money and payment systems and work on CBDC in other countries form the background for the project. The introduction of CBDC can, among other things, ensure access to a means of settlement<sup>5</sup> that everyone trusts, also in new payment arenas, and facilitate responsible innovation and improved contingency arrangements. At the same time, introducing CBDC is not the only – and not necessarily the best – way this can be achieved. The introduction of retail CBDC and/or wholesale CBDC must therefore be assessed in relation to the use of other instruments, such as the regulation of private means of payment and systems.

Norges Bank started its CBDC project in 2016. Phases 1-3 of the project have included assessments of the purpose of CBDC, the characteristics of CBDC, relevant technical solutions for CBDC, schemes for technical testing and the implications of introducing CBDC for banks.

The work in Phase 4 of the project has built on the analyses from previous phases and enriched certain aspects. The purpose of Phase 4 has been to strengthen the decision-making basis for whether CBDC should be introduced by conducting experimental testing of technical solutions and analysing the purpose and consequences of the introduction of CBDC.

The work has been carried out in four sub-projects:

- Discussion of the adoption of a precautionary approach as motivation for the introduction of CBDC: Analysis of scenarios for the development of the payment system that may entail risks in Norges Bank's areas of responsibility, and assessment of whether the introduction of CBDC or other instruments is appropriate to reduce the risks.
- Experimental testing and other validation of technical solutions to assess whether different technologies can ensure the necessary characteristics of CBDC required to fulfil its purpose.
- Assessment of the implications for Norges Bank's liquidity management regime and the impact of monetary policy through the introduction of CBDC with various design elements.
- Review of necessary legislative amendments to introduce CBDC. The introduction will affect a number of provisions on payments and settlement pertaining to both private and statutory law.

In parallel with the work in the sub-projects, several developments have influenced the assessments of elements that should be included in Phase 5. This applies, for example, to work on CBDC in other central banks and the BISIH, as well as developments regarding stablecoins and tokenised bank deposits. The international debate on wholesale CBDC and other forms of settlement in central bank money of payments and trading on tokenised platforms has also influenced the assessments.

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<sup>5</sup> Money has three functions: medium of exchange or means of payment/settlement, unit of account and store of value.

So far, the project has mainly focused on retail CBDC. As discussed below, we recommend that the next project phase include the study of wholesale CBDC and other forms of settlement in central bank money of payments and trading on tokenised platforms.

Sections 2 to 5 summarise the work, lessons drawn and assessments in the sub-projects mentioned. Section 6 contains a recommendation on required elements for the content of the upcoming phase 5.

## **2. A precautionary approach motivating the introduction of CBDC – analysis of payment system scenarios**

The payment system is changing. New financial actors are emerging, new payment services are being developed and new technology is providing fresh opportunities. This may lead to a more secure and efficient payment system, but some developments may also lead to a situation in which Norges Bank's scope for exercising its corporate social responsibility is reduced. In a sub-project, we have assessed some scenarios for the development of the Norwegian payment system.

The purpose of the scenario analysis was to be explorative and to shed light on how adopting a precautionary approach to threats from new monetary and payment systems and new types of financial actors may be part of the motivation for introducing CBDC. The relevant main scenarios we have considered are the following:

- Increased use of crypto-assets, including stablecoins in foreign currencies and Norwegian kroner (NOK).
- Increased presence of global financial actors/bigtechs within the payment system.
- Other central banks introduce CBDC that is available to Norwegian users.

We also point out that the introduction of CBDC is relevant if there is no prospect of private money in NOK with attractive new functionality, ensuring access to a means of settlement that everyone trusts, also in new arenas. In this case, CBDC is therefore motivated by the payment system's potential failure to develop in a desired direction, rather than the payment system's potential development in an undesirable direction.

We consider the three scenarios to be plausible, but they do not necessarily represent expected developments. We have not assessed the probability of them occurring, but are discussing factors that may shed light on and influence the probability. The time perspective in the analyses is in the range of 3-10 years.

The scenarios entail various forms of innovation in the payment system, which may entail both benefits and risks. Here we have focused on risks/potential negative consequences. The two most important risks in Norges Bank's areas of responsibility are linked to currency substitution away from NOK and diminished national control over the payment system. The first risk can undermine the impact of monetary policy and may result in our losing a common unit of calculation or measurement for the cost of goods and services and shall be traded in. The second risk may lower the efficiency and security of the payment system and financial stability.

