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DANMARKS NATIONALBANK

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New types of digital money

Denmark has a safe and efficient infrastructure when it comes to payments and is a leader in the use of digital money. New types of digital money may potentially supplement the existing types, but they also involve new dangers. For Danmarks Nationalbank, it is essential that the solutions are safe and efficient for citizens and society – regardless of provider and technology.

Crypto-assets, blockchain technology and new actors

The future use of stablecoins depends on how they are regulated and what benefits they can offer for citizens and society.

Read more

Central bank digital currency between financial actors based on new technology

The existing infrastructure, for example for cross-border payments, may potentially be supplemented by wholesale central bank digital currency.

Read more

Central bank digital currency for citizens

Several central banks are investigating the use of retail central bank digital currency – for various reasons. Danmarks Nationalbank is monitoring the development closely.

Read more

DIGITALISATION

Digitalisation

The digital transformation is progressing rapidly in these years, and Denmark and the other Nordic countries are currently among the most digitalised countries in the world.

Digitalisation brings changes. Obvious changes are in the way we purchase and pay for goods and the way we transfer funds to each other. But increased digitalisation and new digital technologies may also affect the growth potential of the economy and labour market developments. Prices of goods, trade, financial sector stability and the way we calculate the digital economy are also impacted by digitalisation.

In a series of publications, Danmarks Nationalbank focuses on the digital development and its significance for the economy.

ABOUT THIS ANALYSIS

New types of digital money

Based on the types of money of which we have knowledge today, this analysis provides an overview of key trends, all of which may affect the development of new types of digital money.

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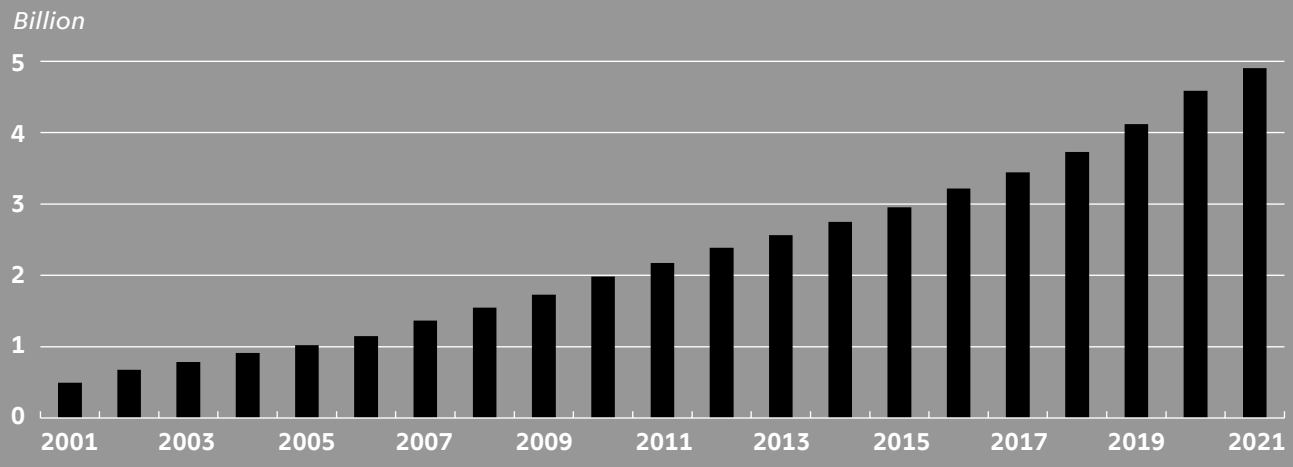
Online users globally



Source: ITU World Telecommunication /ICT Indicators database.

Background and summary

The technological development and new actors in the financial markets have generated a debate about new types of digital money in recent years. This is a complex debate because it encompasses new types of assets, new financial service providers and various forms of regulation.

Danmarks Nationalbank's core tasks are to ensure financial stability, stable prices and safe payments in Denmark. Therefore, Danmarks Nationalbank is working to ensure access to secure and efficient money and payment solutions that are available to the whole of society, also in the future. This applies regardless of the solution, provider or technology that may form the basis of new types of digital money.

The money we currently use in Denmark is well-functioning, and new types of digital money are likely to gain a foothold if they offer benefits for citizens and society.

Based on the types of money we have today, this analysis provides an overview of three key trends, all of which may affect the development of new types of digital money and payment solutions: stablecoins, new central bank digital currencies between banks (wholesale CBDC) and central bank digital currencies for citizens (retail CBDC).

Each of these three trends may present new opportunities, but they also raise a number of issues that may be of importance to the individual citizen, payment systems and the financial system. It is possible that the digital money of the future will be a combination of new types of digital money and the types we have today. Chart 1 provides an overview of the types of money and assets reviewed in the analysis.

Stablecoins, which are crypto-assets that seek to track the value of, for example, a currency, may have a long-term potential to supplement the money we use today. However, there are unanswered questions about stability, trust, and how these assets are regulated effectively, as well as how they are disseminated to citizens and merchants.

A decentralised database technology called DLT (distributed ledger technology) may impact the settlement of payments between financial institutions. Preliminary studies conducted by some central banks show that the existing infrastructure for settlement of interbank payments can be supplemented with DLT. It is referred to in this analysis as wholesale CBDC and can form the basis for faster and more efficient payments between financial institutions, including cross-border and cross-currency payments. At the same time, central banks are also working to further develop the existing infrastructure and make it more resilient. For example, in 2020, Danmarks Nationalbank decided to migrate the central systems for interbank payments in Danish kroner, among other payments, from a purely Danish platform to a pan-European platform for payments and settlement of securities in 2025. This will create a strong foundation for the future development.

Retail central bank digital currency is also being investigated by many central banks, but few have yet decided to issue such a currency. The reasons for investigating the use of CBDC vary greatly between central banks. Some of the reasons that are highlighted include inter alia financial inclusion, broad use of technology and innovation as well as critical infrastructure. With the well-functioning financial infrastructure we have in Denmark, it is not clear how a retail CBDC in Danish kroner can contribute to better and more secure access to payments and financial services or to creating more safe and efficient solutions for citizens and society in general.

However, it is often the case with new technology that development and maturation take time, making it unclear from the outset under what conditions and to what extent a new solution will create value. Likewise, it can also be difficult to predict which financial solutions and services will be in demand in the future. The development may impact the private sector, central banks and other institutions' demarcation and role, including the relevance of new types of digital central bank money, if socio-economic benefits depend on this. Therefore, Danmarks Nationalbank monitors the development closely and participates actively in international working groups and forums that focus on new payment technology and on the opportunities and risks connected with a retail CBDC.

Chart 1

Assets and types of money treated in this analysis

	CASH	BANK DEPOSITS	E-MONEY	STABLECOINS	OTHER CRYPTO-ASSETS	RETAIL CBDC	WHOLESALE CBDC
STABILITY	Yes	Yes	Yes	Maybe	No	Yes	Yes
ISSUER	Central bank	Private bank	E-money institute	Private company	No central issuer	Central bank	Central bank
BACKED BY	Central bank/state	Central bank reserves/ regulation	Bank deposits	Bank deposits/ (EU-regulation under way)	No security	Central bank/state	Central bank/state
AVAILABLE TO	Citizens and companies	Citizens and companies	Citizens and companies	Citizens and companies	Citizens and companies	Citizens and companies	Financial actors
TECHNOLOGY	—	Centralised database technology	Centralised database technology	Decentralised database technology	Decentralised database technology	Centralised/decentralised database technology	Decentralised database technology

Denmark is a leader in the use of digital money

Every day, billions of kroner are transferred from one account to another in Denmark. The payments are made quickly and safely, and the citizens have trust in the payment systems, regardless of whether physical money (cash) or digital money (bank deposits) is used.

From physical to digital payments

Citizens' and companies' payments have gone from being primarily made with physical money, i.e. cash, to being mainly made with digital money today. Digital money in the retail trade consists primarily of private bank deposits. The difference between bank deposits and cash is described in more detail in box 1. Added to this is e-money, which, however, is only used to a very limited extent in Denmark. E-money is prepaid digital money which constitutes a claim on the issuer. This could, for example, be gift vouchers, prepaid payment cards and cards used to purchase public transport tickets.

Denmark is a leader in the use of digital payments and is also among the world's most digitalised countries.[1] In 2021, just under 90 per cent of payments made in physical trade were digital, and the average number of card transactions per citizen in Denmark was about twice as high as the EU average.[2] Added to this are online shopping, credit transfers and automatic bill payments, which are inherently made using digital money.

The development from physical to digital money in the retail trade is caused by a number of factors, including the development of new payment solutions, decreasing costs and continuously improved infrastructure.

The private sector has gradually launched new and better payment solutions such as debit cards and mobile payment solutions. The payment cards have continuously improved their security and functionality in the form of use of chip and the option of contactless payment, among other features. Added to this is the introduction of mobile solutions such as MobilePay, Apple Pay, Dankort app and Google Pay, which accounted for 22 per cent of total retail payments at point of sale in 2021.[3]

At the same time, the costs to society of payments between citizens and merchants have decreased.[4] They accounted for 1 per cent of GDP in 2009 and fell to 0.5 per cent of GDP in 2016. This is a significant improvement in efficiency, as the number of payments have increased sharply over the same period.[5]

Finally, the financial infrastructure has been continuously improved and has thus become more efficient. This has also contributed to the development from physical to digital retail payments. For example, in 1981, Danmarks Nationalbank made the first digital payment system available to the banks, which has since been further developed and is today called Kronos2.[6] Another significant milestone was in 2014, when instant clearing of retail payments made it possible for citizens and companies to make instant transfers 24/7/365.

The work to improve the infrastructure continues. In 2020, Danmarks Nationalbank decided to migrate the Kronos2 activities to a coming European payment platform, TARGET Services. With TARGET Services, Denmark forms part of a common infrastructure

1 See European Commission, *Digital Economy and Society Index 2021*, November 2021 (*link*).

2 See Danmarks Nationalbank, Denmark is among the most digitalised countries when it comes to payments, *Danmarks Nationalbank Analysis*, no. 2, February 2022 (*link*).

3 See Danmarks Nationalbank, Denmark is among the most digitalised countries when it comes to payments, *Danmarks Nationalbank Analysis*, no. 2, February 2022 (*link*).

4 The social costs express the aggregate use of resources by the parties involved in a payment transaction. Transfers between the parties have been excluded.

5 See The Danish Payments Council, *The costs of consumer-to-business payments have decreased considerably*, September 2018 (*link*).

6 See Kim Abildgren, Danmarks Nationalbank, *Danmarks Nationalbank 1818-2018*, 2018 (*link*).

across EU member states with increased economies of scale in relation to maintenance and further development as well as strengthened IT security and a united front against cyber threats.[7]

Unlike the development in retail payments, there have been no major changes in the way in which Danes hold their money. Already since the middle of the 19th century, liquid funds have predominantly been held in bank accounts rather than in cash, which is also the case today.[8]

Well-functioning money is essential to a society
Historically, it has been important for citizens and companies that the types of money used for the exchange of goods and services have met a number of basic prerequisites for functioning well.[9] The completely fundamental prerequisite is trust. Added to this is that the funds can be used as means of payment, a store of value and a unit of measurement.