The degree of risk depends on the extent to which Norwegian users will use means of payment in currencies other than NOK and from parties other than financial actors in the Norwegian payment system. This will depend, among other things, on whether users perceive that these alternatives inspire trust and can offer attractive functionality, good conditions and network advantages. Such risk increases

if changes in the payment system coincide with changes in trading patterns. Regulations, particularly the extent to which they permit the use of alternative means of payment, will also affect risk.

The literature assesses different, more macroeconomically oriented explanatory factors for currency substitution than factors in the payment system, such as instability in the value of money and limited confidence in monetary policy. We consider the risk of currency substitution to be minor. The first line of defence against currency substitution is a well-executed monetary policy that inspires confidence, and an otherwise responsible macroeconomic policy. This implies that currently the risk of currency substitution in Norway is relatively limited. However, we cannot exclude the possibility that highly secured stablecoins denominated in foreign currency issued by, for example, bigtechs, or CBDC from countries with significant financial links to Norway, such as a digital euro, may be used by the Norwegian public to a certain extent, even though holdings of such assets for payment purposes entail currency risk if the funds are to be used in Norway. A gateway to such means of payment may be the use of mobile applications when shopping online and travelling.<sup>6</sup>

All three scenarios – or combinations of them, such as bigtechs offering stablecoins – entail a risk of weakened national control over the payment system. Bigtechs are very large companies who have their primary activity in digital services, for example in social media, search engines, e-commerce and IT/telephony equipment. A key part of bigtechs' business model is to collect, analyse and commercially exploit information about users. The size of customer networks and the use of customer data also make it easier for them to achieve economies of scale if they step into payment and financial services. The extent to which this could lead to weakened national control over the payment system will – in addition to customer demand for services from bigtechs and regulations – depend on how deep in the payment chain bigtechs will be.

CBDC can be designed to facilitate new functionality that can meet the competition from bigtechs and/or token-based money such as stablecoins. CBDC can contribute to interoperability and make it easier for customers to move money between payment platforms, and central banks can use CBDC to set standards for the appropriate development of new functionality in the payment system.

However, it is not obvious that introducing retail CBDC is necessary to ensure a payment system offering functionality that makes it attractive to pay in NOK also in the future. The introduction of CBDC is relevant if there is no prospect of private money with such functionality, and which can ensure access to a means of settlement in which everyone has confidence, also in new arenas. Furthermore, the question of whether current private money can provide a sufficiently competitively neutral and robust infrastructure for such functionality arises.

Technological experimentation and literature on tokenisation of bank deposits is a relevant new development, especially internationally. Domestic banks' issuance of stablecoins in national currency is a variant of this development. In both areas, developments have been fairly limited, and Norges Bank should monitor further developments. If the trend is towards more tokenised bank money, this also raises the question of how the settlement of payments with such money should take place and, if applicable, can facilitate the development of such money, including whether the introduction of settlement with tokenised reserves (wholesale CBDC) is appropriate.

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<sup>6</sup> Alstadheim (2023) discusses the risk of currency substitution associated with the use of cryptocurrencies.

In summary, our assessment so far is that with respect to the precautionary approach, introducing retail CBDC is not a very urgent matter.<sup>7</sup> The idea that the introduction of retail CBDC is the most adequate instrument for managing risks in Norges Bank's areas of responsibility associated with new monetary and payment systems is uncertain as well. Nevertheless, we cannot exclude the possibility that highly secured stablecoins in foreign currency issued by, for example, bigtechs, or CBDC from countries with significant economic relations to Norway, may be used by Norwegian audiences to a certain extent. Norges Bank should therefore pursue its assessment of how to ensure that payments in NOK offer required functionality demanded by end users in the future. Retail CBDC, wholesale CBDC, other changes in the settlement system and regulatory instruments are all relevant in such an assessment.

### **3. Experimental testing and other forms of validation of technical solutions**

This sub-project has conducted experimental testing of relevant technology as part of a broader validation work. A separate report on the sub-project will be published in Norges Bank (2023c).

The purpose of this work has been to validate whether technology can deliver the necessary characteristics of CBDC, required to fulfil its purpose, as defined in Norges Bank (2021). Furthermore, the purpose of the work was to highlight economic and regulatory factors related to the use of these technologies, as well as serve as a basis for dialogue with the banking/financial industry, other authorities and other central banks. The validation work has also helped to build the expertise necessary to assess how the work on CBDC should be pursued.

In its work, the project has engaged in dialogue with a number of private financial actors (including Norwegian and international technology companies as well as banks established in Norway), authorities, other central banks and international organisations such as the BISIH. We have accounted for the investigation into CBDC at many conferences and seminars, as well as arranged two conferences and three hackathons, all in collaboration with others.

The experimental testing was conducted by constructing a series of test cases, each validating one or several characteristics (see Figure 1). Examples of test cases are 1) issuance and destruction of CBDC, 2) mass payments and 3) cross-border payments.

The testing was mainly conducted in a test network/prototype and blockchain technology (private/closed Ethereum network). The prototype is a simple core infrastructure for CBDC: a registry/database and functionality for issuing, distributing, confiscation and settlement of CBDC.

The prototype was developed by a Norwegian IT company that has been engaged to develop applications for testing. In addition to the prototype, we have tested other technologies on a smaller scale, such as OpenCBDC.

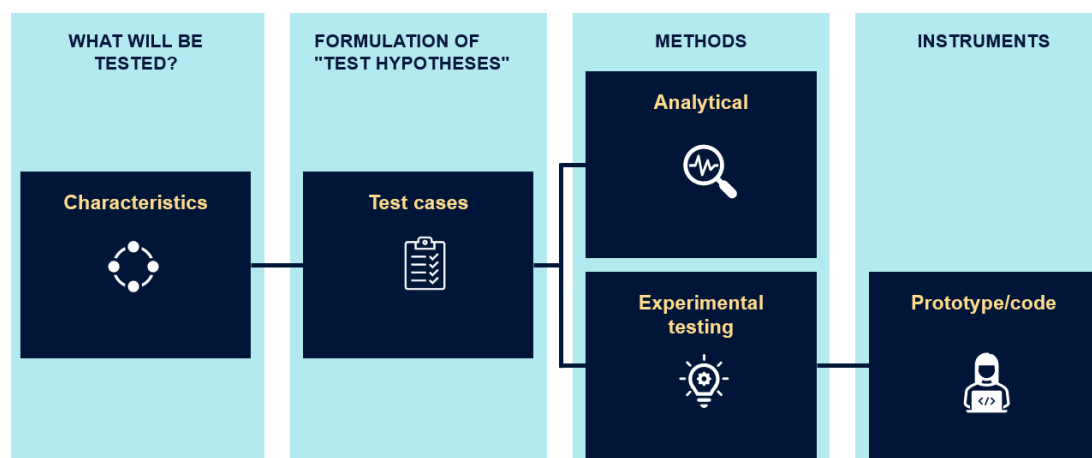
An important finding is that the characteristics from Norges Bank (2021) so far appear to be achievable with the technology employed in the testing. This may indicate that it is possible to introduce CBDC with the characteristics we believe are required. However, we must make the reservation that we have not sufficiently tested all the characteristics yet. Moreover, not all of the characteristics' aspects are suitable to be verified by means of technical testing. It should also be noted that conclusions from the testing so far do not imply that the technology we have tested necessarily represents the most appropriate technology for the CBDC core infrastructure.

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<sup>7</sup> Note that any customer-oriented CBDC may have a different/broader purpose than that of the precautionary approach, e.g. related to contingency arrangements for payment (see Norges Bank (2021) and Norges Bank (2023)).



Figure 1. Conducting testing



Source: Norges Bank

Some elements of the testing have not previously been carried out by other central banks. The testing has also been the starting point for useful cooperation with other central banks and other external financial actors, e.g. in the project Icebreaker discussed below.

The technology choices that were made, including the use of known technology based on open source, have been an important factor in our investigation. If a more unknown and/or proprietary technology had been chosen, the testing would unlikely have advanced as much as it has. For example, it would probably have been challenging to find IT expertise to develop a prototype, develop test cases and hold hackathons if a little-used and/or proprietary base technology had been chosen.

Many tests and test cases have been carried out. At the same time, continued experimental testing through the establishment of new test cases and further development of existing test cases should provide further needed insight for the potential introduction of CBDC. It should also be a springboard for further cooperation with external actors. Among other things, privacy solutions and solutions for regulatory compliance can be further elucidated. Test cases should also be developed for performance testing (e.g. number of transactions per second and time of final settlement) and security testing. Furthermore, testing incentive structures and new business models for third parties (e.g. banks), retailers and consumers is needed.

One lesson from testing is that different types of technology and maintenance of registries (databases of transactions) offer diverse functions that are to varying degrees suitable to ensure the necessary characteristics of CBDC. Thus, to exploit the advantages and disadvantages inherent in different registry solutions, it may be appropriate for CBDC to use several registries linked together through bridges. By way of such bridges, the relative advantages of different types of registries can be exploited. However, bridges raise some special challenges that have been highlighted in the experimental testing.