Throughout history, various goods have functioned as money to facilitate the exchange of goods and services, for example grain. Money was subsequently pegged to an asset and could, for example, be exchanged for gold. Today, modern economies are based on so-called fiat money. Fiat money is not supported by underlying assets, but has instead been declared legal tender[10].

Trust is the prerequisite for well-functioning money
Without trust, the monetary system will be connected with uncertainty and thus not function well. Money represents a value because people trust that it retains a stable value. Trust in both digital and physical Danish kroner first and foremost reflects that there is confidence in the Danish State and in Danmarks Nationalbank ensuring via the pursued monetary policy that the value of the Danish krone remains stable over time. Low and stable inflation creates certainty about the future value.[11]

The trust is also based on a general trust in the key actors, such as banks, that handle registration of transactions and the value of the funds. This trust is especially due to three factors. Firstly, banks have assets, liquidity and capital to support and ensure the value of the funds. Secondly, there is effective legislation regulating these actors, with capital requirements to ensure that they can withstand losses and caps on the risks that banks are allowed to undertake. And, finally, the deposit insurance scheme (the Guarantee Fund) secures deposits of up to approx. kr. 750,000 in the event that a bank enters into liquidation.[12] These factors mean that both bank deposits and cash are regarded as secure ways of storing value, even though bank deposits are a claim on the bank, i.e. a receivable against a private bank, and cash is a claim on Danmarks Nationalbank, see box 1.

Trust is also the prerequisite for the existence of the three characteristic features of well-functioning money.

Money must:
- be widely accepted so that it can be used as *a means of payment;*
- have a stable value so that it can be used as *a store of value;*
- be the *unit of measurement* in which the prices of goods and services are denominated.

7 TARGET Services is a European, consolidated payment and securities settlement platform. TARGET Services thus replaces the current payment system, Kronos2. As part of the consolidation, TARGET Services will support settlement in several currencies and the coming ISO 20022 format – to which payment messages must switch before November 2025. See Danmarks Nationalbank's website for a detailed description of the migration to the European payment platform TARGET Services (*link*).

8 See Danmarks Nationalbank, The use of cash in society, *Danmarks Nationalbank Analysis*, no. 3, February 2022 (*link*).

9 See Kim Abildgren, Danmarks Nationalbank, *Danmarks Nationalbank 1818-2018*, 2018 (*link*).

10 Legal tender is the means of payment that you have the right to use to buy goods and services or discharge yourself from a payment obligation in Denmark. Unless there is another agreement or special statutory provisions, for example the anti-money laundering legislation, Danish banknotes and coins are always legal tender, see section 8 of the National Bank of Denmark Act and section 4 of the Danish Coinage Act.

11 See Kim Abildgren, Danmarks Nationalbank, *Danmarks Nationalbank 1818-2018*, 2018 (*link*).

12 The purpose of the guarantee is to provide coverage for depositors and investors in institutions that are covered by the scope of the Guarantee Fund, and it covers up to approximately kr. 750,000. The deposit guarantee scheme is financed by the banks.

Digital Danish kroner in the form of bank deposits thus meet both the basic trust and the three above characteristic features: It can be used as a means of payment in virtually all stores. It is suitable as a store of value, as the value of the money is stable. And bank deposits are denominated in Danish kroner, which is the unit of measurement for goods and services in Denmark.

The advantages of using digital money over cash have contributed to the development from physical to digital payments. And new types of digital money are likely to gain a foothold if they entail advantages for citizens or companies in the form of improved functionality, security or lower fees.

For Danmarks Nationalbank, it is essential that the solutions that are made available are safe and efficient for citizens and society. Therefore, any new types of money must be well functioning, i.e. there must be trust in the money and that it adequately meets the three basic characteristic features. This applies regardless of the solution in question or the technology used for the new types of digital money.

Cross-border payments can be improved

In relation to cross-border payments, there is potential for improving efficiency and reducing costs. For example, payments out of the EU can be costly, slow to settle and, in some cases, fees can be significant and non-transparent for citizens and companies.[13] The reasons include different technological standards, intermediaries, risks connected with currency exchange and differing legislation.

Large-scale international work is being done to improve cross-border payments. For example, under the auspices of the Bank for International Settlements (BIS), work is being done on how use of DLT can contribute to improved settlement of payments.[14]

Difference between cash and bank deposits Box 1

Physical money is cash consisting of banknotes and coins issued by Danmarks Nationalbank. Physical money constitutes a claim, i.e. a receivable, on Danmarks Nationalbank.

Digital money consists of household and corporate deposits with banks and e-money[1]. Digital money for citizens is not issued by Danmarks Nationalbank, but by private banks (or e-money institutions that issue e-money), and thus constitutes claims on the bank with which the digital money is deposited.

In practice, the difference in who issues the money means that the value of the cash is guaranteed by the central bank, whereas the value of digital money is guaranteed by private banks. The fact that the value of cash is guaranteed by Danmarks Nationalbank entails that there is no credit risk involved in holding cash as opposed to bank deposits. For bank deposits, a balance that exceeds the amount covered by the deposit guarantee scheme will be associated with a credit risk, as all or parts of the amount may be lost if the bank enters into liquidation.

While citizens and companies can only have a claim on Danmarks Nationalbank in physical form, i.e. in the form of cash, the situation is different for banks. Banks can have a digital claim on Danmarks Nationalbank, as Danmarks Nationalbank, like other countries' central banks, is banker to the banks.

Banks' deposits in accounts with Danmarks Nationalbank are central bank digital currency and are called central bank reserves. They are used for interbank payments. This means that the final settlement of payments between banks is typically made through the use of central bank digital currency.

1. E-money, or electronic money, is defined in the Danish Act on Payment Services and Electronic Money as: 'an electronically or magnetically stored monetary value representing a claim on the issuer. It is issued in connection with the reception of payment with a view to executing payment transactions and it is accepted by others than the issuer of electronic money'. E-money may, for example, be gift vouchers, prepaid payment cards and cards used to purchase public transport tickets.

13 See Bank for International Settlements, *Investigating the impact of global stablecoins*, October 2019 (*link*); Bank for International Settlements, *Cross-border retail payments*, February 2018 (*link*) and Bank for International Settlements, *Central bank digital currencies for cross-border payments*, July 2021 (*link*).

14 For example, BIS's Project Jura is investigating the settlement of cross-border payments using CBDC based on distributed ledger technology. See Bank for International Settlements, *Project Jura: cross-border settlement using wholesale CBDC*, December 2021 (*link*).

As another example, BIS is working with the development of a platform that can interconnect instant payment systems across countries that have such a system. Opportunities for developing a common set of rules and standards across countries are also being investigated, and this could also contribute to improving the efficiency and lowering the costs of cross-border payments.[15]

Blockchain technology and crypto-assets

A decentralised database technology called distributed ledger technology (DLT), including blockchain technology, has attracted much attention since the introduction of the blockchain-based asset Bitcoin in 2008.[16] In brief, the term 'distributed ledger' means that the main ledger, i.e. the database containing an overview of transactions and holdings, has been distributed to a number of participants, rather than being held by a central party. In the future, the technology may be of importance to new types of digital money, but it can also be used in many other contexts in addition to financial matters.

The following section initially describes the difference between centralised and decentralised registration of ownership. A description is subsequently provided of blockchain technology, its applications and the assets that depend on blockchain technology – so-called crypto-assets[17]. A recurring question in relation to crypto-assets is whether they – and in particular stablecoins, which are a category of crypto-assets – can become new types of well-functioning digital money. This question is therefore also addressed in the following.

DLT and blockchain technology

A joint feature of crypto-assets is that they use the type of DLT, known as blockchain technology. The technology is used as infrastructure to complete transactions and to register who owns which assets.

Secure and effective registration of ownership is a prerequisite for well-functioning financial systems. In current systems, centralised database technology is typically used for registration of ownership. By using centralised database technology, information about ownership of assets is verified, registered and stored in a central database at a central, trusted party, for example a bank or an authority.

DLT is a decentralised database technology in which information is continuously registered and distributed among the network participants. In a decentralised database, there is consequently no need for a central party that continuously verifies, registers and stores ownership information, as all participants in the network can choose to keep a copy of the database, see chart 2. This offers full transparency in relation to the activities that take place in the system.

A blockchain is a variant of DLT, which, by means of cryptography,[18] can ensure the integrity of data without a central party necessarily verifying the information. When an account holder wants to make a transaction and register information on a blockchain, the account holder uses a public key and a private key. The account holder's public key and the funds connected with the account holder are visible to all participants in the network, while the private key is known only by the account holder in question. The public key is thereby comparable to a public account number that represents an account with a balance. And the private key is comparable to the password that allows the

15 See, for example, Bank for International Settlements' Cross-border payments programme, July 2020 (*link*), Bank for International Settlements' Project Nexus, July 2021 (*link*) and Bank for International Settlements Project Inthanon-LionRock, September 2021 (*link*).

16 See Bitcoin, *Bitcoin: A Peer-to-Peer Electronic Cash System*, 2008 (*link*).

17 Crypto-assets are often referred to as crypto-currencies. However, not all crypto-assets have the characteristic features of money, and they consequently cannot be equated with currencies. For this reason, these assets are referred to as crypto-assets in this analysis.

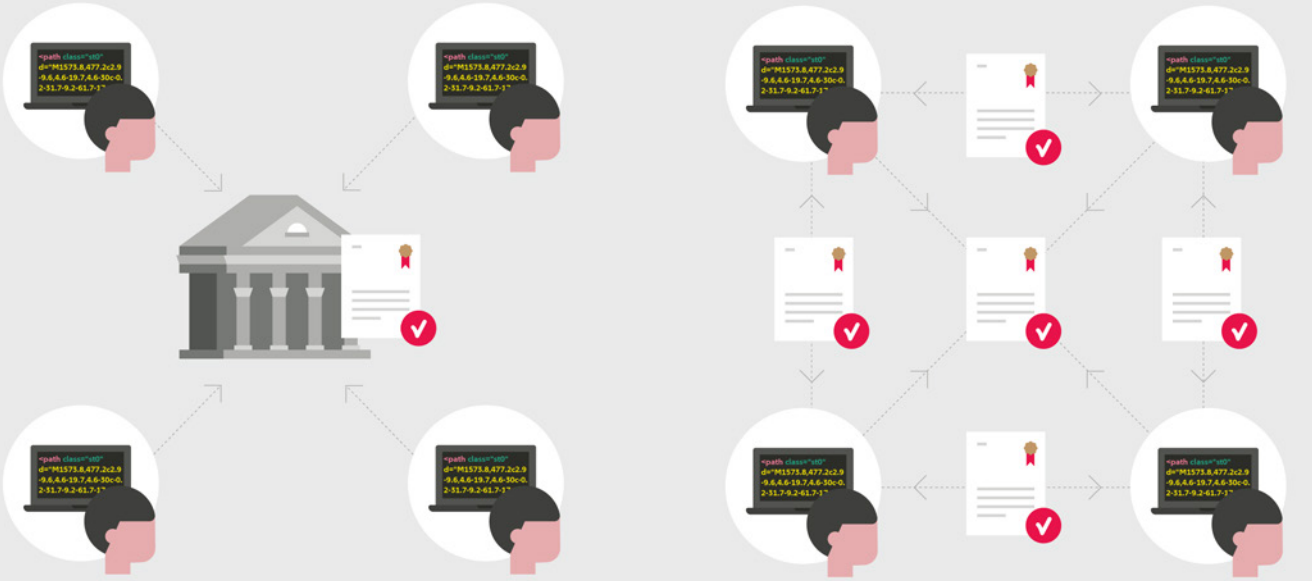
18 Cryptography can be described as a method for keeping information secret by making it illegible to a third party.

Chart 2

Centralised vs. decentralised database

Centralised database

Decentralised database



In a centralised database, there is one central actor who registers and verifies information, e.g. ownership of money or other assets. In a decentralised database, all the network participants have a copy of the database with information, and there is thus no need for a central actor, as everyone can see who owns which assets.

account holder to make transactions with the funds connected with the public key and the associated account.[19]

On a blockchain, the verification of who owns which assets is done using a set of rules for verification of transactions, a so-called consensus mechanism. There are several different consensus mechanisms, see chart 3.

All the network users can choose to participate in verification of the transactions. The verification consists in checking, for example, whether the user who wants to transfer a given asset is, in fact, in possession of this asset. To participate in this part of the verification, the user must have a copy of the database that is continuously updated. Such a copy can be stored and updated on an ordinary computer.

Achieving consensus requires a mathematical puzzle to be solved in connection with the final validation of the transactions. In practice, the mathematical puzzle is solved by computers in the network. For some consensus mechanisms, this process requires so much computing power that ordinary computers have to give up, see chart 3.

If consensus is reached, i.e. that the set of rules for verifying the transactions has been complied with and approved among the participants, the transaction will be stored in a so-called transaction block, which is published on the public blockchain. All the network participants can thereby see the transactions that take place on the blockchain in question. This transparency contributes to ensuring data integrity. Chart 4 summarises how a transaction is initiated and settled on blockchain.

19 See The Danish Financial Supervisory Authority, *Blockchain technology can provide efficient infrastructure for payment services*, February 2022 (*link*).

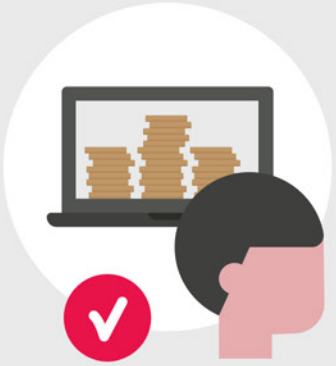
Chart 3

Consensus mechanisms

A consensus mechanism is a joint set of rules that ensures that the network participants can reach consensus on the integrity of data, i.e. who owns which assets. There are several types of consensus mechanisms, but the most widely used in blockchain technology are called proof-of-work and proof-of-stake. A joint feature of these mechanisms is that they try to give the participants an incentive to verify the transaction blocks correctly.

Proof-of-work

In a proof-of-work consensus mechanism, the participant who first solves an energy-intensive mathematical puzzle will enable the final validation of the information in the transaction block in question.

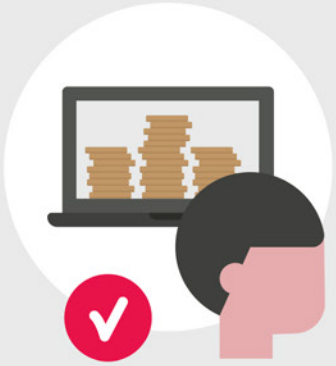


The participant who first solves the energy-intensive mathematical puzzle will be rewarded with the assets issued on the blockchain in question. There are typically many participants who are in competition with each other in solving the mathematical puzzle first, and as only one participant is rewarded, the energy used by the remaining participants' computers will have been wasted.

Being able to add a block of unlawful information requires that a participant is in possession of at least 51 per cent of the total computing power.

Proof-of-stake

In a proof-of-stake consensus mechanism, one participant is selected to solve the mathematical puzzle, which must be validated by the other network participants. The selection can be done by, for example, so-called staking, where one participant 'locks' a share of the participant's assets. The more assets that are locked, the more likely it is that the participant will be selected to solve the mathematical puzzle. This method is less energy-intensive relative to the proof-of-work consensus mechanism.

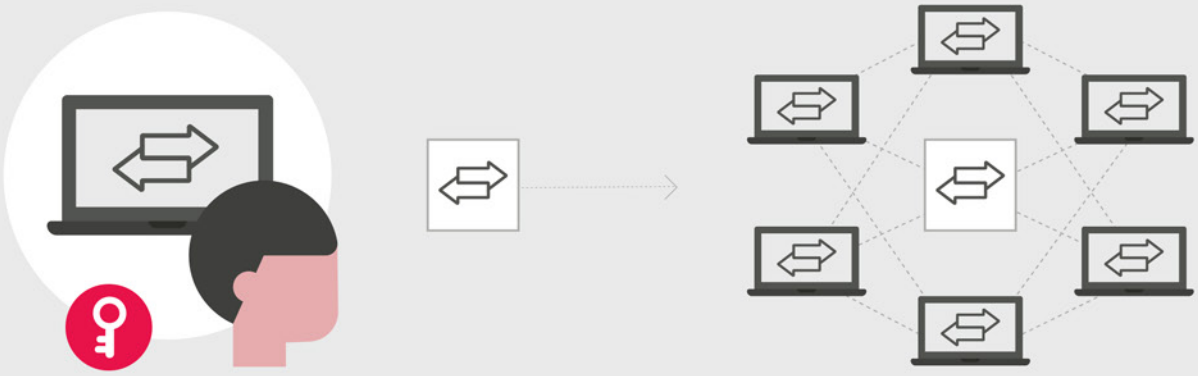


The participant who has been selected on the basis of the so-called staking and who solves the energy-intensive mathematical puzzle will be rewarded with assets issued on the blockchain in question.

Being able to add a block of unlawful information generally requires that a participant is in possession of 51 per cent of the total assets issued on the blockchain in question.

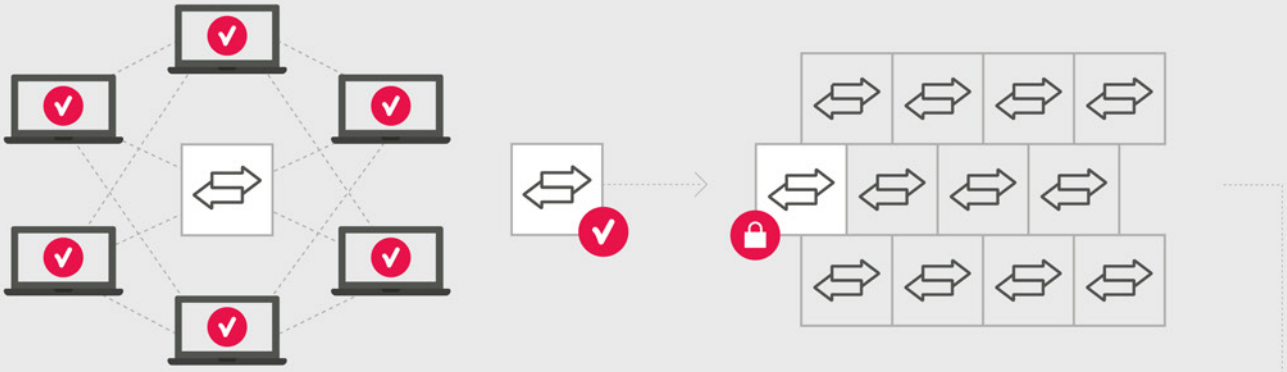
Chart 4

Registration of transactions on blockchain



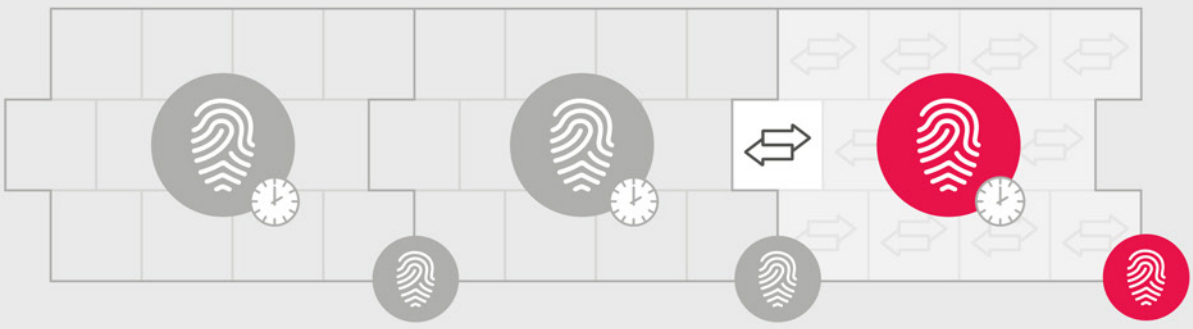
1. A transaction is initiated by a participant, e.g. a transfer of a crypto-asset to a given account holder. The participant signs the transaction with the participant's private key. A private key can be compared to a password which gives a right of disposal of an account holder's funds.

2. The transaction is shared with the network.



3. The transaction is verified using a consensus mechanism, see chart 3. This ensures the integrity of data, i.e. information about the validity of the transaction, including who owns which assets.

4. Once verified, the transaction is stored and locked in a transaction block. The transaction block is published on the public blockchain, and all participants can verify the validity of the transaction block.



5. The transaction blocks are encrypted and arranged in chronological order
Each transaction block contains data, including a timestamp, transaction data and a cryptographic fingerprint that also refers to the cryptographic fingerprint of the previous block. After the transaction block has been added to the chain of the previous transaction blocks, the transaction will be finally completed.

The verification is linked to a predominantly mechanically driven confirmation of ownership. This means that, as a general rule, matters such as the lawfulness of the origin of the funds or the purpose of the payment are not investigated. However, the high level of transparency makes it possible subsequently to investigate these matters.

The construction of blockchain technology also contributes to making it difficult to manipulate or modify data. In fact, the transaction blocks are arranged in chronological order and are linked together with so-called cryptographic 'fingerprints', which contain information about the previous block. This is, for example, the basis of the built-in security of the technology. The opportunities and challenges of the technology are described in further detail in box 2.

Applications of blockchains

A blockchain can be designed in different ways, and the design is of importance to the properties and applications of the blockchain in question. Some blockchains can solely be used to transfer

Blockchain technology – opportunities and challenges

Box 2

Blockchains can be designed in different ways, and most options entail both advantages and disadvantages. In particular, the blockchains that are prevalent today are especially characterised by the following options and challenges:

Options

Omission of third parties: The consensus mechanism ensures that the network participants can agree on the integrity of data. A central third party for registration and verification of information can thus be omitted.

Automation: Some blockchains allow the implementation of so-called smart contracts. Smart contracts are computer programs that can contribute to automatic execution of actions – for example, the exchange of values – according to the terms of a contract. Smart contracts can thus contribute to assets becoming programmable, meaning that the assets can be programmed to perform an action when a number of specific conditions have been met. As the actions are self-executing, and if both parties trust the underlying code, there is no need for a central authority or a third party to run the processes manually or to establish the necessary trust. The smart contracts can be used to implement so-called decentralised financial services (DeFi services). The programmability can, for example, be used for corporate payments, thus reducing a number of manual procedures.[1]

Increased transparency: A decentralised database gives all participants access to the same data and thus insight into all transactions in the network.