In principle, the core infrastructure (primary registry/account system, arrangements for issuing, distributing and confiscation of CBDC and interface, inter alia to Norges Bank's settlement system) can be developed in three ways:

- In-house development.
- Purchases from suppliers who offer more or less fully developed comprehensive CBDC solutions or parts thereof, possibly in combination with in-house development.

- Association with CBDC infrastructure of other central banks.

So far, only a few central banks in other parts of the world have introduced CBDC or have pilots with real payments. Most of these central banks use systems from external suppliers of comprehensive solutions, some of them based on token technology. So far, its use seems to be limited.

Many central banks are studying CBDC. A number of central banks have – often with the help of external suppliers – developed various forms of prototypes (simple test versions) in order to gain more knowledge about various technological solutions and how they can contribute to fulfilling the desired purpose. Overall, this is similar to Norges Bank's course of action, but differences also appear, e.g. in terms of scope and use of resources.

Furthermore, a number of tests pertaining to CBDC are carried out in collaboration with, or under the auspices of, the BISIH. One such project was Project Icebreaker on international payments with CBDC.<sup>8</sup> This was a collaboration between Norges Bank, Sveriges Riksbank, Bank of Israel and BISIH in autumn and winter 2022-23. Participation in such cooperation and participation as observers in other projects have provided and will provide Norges Bank with useful insights for further work on CBDC.

In October 2023, the Governing Council of the ECB decided that work on a digital euro continues in a "digital euro preparation phase."<sup>9</sup> In parallel, the European Union (EU) is working on necessary legislative amendments to introduce a digital euro.

The digital euro project discusses, among other things, whether several central banks can use the same infrastructure for CBDC in different currencies. The ECB (2023c, p. 2) states that multi-currency payments with CBDC can be facilitated in various ways, including:

*"... by following a single-system approach whereby a common technical infrastructure would host multiple CBDC issued by their respective central banks. The priority for the Eurosystem is to ensure the timely delivery of a digital euro that serves the needs of euro area users. If a digital euro is introduced successfully in the euro area, the provision of cross-currency functionalities could be supported where there are mutual interests with other monetary jurisdictions."*

A potential use of the Eurosystem's CBDC infrastructure is thus likely to apply not only to cross-border payments, but also to domestic CBDC payments in national currencies in non-euro countries.

In general, our assessment, based on the testing work and information obtained from suppliers of CBDC solutions to other countries, is that there are currently no available fully developed solutions that can satisfactorily fulfil the requirements and necessary characteristics of a Norwegian CBDC.

Our experimental testing and analysis so far indicate that fulfilling the characteristics is possible. However, we believe it is premature to draw a conclusion about which technological solution for the core infrastructure of a potential Norwegian CBDC is most appropriate. CBDC technology is developing rapidly because there is a strong willingness to invest. It is likely that more suitable solutions will be developed for Norwegian CBDC (i.e. that can fulfil the requirements for characteristics even better) in the coming years, both by private financial actors and as a result of development and testing work performed by other central banks.

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<sup>8</sup> See BIS Innovation Hub, Bank of Israel, Norges Bank and Sveriges Riksbank (2023).

<sup>9</sup> See ECB (2023a) and ECB (2023b).

At the same time, information obtained by the BSIH shows that the suppliers offering CBDC solutions have chosen very different technologies, design and security solutions. There is reason to believe that if CBDC becomes more widespread, there will be convergence and standardisation in solutions. A lack of standardisation in a start-up phase may mean that central banks that introduce CBDC early may later have to implement substantial upgrades if the solution they chose ended up failing to meet up to the future standard.

More generally, CBDC infrastructure developed and/or tested in other central banks may be relevant technology for Norwegian CBDC. In Phase 5, the project should therefore assess the characteristics of, and advantages and disadvantages of, a connection to other central banks' CBDC infrastructure, including a potential digital euro infrastructure.

Norges Bank's evaluation, in the coming years, regarding the pertinence of connecting to the Eurosystem's TARGET settlement system is an additional element in this assessment.<sup>10</sup> A potential association with TARGET could entail both advantages and disadvantages for a potential connection to the digital euro infrastructure. If both the CBDC and the ordinary settlement system use ECB/Eurosystem infrastructure, advantages may be gained, among other things, in links between the systems and other forms of harmonisation. On the other hand, a large part of the core of the Norwegian payment system would then be dependent on one and the same actor. Such factors must be further assessed.

Developing the core infrastructure for a full-scale CBDC solution is a complex task. The working group is of the opinion that it is probably not appropriate for Norges Bank itself to develop and maintain the core infrastructure, given the resources this requires and the role Norges Bank must then take on. This applies both to work performed by the Bank's own employees and work performed with external suppliers' support.