Increased robustness: By using blockchain technology copies of the database are shared among the participants. This implies, that a system crash or a hacker attack at one participant will not compromise the database, as the other network participants have copies of the uncompromised database.

Challenges in relation to capacity and scalability

Transaction speed: Especially the blockchains that use proof-of-work consensus mechanisms can take a long time to complete payments relative to the current payment systems.

High fees: Periods with only a few participants to verify transactions or a high transaction volume may result in an increase in transaction fees. The fees are intended to compensate the participants that validate the transactions on the blockchain for their energy costs.

High energy consumption: The blockchains that use proof-of-work consensus mechanisms are very energy-intensive, as there will be many participants trying to solve the energy-intensive mathematical puzzle.

Lack of interoperability: At present, interoperability, i.e. the capacity of different systems to communicate with each other, is limited for some blockchains. Interoperability is of significant importance to an efficient exchange of data between systems. Therefore, trials have been initiated with both the establishment of bridges between blockchains and the establishment of separate ecosystems that can contain different blockchains that are able to communicate with each other.

The above challenges constitute a restriction on the scalability of the network, but an attempt is made to solve the problem through the development and implementation of more efficient consensus mechanisms, among other measures.

1. For example, the company ZTLment ApS (ZTLment), which conducted a test course under the Danish Financial Supervisory Authority during 2021, uses smart contracts on blockchain to settle business-to-business payments in real time using e-money tokens. ZTLment's payment solution is integrated on platforms that digitise the processes for concluding and documenting purchase agreements between buyers and sellers, see The Danish Financial Supervisory Authority, *Blockchain technology can provide efficient infrastructure for payment services*, February 2022 (*link*).

specific assets, while other blockchains allow for the implementation of decentralised financial services, also known as DeFi services.[20] DeFi services differ from other financial services in that there is no central party, for example a bank, which is responsible for facilitating them. Instead, the network participants can themselves program and implement financial services on blockchains via smart services by using so-called smart contracts, see box 2 for further details on this.

Blockchain technology is also used in non-financial contexts. The technology is today especially used in industries in which efficient supply chains are essential, for example in shipping. Here, the security and transparency of blockchain technology are used to, for example, track goods through a supply chain. Tracking can be done by the respective stages of the supply chain registering when the item is received and forwarded to the next stage of the supply chain. Anyone with access to the blockchain in question can track the journey of an item through the supply chain at a highly detailed level. And the construction of the blockchain technology makes it difficult for an actor in the supply chain subsequently to manipulate data concerning a consignment.

The prevalence of a blockchain, including how attractive a given blockchain is, depends to a great extent on network effects. Network effects occur when the value of a product or service is affected by how many users already use it. Therefore, blockchains with many participants are more attractive to new users, as there are more users to whom a service can be sold or from whom a service can be bought. The importance of network effects in relation to the prevalence of blockchains does not differ much from the importance of network effects in the payment systems that we use today. However, network effects are of particular importance in blockchain technology. The more participants who are on the network and have a copy of the database, the harder it will be to compromise the database information.

As previously mentioned, blockchain technology can be used in many contexts, but it has attracted much attention since the introduction of crypto-assets. Crypto-assets rely on blockchain technology and utilise some of the advantages offered by this technology. The following section describe crypto-assets and address the question of whether they can become new types of well-functioning digital money.

Crypto-assets

Crypto-assets are defined by the European Commission as a digital representation of value or rights which may be transferred and stored electronically, using distributed ledger technology (DLT) or similar technology.[21] The definition of crypto-assets covers many types of assets. This analysis distinguishes between crypto-assets that are pegged to other assets and crypto-assets that are not backed by other assets.

Unbacked crypto-assets

Unbacked crypto-assets (such as Bitcoin and Ethereum) are not based on or valued on the basis of the value of other assets. There are thus no underlying tangible assets, liquidity or capital to support the value of the crypto-assets.

These crypto-assets are associated with much speculation. Investors trade the assets in the hope of cashing in on a price gain based on expectations of how large the demand from other investors will be in the future. Some also argue that there is a value attached to the possible future use of the blockchain underlying the crypto-asset in question. As described in the previous section, blockchains have various applications. Investments will therefore follow the crypto-assets that are issued on blockchains which offer applications that are regarded as the most promising. Such speculation contributes to the price of unbacked crypto-assets being driven by, among other factors, shifts in expectations with resulting large price changes, see chart 5.

The absence of the underlying values and the large fluctuations in the value of crypto-assets have been pointed out by the European System of Financial Supervision, the European Central Bank, the Danish Financial Supervisory Authority and Danmarks

20 For example, the blockchain on which the crypto-asset Ethereum is based allows developers to code contracts and financial services on the blockchain themselves, while the blockchain on which the crypto-asset Bitcoin is based solely allows the transfer of bitcoins.

21 See Regulation of the *European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937*, September 2020 (*link*).

Nationalbank. These have emphasised that there is no regulation that sets the framework for how complex, non-transparent and risky an investment in crypto-assets may be.[22] Due to, inter alia, their volatility, unbacked crypto-assets have therefore not proven to be well-functioning as money.

Backed crypto-assets
Backed crypto-assets (such as USD Coin and Tether) that follow the value of currencies, commodities or other crypto-assets are often referred to as stablecoins. They can be further divided into two categories:

- Asset-referenced tokens: Stablecoins which follow the value of several different assets, for example currencies, commodities or other crypto-assets
- E-money tokens: Stablecoins which follow the value of one currency. Examples of e-money tokens are Tether and USD Coin, both of which are sought pegged to the dollar.

There are also stablecoins that seek to maintain a stable value by, for example, letting algorithms adjust the supply of stablecoins in circulation. Such stablecoins are called algorithmic stablecoins.

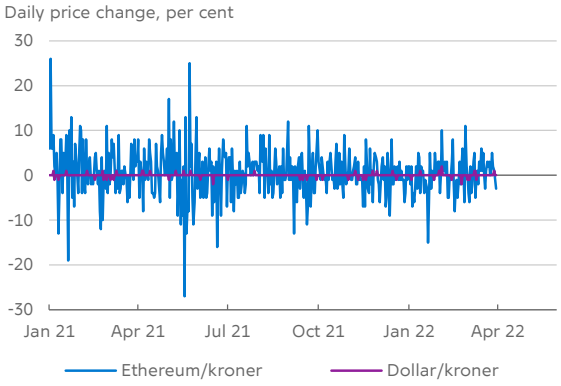
Most stablecoins require a central actor, such as a commercial company or a bank, which can manage the reserve to which the crypto-asset is pegged. In practice, this means that the funds generated through the issue of the crypto-asset are placed in the assets, the value of which the stablecoin is stated to follow. Buyers and investors can thus exchange their stablecoins for the assets, the value of which the stablecoin in question is stated to follow, and this may, for example, contribute to the asset maintaining a stable value. A secure reserve is essential in meeting the investors' expectation that they will be able to exchange the crypto-asset. Stablecoins thus have certain similarities with e-money, see box 3.

Although stablecoins are issued via a central actor, the infrastructure that is used to execute the trans-

22 See The Danish Financial Supervisory Authority, *Warning – Cryptocurrency market is an Eldorado for scammers*, March 2022 (*link*) (*in Danish only*); The European Banking Authority, *EU financial regulators warn consumers on the risks of crypto-assets*, March 2022 (*link*); and The European Central Bank, *Decrypting financial stability risks in crypto-asset markets*, May 2022 (*link*).

Daily price change
Ethereum kroner and dollar kroner

Chart 5



Note: The daily percentage change in the price of the unbacked crypto-asset Ethereum and the exchange rate between kroner and dollar.
Source: See Yahoo Finance (*link*) and Danmarks Nationalbank (*link*).

Stablecoins and e-money – similarities and differences

Box 3

Stablecoins have certain similarities with e-money, as the issuer correspondingly places the funds in bank accounts, and as it is not generally allowed to use these deposits for, for example, on-lending or investments. Some issuers of stablecoins comply with the requirements for e-money institutions, and these issuers have thus obtained an e-money licence.[1]

One difference between issuers of e-money and issuers of stablecoins (which do not have an e-money licence) is that e-money issuers are subject to requirements for the company's management and the structure of the company's organisation etc. There are currently not the same requirements for stablecoin issuers, but it will become a requirement in the EU when the Regulation on Markets in Crypto-assets enters into force, see box 4.

Another key difference between e-money and stablecoins is that stablecoins always use blockchain as infrastructure, while e-money is defined as an electronically or magnetically stored monetary value, which consequently does not necessarily use blockchain as infrastructure.

1. For example, the company Monerium, which issues a stablecoin that follows the exchange rate of the euro, see Monerium, 2022 (*link*).

actions is typically based on a blockchain and is thus decentralised. The registration of ownership and transactions is thus shared in a database distributed to all the network participants.[23] Therefore, stablecoins can be exchanged without a central actor handling the transaction.

Stablecoins – trust and stability?

Whether stablecoins can be a well-functioning means of payment will depend in particular on trust and stability. Although the word 'stable' forms part of the term stablecoins, not all issuers of stablecoins are in practice able to ensure that the stablecoins in question follow the value of the associated asset[24]. As previously described, trust and stability are key elements in widespread and accepted use of a means of payment.

Regulation is of completely central importance in ensuring trust in and stability of stablecoins. Although some stablecoins have certain similarities with other financial services and products, see box 3, the current regulation is very limited. New financial services and products, regardless of the technology on which they rely, should be regulated in the same way as similar regulated services that contain the same risks. Uniform regulation can contribute to more effective competition and better consumer protection and can prevent providers from circumventing financial regulation by offering services which, in practice, resemble existing services, but which are not subject to the same requirements. For stablecoins, this is particularly relevant as a stablecoin issued in one country, under a given legislation, can easily be traded online by users residing in other countries with different legislation. There is consequently a need for internationally coordinated efforts to regulate stablecoins so that, among other measures, the stability of the asset is ensured and users can securely trade the assets.

There is currently no regulation in the EU targeted at issuers of stablecoins. However, this will change once the Regulation on Markets in Crypto-assets enters into force, see box 4. The Regulation lays down a number of specific requirements which providers of stablecoins must meet in order to be in compliance with the regulatory framework. This may, for example, help build trust among citizens and merchants that use stablecoins.

Applications of stablecoins

Although stablecoins are not currently widely used and accepted as a means of payment, the market value of some stablecoins is nevertheless increasing rapidly.[25] One of the reasons for this increase is the other application options that the assets offer.

Stablecoins can inter alia be used for DeFi services on blockchain, for example borrowing and lending. Stablecoins can also be used as a more secure investment of funds than other crypto-assets. Investors can thus exchange funds placed in, for example, unbacked crypto-assets that fluctuate widely in value with stablecoins that have a less unsecure value. This reduces the need to exchange crypto-assets with conventional secure means, such as fiat money, and allows investors to be independent of systems that are not connected to the blockchain. Independence from systems that are not blockchain-based is particularly important, as exchanges between conventional currencies and crypto-assets may be costly. The reason for this is that a fee is typically charged from, for example, a trading platform that facilitates the transaction between conventional currencies and

23 The network participants will not be able to gain insight into who owns the assets in question, but will instead acquire knowledge of the number of the so-called wallet in which the funds are placed. A wallet can be equated with an account.

24 Not all issuers of stablecoins manage to maintain a stable value and thus ensure that buyers or investors can exchange their stablecoins for the assets, the value of which the stablecoin in question follows. In particular, for some types of algorithmic stablecoins, there have been examples where even minor value fluctuations have led to uncertainty among the investors, with resulting sharp declines in the value. An example of this is the algorithmic stablecoin Terra, which, in just a few days in May 2022, fell from a value of just under 1 dollar to 0.1 dollar. Terra had a reserve consisting of the crypto-asset Luna. Luna has been issued by a fund that held a reserve primarily consisting of unbacked crypto-assets. The incident meant that Tether, the world's most widely used stablecoin stated by market capitalisation, had briefly to abandon its pegging to the dollar.

25 The market capitalisation of the ten largest stablecoins was 36.48 billion dollars in January 2021. In January 2022, the market capitalisation of the very same stablecoins was 167.77 billion dollars, see Statista, 2022 (*link*).

crypto-assets. The fee comprises the costs connected with the operation of the platform, examination of customers and the sources of their funds, so-called know-your-customer checks and money laundering checks.

The use of stablecoins as a means of payment for blockchain services depends to a great extent on network effects. More and better financial services, implemented on a given blockchain, can attract more users to the network. Therefore, it is expected that the use of stablecoins will increase in line with the development of new financial services on blockchain. Stablecoins which achieve large cross-border distribution are called global stablecoins.

Global stablecoins – opportunities and risks
Global stablecoins entail new opportunities for citizens and companies, but may also entail certain risks.

The opportunities offered by global stablecoins include that they can lead to more efficient payments and increased competition by challenging

Regulation of crypto-assets Box 4

At present, there is no regulation specifically targeting crypto-assets. Some crypto-assets are currently regulated by existing legislation, for example rules for e-money, securities, consumer goods, while other crypto-assets fall outside the existing rules. The crypto-assets that are not covered by the existing legislation are thus not subject to relevant supervision by authorities. The fact that some crypto-assets are not supervised may mean that consumers and investors are not protected against the risks related to crypto-asset investments.

Moreover, lack of financial regulation may be an obstacle to innovation, as issuers do not have legal clarity about which activities are legal and which are illegal. For users, a lack of legal clarity may lead to scepticism and distrust towards the unregulated issuer. It is, for example, important to have knowledge of what rights you have as a consumer if the issuer enters into liquidation.

However, the growing interest in crypto-assets has led to several regulatory initiatives, including the European Commission's Proposal for a Regulation on Markets in Crypto-assets, also known as MiCA, and the European Commission's anti-money laundering package.

The Regulation on Markets in Crypto-assets (MiCA Regulation) was tabled by the European Commission in September 2020.[1] The purpose of the Regulation is to regulate issuers of crypto-assets and providers of services related to crypto-assets, for example trading platforms that offer purchases and sales of crypto-assets. The Regulation proposes that an undertaking must apply for a licence from relevant authorities if it wishes to issue crypto-assets or provide services related to crypto-assets. Under the MiCA Regulation, issuers of asset-based tokens and e-money tokens (referred to as stablecoins in this analysis) will be subject to requirements for good practice, including that issuers must act honestly, fairly and professionally. In addition, the issuers are subject to capital adequacy requirements, organisational requirements and requirements for the composition of the underlying reserve. Finally, the Regulation also contains a number of requirements aimed at ensuring consumer and investor protection. For example, issuers of crypto-assets are subject to requirements for how the consumer's paid-up funds with the issuer may be placed and, for certain types of crypto-assets, consumers have the right to redeem the crypto-asset in question and thus recover deposited funds. The requirement for regulatory oversight of issuers also contributes to making it possible for consumers to distinguish between, on the one hand, assets issued by undertakings that are subject to requirements and oversight by relevant authorities, and, on the other hand, assets that are not subject to the above requirements. However, the term 'stablecoin' is not defined under MiCA, which means that issuers that designate their assets as being stablecoins cannot simply expect to have obtained a licence to issue e-money tokens or asset-referenced tokens.

In July 2021, the European Commission tabled an anti-money laundering package containing proposed amendments to the Funds Transfer Regulation regarding crypto-assets. The proposal requires providers of crypto-assets and accompanying services to store information about sellers and buyers of crypto-assets. The aim is to contribute to facilitating the tracking of crypto-assets.

1. See Regulation of the European Commission and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937, September 2020 (*link*) and see The Danish Financial Supervisory Authority, *New Anti-Money Laundering Package from the Commission*, July 2021 (*link*) (in *Danish only*).

the established providers of financial services.[26] At present, stablecoins can only be used as a means of payment in very few places, and the holder will therefore need to exchange stablecoins to fiat money in order to use them for payments. If stablecoins become a widespread means of payment, this exchange between stablecoins and conventional currencies will become less necessary.

However, there are also risks associated with global stablecoins, including in relation to fragmentation of the payment market, hampered competition and innovation as well as lack of consumer protection. Fragmentation of the payments market may result in providers of global stablecoins achieving a market dominance due to strong network effects to the detriment of competition. There is also a risk that global stablecoins may lead to closed ecosystems in which private companies can decide which citizens and merchants are to have access to the stablecoin in question. Thus, those citizens or companies that do not have access to the network will have poorer conditions than those that have access. This may hamper competition and innovation. Finally, global stablecoins are also associated with risks related to consumer protection, mainly as a result of a lack of regulation.[27]

Coming EU regulation does not directly address the concept of 'stablecoins', which means that there will, in parallel, be providers both with and without the relevant licence that use the designation for their product. However, the regulation will, among other effects, mean that, in future, some stablecoins can be classified as e-money tokens and asset-referenced tokens, respectively, provided that they meet a number of requirements.

It is important to manage these risks before stablecoins can provide a real alternative to today's digital money. The potential of stablecoins supplementing the present types of digital money thereby depends on how they specifically are regulated, including whether the regulation proves effective and whether their distribution brings advantages to citizens and society.

Wholesale central bank digital currency based on DLT

Several central banks are experimenting with using DLT and blockchain technology for paymentsbetween banks and other financial actors. This is typically referred to as wholesale CBDC and covers the use of DLT to improve the functionality of the central bank digital currencies to which private banks already have access.

Central banks are examining whether the use of DLT could usefully become part of the future development of the payments infrastructure between banks and other key financial actors.

Today, banks and other actors of importance to the settlement of payments have direct access to an account in Danmarks Nationalbank – and thus also to central bank digital currency. An account with Danmarks Nationalbank provides access to the central financial infrastructure, thus enabling both instant payments[28] and settlement of securities transactions for the banks and their customers. This infrastructure is the result of a continuous development that has taken place in collaboration between the financial sector and Danmarks Nationalbank.

Experiments with wholesale CBDC in other central banks indicate that DLT and blockchain technology have the potential to supplement the existing infrastructure in some areas, see box 5. The experiments explore the possibility of, for example, streamlining cross-border payments between different currencies.

In 2020, Danmarks Nationalbank decided to migrate the exchange of interbank payments (the so-called settlement of payments) in Danish kroner from the Danish platform, Kronos2, to the pan-European payment and securities settlement platform, TARGET Services, in 2025. In addition, Danmarks Nationalbank follows experiments in other central banks closely.

The migration of settlement in Danish kroner to TARGET Services supports closer cooperation with

26 See Bank for International Settlements, *Investigating the impact of global stablecoins*, October 2019 (*link*).

27 See Bank for International Settlements, *Stablecoins: risks, potential and regulation*, November 2020 (*link*).

28 With instant payments, the money is deposited into the recipient's account within seconds, 24 hours a day, 365 days a year.

other central banks in Europe and provides an opportunity to achieve the economies of scale of a common IT platform. TARGET Services is a modern system that supports the joint initiatives and co-operation of central banks aimed at ensuring a safe and efficient settlement of payments, currencies and securities. It will be a strong foundation for the future development, including considerations regarding DLT as a supplement to the existing system.

TARGET Services also includes the European Central Bank's TARGET Instant Payment Settlement (TIPS) platform. Here, Danmarks Nationalbank participates in the study of the possibility of expanding TIPS to settlement of cross-border instant payments across the connected currencies. This work shows that development of centralised (rather than decentralised) systems may potentially also meet some of the challenges that are typically addressed in experiments with wholesale CBDC.

Although citizens and companies do not have direct access to the central financial infrastructure or a potential wholesale CBDC, better solutions for the direct participants will also lead to improvements for the customers. The introduction of the Straksclearing system has, for example, made instant payments possible for the Danes and is the foundation of the mobile payment solution MobilePay. In the Straksclearing system, the banks' customers can make account-to-account transfers, for example online banking transactions, that are received by the recipient immediately after the transfer has been made. The system is owned by Finance Denmark and was introduced in 2014.

Wholesale CBDC – interbank payments based on DLT Box 5

Several studies have shown that DLT and blockchain technology may potentially lead to faster and more efficient payments between financial institutions.[1]

For example, the Swiss Central Bank has, in cooperation with BIS Innovation Hub and a Swiss financial infrastructure provider, SIX, executed various types of transactions between financial institutions in real time based on DLT. Correspondingly, in cooperation with the French and Swiss central banks as well as a number of private actors, BIS has executed cross-border payments across currencies using DLT.

Provisional results indicate that the new technology could provide the basis for faster cross-border payments across currencies between financial institutions. At the same time, a number of processes can be automated, which provides a potential for transactions that are less resource-intensive and have lower costs.

However, efficient cross-border payments do not depend solely on the technology used. For example, there are also challenges regarding different IT systems, different regulation and currency conversion. These challenges apply regardless of the underlying systems or technology used and require increased international cooperation and harmonised regulation.

1. See Bank for International Settlements, *Project Jura: cross-border settlement using wholesale CBDC*, December 2021 (*link*) and Bank for International Settlements, *Project Helvetia: A multi-phase investigation on the settlement of tokenised assets in central bank money*, January 2022 (*link*).

Central bank digital currency for citizens

In recent years, a number of central banks have investigated the opportunities and challenges of issuing a central bank digital currency to citizens and companies. In this analysis, this is referred to as retail CBDC.

Basically, a retail CBDC is a direct digital claim on a central bank for citizens and companies.

In Denmark, a retail CBDC would, in practice, mean that Danmarks Nationalbank issued digital money to citizens and companies. The question of a retail CBDC is primarily an institutional matter regarding the structure of the financial system, which is of importance to the private sector, central banks and other institutions' demarcation and role. A decision to issue a retail CBDC will not necessarily require amendments to legislation, but will reasonably require a thorough public debate and political decision, see box 6.

The following sections take a closer look at central banks' reasons for examining the use of a retail CBDC. It is also reviewed how new types of central bank digital currencies can be designed, including possible costs and risks. This is followed by a description of possible consequences if stablecoins or other countries' CBDCs gain a foothold in Denmark. Finally, Danmarks Nationalbank's approach to working with a retail CBDC is presented.

Great variation in reasons for examining CBDC
Several central banks have explored the use of a retail CBDC for a number of years. For example, the Chinese and Swedish central banks, as well as the European Central Bank, are examining the use of a retail CBDC in depth, and the banks have launched pilot projects or specific investigative phases.