When Phase 4 started, the work was aimed at validating the characteristics listed in Norges Bank (2021). These characteristics have been useful aids in the testing work. At the same time, experience shows that the characteristics are slightly interchangeable and can be more adequately consolidated and systematised. In the next phase, it is recommended that the project identifies requirements for a Norwegian CBDC that are better suited to differentiating various solutions and serve as a starting point for a more detailed requirements specification for the Norwegian CBDC solution.

Further work on studying a full-scale solution should be agile and exploratory:

- The resources should initially be invested in identifying overarching requirements for a Norwegian CBDC and, based on these, preparing a requirements specification for a full-scale solution.
- Work on a regulatory framework for a full-scale solution should also be carried out, including business models and incentive structures for the financial actors involved. We will be completely dependent on banks and other payment service providers facilitating payment services for end customers based on CBDC as a source of money. This can be just as extensive and demanding a task – both for the private sector to implement in a good manner and for Norges Bank to follow up – as to establish a core infrastructure.
- Experimental testing should be pursued, because it increases our competence, matures the assessment of technological, legal and economic factors, tests various crucial components and provides insight into requirements for a potential Norwegian CBDC solution. Experimental

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<sup>10</sup> See, among other documents, Norges Bank (2023a) and Norges Bank (2023b).

testing should continue to be a catalyst for cooperation with other central banks and private financial actors/suppliers working to develop full-scale, performable solutions.

#### **4. Implications for Norges Bank's liquidity management and the impact of monetary policy**

Depending on how CBDC is designed, CBDC can influence Norges Bank's liquidity management and conduct of monetary policy. This issue has been considered in further detail in a separate sub-project. The paper from the sub-project will be published in Bernhardsen and Kloster (2023).

In its liquidity management, Norges Bank aims to keep banks' deposits in the central bank overnight – *the central bank reserves* – around NOK 35 billion. As with the public's demand for cash, CBDC will be an autonomous factor on the liabilities side of the central bank's balance sheet, i.e. they affect the amount of central bank reserves beyond the central bank's control. Norges Bank counteracts such autonomous factors with market operations (F-loans and F-deposits) with a view to keeping the shortest money market rates close to the policy rate. This is how monetary policy is implemented.

CBDC may present some challenges for today's financial system, depending on how CBDC is designed. These challenges were also discussed in Norges Bank (2018). The potential challenges will be greater if CBDC becomes well suited as a store of value, so that public demand for CBDC may be high. High demand for CBDC can affect banks' balance sheets, funding costs and the monetary and credit-generating process, as well as the central bank's balance sheet and risk, and the implementation of liquidity and monetary policy. The reason for this is that banks may lose deposit funding in the case of demand for CBDC: Banks' customers may wish to exchange part of their bank deposits for CBDC. Banks can meet this challenge by raising their deposit rates. The quantity of CBDC that will be demanded in a new equilibrium is uncertain. To supply CBDC to their customers, banks must purchase them from the central bank and pay with central bank reserves. On banks' balance sheets, deposits from the general public and deposits in Norges Bank are reduced to the same extent. If banks lack sufficient central bank reserves, they must borrow from the central bank.

This is entirely parallel to effects of the public requesting cash. However, if demand for CBDC in a new equilibrium becomes substantially higher than demand for cash, banks' need to borrow from the central bank may exceed the value of their approved collateral. Ultimately, the central bank may have to accept collateral with higher credit risk. At the same time, greater uncertainty may arise as to the composition of banks' liabilities and funding costs. Uncertainty related to funding costs and interest margins may influence banks' lending behaviour. Banks may be less willing to extend credit to the public. The overall effect is ambiguous and situational.<sup>11</sup>

Literature has extensively shed light on these factors. Much of the discussion revolves around how CBDC can be designed to contribute to a more efficient payment system, while avoiding or at least significantly reducing these financial challenges. Reducing financial challenges implies that CBDC should be designed to enable the management of demand. This can be done via quantitative restrictions (quotas) or through a pricing mechanism (interest rate). Quotas, in the form of a limit on how much CBDC each person can hold, provide a secure limit on the amount of CBDC outstanding. However, a quota system

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<sup>11</sup> Alstadheim and Søvik (2021) discuss how banks' lending rates may be affected by the introduction of CBDC.

may not provide much flexibility for adapting to individual preferences, at the same time as it may also bring forth other challenges within the payment system. The use of interest rates does not result in a limit that is as stable for the total amount of CBDC. However, it provides greater flexibility for the individual and potential challenges in the payment system are eliminated. With the use of interest rates, a two-stage system can be introduced, where the interest rate on CBDC holding within a fixed individual amount limit is higher than the interest rate on holdings beyond the limit. The purpose of such a system is to support CBDC's role as an attractive means of payment, but at the same time to be able to control demand for a store of value. Pros and cons of various solutions for managing the demand for CBDC are discussed in further detail in Bernhardsen and Kloster (2023).