Only three central banks – Central Bank of Bahamas, Central Bank of Nigeria and The Eastern Caribbean Central Bank – had issued a retail CBDC in 2022.[29] The vast majority of the countries that are examining CBDC or conducting tests have thus not made a final decision on whether to issue a CBDC.[30]

The reasons for central banks' increased focus on this area differ widely, see chart 6.

To increase financial inclusion
The wish for increased financial inclusion, i.e. that citizens have access to financial services, is a key reason for examining the use of a retail CBDC in emerging market economies, in which many citizens do not have a bank account. Low financial inclusion is a challenge in many countries, and a retail CBDC can be a means of increasing this inclusion. A joint feature of the countries in which a CBDC has been introduced so far is precisely a wish for higher financial inclusion and the spread of digital payment solutions.

Denmark stands out from many other countries by being a highly digitalised society in which all citizens are entitled to a basic payment account.[31] At the same time, benefits from the public sector can generally only be received as transfers to a bank account. These factors mean that virtually all Danes have a bank account, and that there are only very limited challenges in relation to financial inclusion in Denmark. In other countries with well-developed financial systems and high financial inclusion, other reasons for looking into the use of a retail CBDC are typically also mentioned.

The issue of a retail CBDC in Denmark requires a public debate and political decision Box 6

Danmarks Nationalbank's objects are laid down in the National Bank of Denmark Act. Section 1 of this Act stipulates that the object of Danmarks Nationalbank is to maintain a safe and secure currency system in this country, and to facilitate and regulate the traffic in money and the extension of credit.

As long as the construction of a retail CBDC falls within the objects clause in section 1 of the National Bank of Denmark Act, there are no other provisions in the legislation that prevent the issue thereof. However, an extension of the tasks of Danmarks Nationalbank to comprise the issue of a retail CBDC will involve such major changes to the financial system that a decision on this will require a thorough prior political and public discussion and debate. In such a situation, Danmarks Nationalbank would also involve the political system to obtain a parliamentary decision.

If a retail CBDC is to have the status as legal tender, i.e. where a retail CBDC as a rule can be used to purchase goods and services, this will have to be established by law.

1. Legal tender is the means of payment that you have the right to use for acquisition of goods and services or to discharge yourself from a payment obligation in Denmark. Unless there is another agreement or special statutory provisions, for example the anti-money laundering legislation, Danish banknotes and coins are always legal tender, see section 8 of the National Bank of Denmark Act and section 4 of the Danish Coinage Act.

To ensure citizens of access to central bank digital currency

Several central banks have mentioned the declining use of cash for payments as a major reason for examining the use of a retail CBDC. Among others, the European Central Bank and the Swedish Central Bank have pointed out that there may be a risk connected with a declining use and stocks of cash. However, no central banks have expressed plans to phase out cash.[32]

29 See Atlantic Council, CBDC tracker, June 2022 (*link*).

30 See Federal Reserve, *Money and Payments: The U.S. Dollar in the Age of Digital Transformation*, January 2022 (*link*) and Bank for International Settlements, *Rise of central bank digital currencies: drivers, approaches and technologies*, August 2020 (*link*).

31 The Danish Act on Payment Accounts, Act no. 375 of 27 April 2016 (as amended) means that all consumers have access to a basic payment account with a bank either free of charge or against a reasonable fee.

32 See The European Central Bank, *Central bank digital currencies: a monetary anchor for digital innovation*, November 2021 (*link*); The European Central Bank, *Central bank digital currencies: defining the problems, designing the solutions*, February 2022 (*link*); The International Monetary Fund, Behind the Scenes of Central Bank Digital Currency, *Fintech Notes*, no. 4, February 2022 (*link*) and Sveriges Riksbank, *E-krona*, January 2022 (*link*).

Chart 6

Central banks' reasons for investigating retail CBDC

- To increase financial inclusion
- To ensure citizens of access to central bank money
- To support wide application of new technology and innovation
- To strengthen future competition
- To strengthen critical infrastructure
- To restrict commercial exploitation of personal data
- To strengthen operational resilience and cybersecurity
- To prevent currency substitution

The role of central bank money in relation to citizens' trust in money and financial stability in general is a complex issue that concerns a number of fundamental properties of the financial system. A modern economy without some form of central bank money will be an innovation, and the consequences thereof are therefore necessarily unknown.[33]

The European Central Bank states that trust in digital money is based on the possibility of converting it into central bank money, i.e. cash.[34]

According to some central banks, the existence of central bank currency ensures parity, i.e. equal value, between the digital money of different providers in the sense that money offered by a given bank can always be exchanged for central bank money and from there exchanged for money offered by another bank. In this way, an argument is presented for an expedient co-existence of central bank money and private money as an essential element in ensuring efficient payments and financial stability.

For a retail CBDC to have a given role as an anchor that ensures trust in the digital money issued by the banks, requirements for its design may be needed. For example, restrictions on stocks of a retail CBDC may be of importance to its usefulness in terms of constituting a safe and secure alternative to private money and the possibility of exchanging bank deposits for central bank digital currency.

From a Danish perspective, there are certain factors that indicate that cash does not necessarily play an anchoring role in the trust in private money. These factors include declining use of cash, that cash is not used as a store of value because it is central bank money, and that instant payments and regulation help ensure trust in private money, see the following sections.

Digital money is used for the vast majority of all transactions in Denmark. The decline in the use of cash has primarily been driven by citizens' use of digital solutions instead of cash. Furthermore, savings and holding of funds are also primarily in digital money, i.e. bank deposits, rather than cash. The small proportion of citizens who save up in cash state the possibility of anonymity as their primary reason.[35] There is thus nothing to indicate that citizens use and hold cash because they regard it as more secure than bank deposits. The prevalence of instant payments in Denmark also contributes to ensuring the trust in digital money. Instant payments entail that the individual citizen can quickly transfer money from one bank to another. This can support trust in bank deposits because they are available around the clock and can quickly be placed where the citizen has the most trust.

Effective regulation of banks also helps ensure trust in private money in Denmark. One of the reasons for this is that the deposit guarantee scheme covers the citizen's funds by up to approx. kr. 750,000 per bank in the event of liquidation, and that payments with private money are ultimately settled in central bank money.

The above factors thus indicate that access to central bank money in the form of cash does not immediately play an anchoring role in the trust in private money.

33 See The European Parliament, *The digital euro: policy implications and perspectives*, January 2022 (*link*).

34 See The European Central Bank, *Central bank digital currencies: a monetary anchor for digital innovation*, November 2021 (*link*) and The European Central Bank, *Central bank digital currencies: defining the problems, designing the solutions*, February 2022 (*link*).

35 See Danmarks Nationalbank, *The use of cash in society, Danmarks Nationalbank Analysis*, no. 3, February 2022 (*link*).

Although the vast majority of payments are made using private digital money offered by banks, these are still anchored in central bank currency regardless of the prevalence of cash. Central bank currency (in digital form) is the basis for the settlement of inter-bank transactions, as these are executed using the banks' central bank deposits. This helps ensure parity between private money and central bank money.

At present, it is difficult to ascertain whether a retail CBDC can contribute to or is essential in ensuring the same trust going forward. New types of digital money offered by private actors and the use of new technology may be of importance to the relevance of new types of central bank digital currency. If the development goes in a direction in which citizens choose to use a number of competing types of digital money, including global stablecoins with different origins, functionality and regulatory frameworks, this could mean greater uncertainty about the security and value of money. A highly fragmented private supply of different types of digital money with varying security and risks may be inexpedient. In such a situation, a central bank digital currency can be perceived as more secure than private bank deposits, which may potentially increase the relevance of digital central bank currency for the creation of a secure and stable alternative to private money. For these reasons, among others, Danmarks Nationalbank is closely monitoring the development in this area.

To support wide application of new technology and innovation

As a reason for a retail CBDC, some central banks state that the development of a payment system for the exchange of retail CBDC can provide the basis for a wide application of new technology which can lead to new and innovative solutions for the benefit of citizens and companies. This reason must be seen in the light of a scenario in which global stablecoins issued by, for example, big tech companies entail that new innovative blockchain-based solutions do not achieve wide application in society, but are instead concentrated around a few ecosystems offered by big tech companies.

If financial assets and general services are increasingly offered on blockchains, a need may arise for digital money based on the same technology. When both the service and the money used for trading it apply blockchain technology, it will be possible to use smart contracts and new and more innovative ways of executing payments than is the case today. A demand for digital money for such technology can be met by either the private sector or the public sector. If private actors' supply of new types of digital money becomes market forming, the connected technology and standards could lead to solutions offered by private actors being gathered around a few providers due to large network effects.

According to some central banks, blockchain technology for handling CBDC can provide a public open payment platform with a number of rules and standards on which private actors can develop innovative citizens' payment solutions.[36] Instead of connected services and solutions being concentrated on a few private providers, an open public platform can contribute to wider application of new solutions where network effects can benefit a larger circle of actors.

Blockchain technology for handling CBDC is likely to provide a basis for the same new types of services seen as those seen for stablecoins. This applies, for example, to the development of smart contracts and programmable money, where the funds can be programmed automatically to execute a number of actions under specific conditions. Such solutions could become available to a wide range of users and providers.

More common measures are also likely to contribute to innovative use of new technologies. This may, for example, be in the form of international development cooperation, including common standards for the use of new technology. Furthermore, an open blockchain-based platform does not necessarily require the issuance of CBDC to citizens and companies. The work to improve the infrastructure to create a better basis for new technological solutions can also make use of private money. There is thus nothing to prevent bank deposits from being based on blockchain technology. Such measures can also contribute to more companies having equal opportunities for developing new payment solutions, and the measures can also ensure wide application of new technology.

36 See Bank for International Settlements, *Annual Economic Report 2021: III. CBDCs: an opportunity for the monetary system*, June 2021 (*link*).

To strengthen future competition
Several central banks mention CBDC as a safeguard against the potential risks that may be connected with global stablecoins. Global stablecoins may entail a risk of the creation of so-called market silos, i.e. closed ecosystems with large market power, to the detriment of competition and innovation.[37]

Several central banks thus see payment systems for handling a retail CBDC as a means of increasing competition in relation to both existing and potential actors.[38] This may, in particular, be the case where it is not possible to achieve effective and consistent regulation that prevents an inexpedient development in this area.

Unlike digital money offered by private companies, an open payment system for handling a retail CBDC can mean that banks and other payment service providers will have access on equal terms to offer innovative citizen-oriented solutions for the benefit of citizens and companies in competition with each other.[39]

Overall, it is difficult to assess whether any supply of retail CBDC and connected open payment systems by central banks may, in practice, reduce potential market failures. It is a complex question whether, from a societal perspective, a retail CBDC is more expedient than regulatory measures to prevent future restrictions of competition and ensure innovation. This requires thorough analyses.

To strengthen critical infrastructure
The use of a retail CBDC is also being studied to investigate whether critical infrastructure such as central payment systems can become more independent of foreign-owned companies. There may be various reasons why a country wants to maintain control of critical infrastructure. Such problems are directly connected with wider considerations of societal autonomy.[40]

With an open platform for handling a retail CBDC, private foreign actors will still have the opportunity to develop solutions based on the retail CBDC. Such a measure will thus not necessarily prevent foreign ownership of certain parts of the infrastructure. Foreign-owned companies such as foreign payment service providers will still be able to play a key role in the dissemination of a given retail CBDC if they develop attractive consumer-facing solutions on the basis of a retail CBDC.

The degree of independence of foreign-owned companies in connection with a retail CBDC will also be of importance to the integration with existing systems: Greater independence of foreign-owned companies will, other things being equal, make a retail CBDC less useful compared to existing payment solutions. In such case, it may be necessary to develop costly parallel infrastructures.

Foreign ownership is already a fact in large parts of the financial infrastructure in Denmark.[41] But increased independence of foreign ownership does not necessarily require the development of a retail CBDC. Centralised payment systems that are independent of foreign companies could be developed and implemented without this requiring universal access to central bank digital currency, if this were a priority.

To restrict commercial exploitation of personal data
Digital money issued by private companies may lead to challenges in relation to commercial exploitation of sensitive personal data. A retail CBDC is likely to be more attractive from a consumer protection perspective than, for example, stablecoins offered by commercial companies. The reason for this difference is that central banks have no interest in commercial

37 See Bank of Canada, *Contingency Planning for a Central Bank Digital Currency*, February 2020 (*link*); and The European Central Bank, Central Bank Digital Currency: functional scope, pricing and controls, *Occasional Paper Series*, no. 286, December 2021 (*link*).

38 See Federal Reserve, *Money and Payments: The U.S. Dollar in the Age of Digital Transformation*, January 2022 (*link*) and The European Central Bank, *Report on a digital euro*, October 2022 (*link*).

39 See Bank for International Settlements, *Annual Economic Report 2021: III. CBDCs: an opportunity for the monetary system*, June 2021 (*link*).

40 The question of CBDC as a backup for other infrastructure is described in detail in Danmarks Nationalbank, Central bank digital currency in Denmark?, *Danmarks Nationalbank Analysis*, no. 28, December 2017 (*link*).

41 For example, Betalingsservice, which is a direct debit payment method, is owned by the American company MasterCard, while the national debit card scheme, Dankort, is owned by the Italian company Nexi.

exploitation of payment data.[42] Nevertheless, the processing of personal data will be necessary in connection with an account-based retail CBDC to ensure identification of the user, to enforce anti-money laundering rules and to perform know-your-customer checks etc. Personal data will thus be processed in connection with retail CBDC in the same way as ordinary deposits with private banks. However, personal data will not be used for commercial purposes in connection with a retail CBDC, as may be the case with other digital money.

If the purpose of a retail CBDC is to limit the commercial exploitation of payment data, it is a prerequisite that it is used in preference to other solutions from private actors. This requires that CBDC as a whole is assessed as attractive for citizens.

Another way to restrict commercial exploitation of personal data is to further develop existing regulation for protection of citizens' personal data.

To strengthen operational resilience and cybersecurity
Central banks are also examining whether a payment system based on retail CBDC may potentially increase the operational resilience of the financial system by constituting an alternative in the event of any breakdowns of existing systems.

The feasibility of using retail CBDC as a contingency measure will depend on the integration with existing systems. The more integrated a retail CBDC becomes with existing systems, for example with close interconnection to bank deposits and existing payment solutions, the less a retail CBDC can be used as a contingency measure in the event of breakdowns of the existing systems. Here, the dilemma is that integration with other systems and solutions may be decisive to whether a retail CBDC is attractive and useful for citizens.

However, if the purpose of a retail CBDC is that it must be able to function as a contingency measure, it should also be considered whether it is cost-effective to invest in a retail CBDC for precisely this purpose, rather than investing in improving security measures in the existing systems.[43] Or whether the development of an alternative payment system requires the issuance of retail CBDC.

In Denmark, it is today possible to make offline payments in retail stores with most payment cards. Card terminals collect transaction information, which is processed when the Internet is reestablished after a breakdown. The possibility of offline payments is thus an essential part of operational resilience in the financial sector. Therefore, central banks are exploring possible benefits of retail CBDC in connection with operational resilience, including the possibility of holding funds and executing offline payments in a situation with a breakdown in central infrastructure. Among other initiatives, Danmarks Nationalbank participates in this work under the auspices of the BIS Innovation Hub Nordic Centre.[44]

To prevent currency substitution
Retail CBDC is also mentioned as a potential safeguard against a foreign currency gaining a foothold in a country's financial system at the expense of the domestic currency – so-called currency substitution or dollarisation. Such a scenario presupposes that new types of digital money such as stablecoins or other countries' retail CBDCs are available and attractive to such an extent that citizens and companies are willing to handle them alongside the domestic currency. This may pose a threat to monetary sovereignty – i.e. the central government's ability to keep the domestic currency stable, see also the section on stablecoins or other countries' CBDCs in Denmark below.

Several central banks have mentioned the risk that stablecoins or other nations' retail CBDCs could potentially achieve greater prevalence than the national currency in some countries if these currencies can be accessed without restrictions. Such a risk is typically greatest in countries in which the domestic currency is not well functioning, for example due to challenges with financial stability and stable prices. In addition, it cannot be ruled out that new types of money such as stablecoins or foreign CBDCs may potentially constitute an attractive place

42 See The European Central Bank, *Designing a digital euro for the retail payments landscape of tomorrow*, November 2021 (*link*).

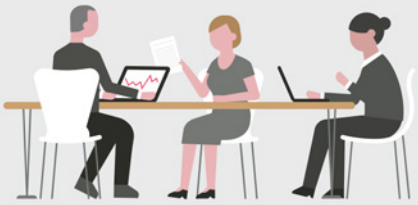
43 See Danmarks Nationalbank, Central bank digital currency in Denmark?, *Danmarks Nationalbank Analysis*, no. 28, December 2017 (*link*).

44 See Danmarks Nationalbank, *BIS Innovation Hub*, January 2022 (*link*).

Chart 7

Essential design choices in retail CBDC

- Functional form
- Distribution
- Personal identification
- Restrictions on applications
- Choice of technology



to hold funds in a financial crisis situation. In such a situation, a domestic CBDC may, in some countries, constitute an alternative that strengthens the use of the domestic currency.

The risk of currency substitution will largely depend on the restrictions that apply to the holding of the foreign currency. Unlimited access to a foreign currency – whether in the form of a retail CBDC or stablecoin – will, other things being equal, increase the risk of currency substitution in countries in which the domestic currency is not well functioning. The risk of currency substitution can be reduced through restrictions on citizens' holdings of a foreign CBDC or stablecoin.

Denmark has a well-developed financial infrastructure, financial stability and stable prices, and thus has a solid foundation for resisting currency substitution and challenges to its monetary sovereignty. In addition, the public sector uses Danish kroner. A significant part of the Danish economy thus consists of disbursements of public salaries, payments of public benefits, purchases of services and tax payments done in Danish kroner.

It will require further studies to establish whether a central government solution in the form of a retail CBDC is more expedient than regulatory measures in relation to preventing a foreign currency from having an inexpedient effect on monetary and financial stability. This assessment also includes the actions of other central banks and the degree of consistent and coordinated regulation across countries.

How a retail CBDC can be designed

As mentioned, a retail CBDC has been studied for several years by a number of central banks, but few have yet made a final decision on this matter. It emphasises that the decision on the issuance of a retail CBDC is complex and requires a wide range of institutional and technical considerations and choices.

A retail CBDC can be designed in many ways, and the financial and economic implications of its issuance will depend to a great extent on how a retail CBDC is designed. The issuance of a retail CBDC thus requires some basic considerations in relation to the purposes that any such retail CBDC is to meet and how it is to be disseminated and used in practice.

From the perspective of citizens and companies, the retail CBDC solutions that are being investigated among central banks will have many similarities with the digital money in the form of bank deposits used today.

Below, a description is provided of some of the significant design choices that may have an effect on the functionality and consequences of a retail CBDC.

Functional form

A retail CBDC can involve either local or central holding of funds.

Central holding is referred to as an account-based CBDC. In this model, the funds are held in a central account, which can be accessed from various electronic devices or via a connected digital wallet, i.e. a piece of software or an online service, which allows citizens and merchants to execute transactions. With an account-based CBDC, the citizen can thus make payments in the same way as with the money held in the ordinary online banking account.

An account-based solution will generally require some form of personal identification and verification via the Internet to access the account.

In case of local holding of funds, they are not held in an account, but locally on an electronic device, for example a smartphone. This solution is often referred to as a token-based model where the user can access the funds without Internet access because they are held locally. This can make it easier to make so-called offline payments than is the case with an account-based solution. Token-based solutions and offline functions will still require an underlying, recurring online updating of the registration of the ownership.

Distribution
Most pilot projects on retail CBDC involve some form of distribution via third parties. This means that even though any such CBDC is issued by the central bank, the acquisition and registration of holdings by citizens take place by means of, for example, banks, payment institutions or telecommunications operators.[45]

Those third parties thus handle the administration of the account containing CBDC. At the same time, there is the possibility that the central bank can maintain an ongoing inventory of the citizens' holdings with third parties. With such a model, the central bank will have the necessary information to ensure the citizens' CBDC holdings if a third party enters into liquidation. In addition, the third parties are also responsible for handling of anti-money laundering rules and know-your-customer checks. The central bank will thus not be the party responsible for the extensive administration in connection with the handling of customer relations, and the actors who already have retail solutions can service the citizens' use of retail CBDC.

Personal identification
A key question in retail CBDC is the consideration of user privacy, i.e. the degree to which data on the user and the individual transaction are collected and processed.[46] Just as cash payments can be made anonymously, similar options are being investigated in the context of retail CBDC.

However, an account-based solution will require some form of personal identification and verification to access the account. This means that anonymous payments are generally not possible. This is also connected with the anti-money laundering and know-your-customer check requirements which obligate banks to be able to identify who is making a given payment. When some central banks explore the possibility of an anonymous retail CBDC, this typically concerns transactions involving minor amounts.[47] In addition, the degree of personal verification may depend on, for example, the size of the transaction or on whether the transaction is executed physically or in e-commerce.

Restrictions on applications
Central banks that are examining the use of a retail CBDC often stress that such use is expected to be subject to a number of restrictions. Such restrictions may, for example, be in the form of a cap on the amount that can be held in the account, or restrictions on the number and size of transactions that may be executed. In such case these restrictions will require an interaction between existing payment systems so that funds exceeding a given limit are automatically transferred to linked bank accounts.

Alternatively, the applications offered by a retail CBDC can be restricted by introducing an interest rate on holdings above a certain amount that is less attractive than the interest rate offered by banks. This will reduce the holdings of retail CBDC.

The purpose of the restrictions is that a retail CBDC will be more suitable as a means of payment than as a storage of value. The cap and, in part, an unattractive interest rate for holdings above a given level can ensure that there is no significant reduction in commercial bank deposits as a result of citizens converting large amounts to retail CBDC.

A retail CBDC may affect the banks' business model, as they use bank deposits as a source of funding of their lending activities. For example, if the banks' deposit base is reduced or becomes less stable as a result of a retail CBDC, the banks must either reduce their lending or find alternative sources of funding. In such a situation, the banks can seek to compensate the loss of deposits by borrowing the money from the central bank. The increased lending to banks and deposits from citizens in the form of CBDC will, in practice, thus result in an increase in the central bank's balance sheet.[48]

45 See Bank for International Settlements, *Annual Economic Report 2021: III. CBDCs: an opportunity for the monetary system*, June 2021 (*link*) and People's Bank of China, *Progress of Research & Development of E-CNY in China*, July 2021 (*link*).