The report also discusses a claim that is often highlighted in the literature, namely that banks as a group can replace deposit funding with wholesale funding to meet the need for central bank reserves when the public requests CBDC. This may be possible for an individual bank, but not for the banking system as a whole. For the banking system as a whole, loss of deposit funding in such a situation can only be replaced by central bank funding (because banks must "settle" in central bank reserves when they lose customer deposits). The fact that banks' loss of deposit funding can only be replaced by central bank funding is also discussed in the report. If the public's CBDC storage/holdings reach a high level in a new equilibrium, the central bank's balance sheet and footprint in the financial system will increase.

This discussion draws the overall conclusion that CBDC should not primarily be seen as a monetary policy instrument and that liquidity management, with reasonable CBDC designs, will be manageable. Further conclusions are as follows:

#### *Liquidity management*

- CBDC is an autonomous factor that influences banks' need for reserves. Under the current system for the management of banks' reserves, the quota system, reserves in the banking system are relatively scarce. In the event of increased demand for CBDC, Norges Bank may have to provide banks with loans (F-loans under the current system). This may lay claim to amounts of banks' collateral that are greater than today and may have an impact on banks' Liquidity Coverage Ratio (LCR).
- Volatile demand for CBDC is likely to make the forecast for the structural liquidity more unclear and subject to unpredictable shifts.
- A number of fine-tuning market operations may be required to keep reserves in the banking system near the liquidity management target.
- Liquidity management is likely to be more unpredictable, but is nevertheless considered manageable, provided that CBDC is designed with a view to substantially reducing the financial disadvantages mentioned above.

#### *Monetary policy*

- If CBDC is introduced, the argument in favour of this should primarily be linked to the payment system and not be thought of as an additional monetary policy instrument. It cannot be completely ruled out that CBDC may play a role as a monetary policy instrument in the long term, but this should not be the motive for introducing CBDC in the next few years.
- The introduction of CBDC can reduce monetary policy leeway by diminishing the pass-through from the policy rate to bank rates and by raising the effective lower bound for the policy interest

rate. The latter is due to it probably being easier for the general public to convert from bank deposits to CBDC than from bank deposits to cash.<sup>12</sup>

- CBDC should be designed in a way that enables the management of demand. This can be achieved by means of individual quotas or by setting interest rates on CBDC. When using interest rates, the introduction of a two-stage system should be considered. The CBDC interest rate cannot be used as a monetary policy instrument while simultaneously being used to regulate CBDC demand.

## 5. Necessary legislative amendments to provide for the introduction of CBDC

The introduction of CBDC for general public use will affect a number of provisions on payments and settlement, both pertaining to private and public law. Among other things, it is necessary to clarify the legal liability placed on the central bank, private banks and other payment system participants. How to assess the relationship between payer and payee must also be clarified, if payment is made with CBDC. We have therefore considered the necessary legislative amendments to introduce CBDC, see Syrstad (2023). Below is a summary of the legislative amendments that must be made in order to introduce CBDC as a generally accessible means of payment for the public.

The issuance of CBDC will require legislative amendments to Section 3-4 of the *Norges Bank Act* on the issuance of cash as means of payment, including potential legal basis for regulating interest rates on CBDC. If CBDC is also to be granted *legal tender* status, this must be specified in Section 3-5 of the *Norges Bank Act* on legal tender. Norges Bank's responsibility for issuing CBDC should also be set out in Section 1-3 of the *Norges Bank Act* relating to central banking operations.

A well-functioning solution for CBDC also requires clarifications to be made in the provisions of the *Financial Contracts Act* relating to *the method of settlement*, under section 2-1, and *the time and place of payment*, under section 2-2. This is necessary if CBDC is to maintain some of the key characteristics of cash, which has been a basis for Norges Bank's project. The *Financial Contracts Act* may also specify that payments with CBDC shall be deemed *final*, and specify that the payments have *legal protection* against the payer's creditors.

Section 16-4 of the *Financial Institutions Act* contains provisions on banks' obligation to receive cash and make deposits available to their customers in the form of cash. These provisions must be extended to include CBDC, if CBDC and cash gain equal status.