46 See The European Central Bank, *A digital euro to meet the expectations of the Europeans*, April 2021 (*link*).

47 See, for example, Sveriges Riksbank, *E-krona pilot Phase 1*, April 2021 (*link*).

48 See Danmarks Nationalbank, Central bank digital currency in Denmark?, *Danmarks Nationalbank Analysis,* no. 28, December 2017 (*link*).

If citizens transfer their deposits from the banks to the central bank, the banks' deposits are reduced. It will also immediately reduce the banks' net position vis-à-vis the central bank and will act as a so-called quantitative tightening. If the latter is inexpedient, this may require that Danmarks Nationalbank increases the net position in some other way.

A retail CBDC without restrictions will immediately increase the risk of systemic bank runs, with many households and companies withdrawing their deposits from the bank at the same time. Today, such bank runs may take place by deposits being converted into cash. A conversion of bank deposits into cash will take time, whereas a conversion into retail CBDC can be done immediately. This risk can be eliminated by setting a cap on the holdings of the retail CBDC.[49] In turn, the construction with a lower interest rate on deposits above a certain amount is unlikely to reduce the risk of bank runs. In times of crisis, citizens are likely to accept bearing a loss of interest against security of their total holdings of value.[50]

It is being widely debated internationally whether it is expedient that citizens can quickly convert large amounts into central bank currency – and thus also make a systemic run on the banks. The key aspect of an efficient financial system is that there is trust in the central parties involved in the system. This trust seems to be based primarily on an effective regulatory framework and the central bank's role in maintaining a stable value of the currency in question, and not on the possibility of being able to exchange bank deposits for cash at any given time.

Choice of technology
A retail CBDC can be based on conventional technology, i.e. a centrally controlled database, or on DLT. Both approaches have advantages and disadvantages.[51]

The advantages of using DLT and blockchain technology may, for example, consist in ensuring backup of systems, because the registration of transactions is not gathered in one central place. The use of blockchain can also support tracking illegal activities such as money laundering.

The disadvantage of a retail CBDC that is based on blockchain technology is that it may be energy-intensive and have difficulty in timely handling of large volumes of transactions. In addition, blockchain technology may pose challenges in relation to the protection of personal data, as the transaction blocks contain data on previous transactions made by citizens and companies.[52]

Costs and incentives
An introduction of retail CBDC will not be without costs and risks. Regardless of the specific design, the issuance of a retail CBDC will involve extensive and resource-intensive administration for central banks, for example in terms of comprehensive supervision and oversight of distributors (for example banks) to ensure trust etc. in a retail CBDC.[53]

In addition, a retail CBDC raises a number of issues in the form of risks related to financial stability as well as political and reputational risks, which have, for example, been described, in Danmarks National

49 These issues are described in more detail in the analysis Central bank digital currency in Denmark?, see Danmarks Nationalbank, Central bank digital currency in Denmark?, *Danmarks Nationalbank Analysis,* no. 28, December 2017 (*link*).

50 See Swiss National Bank, *Retail CBDC purposes and risk transfers to the central bank*, September 2021 (*link*).

51 For a further description of these, see Bank for International Settlements, The technology of retail central bank digital currencies, *Quarterly Review,* March 2020 (*link*) and The International Monetary Fund, Behind the Scenes of Central Bank Digital Currency, *Fintech Notes,* no. 4, February 2022 (*link*).

52 See Bank for International Settlements, Rise of the central bank digital currencies: drivers, approaches and technologies, *BIS Working Paper,* no. 880, August 2020 (*link*) and Sveriges Riksbank, *E-krona pilot phase 2*, April 2022 (*link*).

53 See, for example, Bank for International Settlements, Central bank digital currency: the quest for minimally invasive technology, *BIS Working Papers*, no. 948, juni 2021 (*link*) and Bank for International Settlements, *Central bank digital currencies: system design and interoperability*, September 2021 (*link*).

bank's analysis on the subject from 2017 and other international reports.[54]

Central banks that are examining the use of a retail CBDC are considering several options to ensure that banks and payment service providers are given an incentive to develop attractive retail solutions that enable payments with CBDC.[55] This incentive may, for example, consist in central banks covering third parties' development and operating costs in full or in part, or in allowing third parties to charge fees on payments with retail CBDC.[56]

It is uncertain to what extent a given retail CBDC will be demanded by citizens and companies in countries with well-developed digital payment systems.[57] Retail CBDC is likely to gain a foothold if it entails advantages to citizens or companies in the form of improved functionality, security or lower fees. A given desire for wide use of retail CBDC may entail significant compensation schemes and subsidies that encourage the use of retail CBDC.

Stablecoins or other countries' CBDC in Denmark

New means of payment which are not based on Danish kroner may gain a foothold in the Danish retail trade. Denmark is a small, open economy and is a highly digitalised society.[58] These conditions may immediately be favourable for the introduction of new innovative solutions, regardless of whether these are based on Danish kroner or foreign currency. Therefore, solutions that contain new and better functionality may quickly become prevalent. Solutions based on foreign currency may affect the monetary and financial system. Therefore, Danmarks Nationalbank focuses on the significance it may have if other countries issue a retail CBDC or if private digital money in the form of, for example, a stablecoin should gain a foothold.

The significance of a retail CBDC from another country will depend greatly on how it is designed – including, in particular, the rules which are laid down in relation to availability and restrictions on holdings.

A foreign retail CBDC which is without restrictions and which is designed for the purpose of storage of value, may have a significant impact on financial stability in Denmark. Conversely, a foreign retail CBDC with restrictions on the individual citizen's holdings will not have a major impact on financial stability in Denmark.

Correspondingly, restrictions on access to a foreign retail CBDC will also entail that the impact on the Danish monetary and financial system will be low.

The payment market may be affected if it becomes possible to use, for example, a retail euro CBDC from the ECB in Denmark. A new solution based on a euro CBDC, which can be used in Denmark on an equal footing with other solutions, may constitute a possible alternative to the existing payment solutions in Denmark and thus affect competition in the market.

Unlimited access to holdings of, for example, a euro CBDC for citizens, companies and financial institutions may have an impact on financial and monetary stability. In specific terms, it may affect the demand for Danish kroner, the banks' business model, and increase the risk of systematic bank runs, see the following section.

54 See Danmarks Nationalbank, Central bank digital currency in Denmark?, *Danmarks Nationalbank Analysis,* no. 28, December 2017 (*link*); The European Central Bank, *Report on a digital euro*, October 2022, (*link*) and Swiss National Bank, *Retail CBDC purposes and risk transfers to the central bank*, September 2021 (*link*).

55 See, for example, The European Central Bank, Central Bank Digital Currency: functional scope, pricing and controls, *Occasional Paper Series,* no. 286, December 2021 (*link*) and Bank for International Settlements et al., *Central Bank digital currencies: user needs and adoption*, September 2021 (*link*).

56 See The International Monetary Fund, Behind the Scenes of Central Bank Digital Currency, *Fintech Notes*, no. 4, February 2022 (*link*).

57 See Bank for International Settlements et al., *Central bank digital currencies: financial stability implications*, September 2021 (*link*).

58 See Danmarks Nationalbank, Denmark is among the most digitalised countries when it comes to payments*, Danmarks Nationalbank Analysis,* no. 2, February 2022 (*link*).

If a significant part of Danish banks' deposits are converted into a euro CBDC without restrictions, this will affect the demand for Danish kroner. However, the larger capital movements resulting from the citizens' option of easily place their funds in other currencies, such as a euro CBDC, could be handled within the existing monetary policy framework, i.e. Danmarks Nationalbank's possibility of intervening in the foreign exchange market and setting monetary policy interest rates.

The consequences of a possible wide use of other countries' CBDCs in Denmark may ultimately have an impact on the banks' business model if it results in a reduction in deposits. In such a situation, the banks can compensate the loss of deposits by borrowing the money from Danmarks Nationalbank.

In addition, financial stability may be affected. In connection with financial turmoil, citizens may find it attractive to convert their bank deposits into euro CBDC. This may increase the risk of systemic bank runs.

At the time of this analysis, the European Central Bank had not yet laid down specific criteria for the use of or restrictions on any euro CBDC. If it only becomes possible for citizens in Denmark to hold a limited amount, Danmarks Nationalbank's provisional assessment is that a given euro CBDC will have limited impact on the Danish financial system.

If global stablecoins gain a foothold in Denmark, it may also affect the demand for Danish kroner, the banks' business model and increase the risk of systematic bank runs. However, this will require that global stablecoins are used not only for payments, but also for storage of value, and that there is no upper limit on these holdings.

Retail CBDC in Denmark

New technologies and innovation may lead to new types of digital money that can supplement existing ones. It is important that the solutions are also safe and efficient for citizens and society in the future – regardless of the solution in question or the technology on which it may be based.

The use of a retail CBDC is increasingly being studied among central banks, with the reasons for the increased focus on CBDC differing from country to country. Danmarks Nationalbank continuously assesses the various reasons and their possible relevance in relation to the financial system in Denmark, due in part to the fact that the derived long-term opportunities are still unclear.

At present, and with the associated costs and possible risks, it is not clear how retail CBDCs will create significant added value relative to the existing solutions in Denmark. With new technology, however, it is often the case that it is not clear from the outset how and to what extent a new solution will create value. Likewise, it may also be difficult to predict which financial solutions and services will be in demand in the future.

In the future, the development of financial solutions and digital services may contain elements that may be difficult to handle for the private sector. This may affect the relevance of new types of digital central bank money and the nature of Danmarks Nationalbank's operational role in the payment system. In addition, market failures, economies of scale, any launch of CBDCs or global stablecoins by other central banks may also increase the relevance of a CBDC in Denmark.

Danmarks Nationalbank monitors the development closely and participates actively in international working groups and forums that focus on new technology and on the opportunities, risks and costs connected with a retail CBDC.

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News offers quick and accessible insight into an Analysis, an Economic Memo, a Working Paper or a Report from Danmarks Nationalbank. News is published continuously.

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Working Papers present research projects by economists in Danmarks Nationalbank and their associates. The series is primarily targeted at professionals and people with an interest in academia. Working Papers are published continuously.

The analysis consists of a Danish and an English version. In case of doubt regarding the correctness of the translation the Danish version is considered to be binding.

DANMARKS NATIONALBANK
LANGELINIE ALLÉ 47
DK-2100 COPENHAGEN Ø
WWW.NATIONALBANKEN.DK

This edition closed for contributions on 8 June 2022

Julia Weismann Seixas
Financial Digitalization
Expert
jws@nationalbanken.dk

Søren Truels Nielsen
Digitalization
Task Force Lead
stn@nationalbanken.dk

Samuel Eddie Mogensen
Financial Digitalization
Advisor
sem@nationalbanken.dk

FINANCIAL STABILITY

CONTACT

Ole Mikkelsen
Communications
and Press Officer

omi@nationalbanken.dk
+45 3363 6027

SECRETARIAT
AND COMMUNICATIONS

DANMARKS NATIONALBANK