Various provisions in special legislation should be adapted to make CBDC a new, generally accessible means of payment. If CBDC is to be used for *public receipts and payments*, regulatory adjustments must be made. This applies in particular to Section 9-1, first paragraph, of the *Tax Payment Act* relating to payment of tax claims and Section 1 relating to payments from the Norwegian Labour and Welfare Administration (NAV), in the regulations relating to the implementation of Section 22-18 of the *National Insurance Act* and Section 34 of the *Maintenance Collection Act* on the payment method for benefits.

Responsibility for customer due diligence under Section 10 (1) (a) of the *Anti-Money Laundering Act* will, as is the case today, rest with the banks. However, under Section 10(1)(b) and Section 21 it is unclear

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<sup>12</sup> This is also discussed in Norges Bank (2018), Appendix 1.

who will be responsible for transaction monitoring. This must be resolved through legislative amendments to the Anti-Money Laundering Act.

Potential *interest rates* on CBDC raise some special issues that should be addressed in both the Norges Bank Act and special legislation. This applies, among other things, to questions about how public receipts and payments should be made, responsibility for reporting to the tax authorities and customer due diligence measures pursuant to the Anti-Money Laundering Act.

A general point is that the technical design of CBDC may require various legislative amendments. Some necessary and desirable characteristics of CBDC may also require special technical design. Both in Norges Bank's project and internationally, particular attention is placed on a solution where CBDC are issued and distributed on *blockchain-based solutions*, i.e. solutions that are wholly or partly based on blockchain technology. Compared to account-based solutions, blockchain-based solutions raise some special questions. This applies, for example, to CBDC's legal status, if CBDC identifiers are converted between different blockchains. It must be clarified whether Norges Bank will act as issuer after a conversion, and whether the means of payment are to be regarded as "genuine" CBDC, or whether they are to be regarded as privately issued means of payment ("synthetic" CBDC). In simple terms, "conversions" in this context means that CBDC are moved or transferred between different blockchains. Furthermore, one must consider the possibility of CBDC being stored privately by end users ("self-custody"), or the possibility for only approved providers of storage services to be able to store CBDC for the end user.

The legal status and responsibility of the units that will verify the individual payments, so-called validating nodes, must also be clarified. One must take into account that this type of issue may be further regulated, e.g. by a provision of the Norges Bank Act or other financial regulatory legislation.

## **6. Recommendations on activities and deliveries from the CBDC project Phase 5**

The study of CBDC will be continued in Phase 5, in line with the Bank's Strategy 25 (see Norges Bank (2022, p. 10). It states:

*"Norges Bank will prepare the ground for the issue, if appropriate, of a central bank digital currency (CBDC). A CBDC may be necessary to ensure that NOK will continue to be a safe, efficient and attractive means of payment in the future too. During the strategy period, we will analyse the possibilities afforded by, and the consequences of, introducing a CBDC and test candidate solutions. To obtain knowledge and contribute to international standardisation and cooperation, we will work with other central banks and international organisations."*

We propose the following recommendations for the content of Phase 5:

The main delivery should be a report to central bank management with a decision basis for and recommendation as to whether Norges Bank should introduce CBDC and, if so, the recommended type of design and implementation.

In this context, the project should assess both retail CBDC and wholesale CBDC. The analysis should include an assessment of how the payment system in NOK can develop, with or without the introduction of various forms of CBDC, respectively, and by using measures other than the introduction of CBDC. The analysis should, as far as possible, be carried out in accordance with the Instructions for Official Studies,

the Ministry of Finance's circular on cost-benefit analysis and the cost-benefit analysis guide drawn up by the Norwegian Agency for Public and Financial Management (DFØ). The report should be available so that it can be considered by the Executive Board by the end of 2025.

Important part deliveries should be:

- A proposal for the potential design of a full-scale retail CBDC solution. The solution consists of a technical infrastructure and a regulatory framework. This means:
  - Analyse, identify and determine fundamental requirements and characteristics of a Norwegian CBDC solution.
  - Develop a requirement specification (functional, security-related and technical requirements) for the infrastructure, which includes, among other things:
    - Core infrastructure (primarily ledger/account system, schemes for issuing and confiscating CBDC and interfaces with, inter alia, Norges Bank's settlement system).
    - Link to payment services from private banks and other suppliers to end customers.
    - At least one dedicated payment service that is independent of banks' systems.
  - Develop a regulation/framework ("scheme") for a full-scale CBDC solution. One should develop a set of rules, guidelines, requirements for/approval of service providers (possibly a requirement to have a relevant licence and be subject to supervision) and agreements describing the roles of the actors involved in a CBDC solution, rights and obligations and set standards for payment notifications, among other things. The framework shall provide an appropriate incentive structure for the stakeholders involved and must be based on an assessment of business models. The framework is also intended to give Norges Bank necessary control over relevant parts of the solution and provide an appropriate division of roles between Norges Bank and private financial actors. This framework comes as an addition to necessary legislative amendments, see below.
  - Assess how an introduction can be implemented, both for the core infrastructure and for those parts of a full-scale solution that must be facilitated by parties other than Norges Bank.
- A proposal for how a potential full-scale solution for wholesale CBDC should be designed. To the extent relevant, the proposal should, in the same way as for retail CBDC, describe the technical infrastructure, basic requirements and characteristics of the solution and associated regulations. Various forms of central bank settlement of payments with tokenised bank deposits and the money-related aspect of trades in tokenised assets should be examined. The study should cover opportunities and challenges related to this within Norges Bank's areas of responsibility. This includes examining whether the introduction of wholesale CBDC can help support the development of tokenised private bank money and assets. Such money could potentially offer attractive new functionality for payments in NOK and thus reduce the precautionary approach motivating the introduction of retail CBDC. At the same time, the introduction of wholesale CBDC will have implications for, among other things, Norges Bank's liquidity management.



- An assessment of whether relevant solutions for retail CBDC and wholesale CBDC raises legal issues beyond those discussed in Syrstad (2023), and potentially offer suggestions as to how this can be resolved. Based on Syrstad (2023) and in light of relevant solutions consider how a possible requirement for CBDC as legal tender should be regulated.

The assessment of technical infrastructure for retail CBDC and wholesale CBDC should be based on several work processes:

- Experimental testing of technical solutions to gain more insight into which solutions can best provide the characteristics necessary for CBDC in Norway. Norges Bank (2023c) provides a more detailed description of and recommendations on how experimental testing can be further developed. Experimental testing helps us to assess which solutions can best provide the necessary characteristics of CBDC. There is therefore no conflict between continuing experimental testing and our assessment that Norges Bank should probably not develop infrastructure in-house.
- Mapping of relevant actors who offer all or parts of CBDC solutions, and who may be engaged in an introduction of CBDC in Norway.
- An assessment of whether participation in other central banks' CBDC solutions may be a relevant alternative. Norges Bank would then issue CBDC in NOK using such a technical platform.

The project should cooperate/engage in dialogue with other central banks, international organisations, academia and other external experts and potential actors within and users of a Norwegian CBDC solution. The project should establish and operate appropriate bodies, such as reference groups, for communication with and input from stakeholders in Norway.

The project should take into account the report from the public commission that examines secure and easy payments for all (see Government, 2023).

## Box: Concepts

**Wholesale CBDC:** Tokenised central bank reserves that can be used for settlement between banks and certain other financial actors with an account at the central bank. Such settlement corresponds to today's interbank settlement in Norges Bank, but in a different technological form and potentially with a different setup for access.

**Cryptoassets:** Collective term for cryptocurrencies, stablecoins and tokens (see below). Often used in regulatory contexts to refer to assets represented by cryptographic codes in decentralised systems.

**Cryptocurrency:** Units on a ledger or computer system that are designed to operate in a decentralised manner. The ledger is often referred to as a blockchain. The units are accessed/disposed of through cryptographic codes. The system itself can be referred to as a cryptocurrency system, while the units are cryptocurrencies.

**Central bank reserves:** Banks' and other professional financial actors' demand deposits in the central bank. Banks need central bank reserves for interbank settlements.

**Smart contracts:** A smart contract is a computer program that automates performances between parties according to predefined terms. Often used to refer to programs in a cryptocurrency system.

**Stablecoins:** Cryptoassets that strive for stable value against a benchmark (e.g. USD) through a stabilisation mechanism. Often implemented as tokens in a smart contract in a cryptocurrency system. Attempts may be made to secure their stable value through external assets managed by an external market participant, external cryptoassets and/or algorithms that influence supply and demand.

**Tokens:** Items of value in a cryptocurrency system, often issued in a smart contract. Disposed of through cryptographic codes. Tokens can be exchangeable (fungible) or non-exchangeable (Non-fungible token – NFT). The latter represents a unique value, such as a digital work of art or objects in a virtual game. Such non-exchangeable tokens can also represent other traditional assets, such as securities and real estate.

**Tokenisation:** The process of representing assets/liabilities in a digital form, which allows them to be traded in cryptocurrency systems/on programmable platforms using smart contracts.

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