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# Central Bank Digital Currencies: Key Characteristics and Directions of Influence on Monetary and Credit and Payment Systems

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## ABSTRACT

The article is devoted to the study of prospects for digital currency issue by central banks as a new form of central bank money and to the potential of their influence on monetary and credit system. The aim of the article is to interpret and classify central bank digital currencies, to identify key characteristics of digital currencies and possible models of their issue, as well as to define the main directions of influence of digital currencies on the monetary and credit and payment systems. The scientific novelty of the article is in the systematization and comparison of different ideas about the implementation of sovereign digital currencies considering the use of distributed registry technologies. The study analyzed the projects of central banks on the issue of digital currencies and identified their features. Possible directions of influence of central bank digital currencies on the monetary and credit policy of the Central Bank and the activities of credit institutions were determined. It revealed that central bank digital currencies can be considered as a new form of money of the Central Bank, which can be issued to be used both in retail and in wholesale payments. Digital currencies may differ in some characteristics. The key ones are: a way to integrate into the monetary and credit system; emission technology; currency storage method; mechanism of mutual settlements and anonymity level. The study showed that the main incentives for introducing digital currencies are the possibility to provide an alternative and universally accessible legal means of payment, as well as to provide faster, more transparent and cheaper in-country and cross-border payments. The influence of digital currencies on the monetary and credit system and the monetary and credit policy of the Central Bank will largely depend on the scenario of their system integration. If cash is simply replaced in circulation by digital currencies, the effect on the Central Bank monetary and credit system and policy will not be significant. However, if central bank digital currencies are issued as an addition to cash, or are in parallel circulation, they can strengthen the transmission mechanism of the monetary and credit policy and increase the centralization of assets on the Central Bank balance sheet, as well as reduce the funding provided by credit institutions.

**Keywords:** digital currencies of central banks (CBDC); issue of digital currencies; distributed ledger; monetary and credit system; forms of money; payment system; electronic money; cryptocurrencies; retail payments; wholesale payments

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## INTRODUCTION

New digital information technologies have been mainstreamed in the financial market over recent years. Distributed ledger technology (DLT) is one of the most advanced information technologies applied in the financial sector<sup>1</sup>. Among multiple use cases for distributed ledgers, central banks (hereinafter — the central bank) view the key ones in: issuing central bank digital currencies; developing cross-border payment systems; using interbank payments in the securities market; issuing bonds and managing their lifecycle, etc.<sup>2</sup>

The introduction and widespread use of the distributed ledger technology can revolutionise the payment, clearing and settlement processes in payment systems improving their efficiency and reducing settlement risks. The issuance of central bank digital currencies is one of the most important applications for the distributed ledger technology in the central bank activities. It is associated with a fundamentally new money equivalent issued by the central bank rather than with modernization of the current technologies for providing central bank services. However, implementing digital currencies into the existing monetary and credit system is not obvious. It involves financial and systemic risks both for the regulator and the participants in the monetary and credit and payment systems. In particular, now it is not clear what characteristics and

forms of issue central bank digital currency will have, nor what advantages and disadvantages digital currencies will have compared with the contemporary monetary forms. The most important, it is not clear what potential impact the issue of digital currencies will have on the monetary and credit system.

Today, the possibility for issuing central bank digital currencies is a hot-button issue among economists and monetary regulators around the world. At the beginning of 2019, more than 60 central banks around the world studied the problems of issuing digital currencies, including: the US Federal Reserve, the Central bank of Canada, the Central bank of Japan, the People's Bank of China, the Central bank of Sweden, the Central bank of Russia and others<sup>3</sup>. The interest in central bank-issued digital currencies problems is not only due to comprehending the opportunities provided by new technologies in order to increase the efficiency of the monetary and credit and payment systems. It is also due to the concerns of international financial institutions, such as the International Monetary Fund (hereinafter referred to as the IMF), the Bank for International Settlements (hereinafter referred to as the BIS), the European Central bank and others regarding the stability of national monetary systems and the future of central bank money<sup>4</sup>. This concern is caused by the rapid development of a new class of financial instruments, crypto-assets<sup>5</sup>, which are created and operate on the basis of the distributed ledger technology. Among them,

<sup>1</sup> A distributed ledger is a decentralized or distributed accounting system for data on financial transactions, in form of chains built of certain transaction blocks according to certain rules. The key features of the distributed ledger technology are: 1) decentralized distribution of equivalent copies of data among the system participants; 2) sharing and synchronizing data in the system according to the consensus algorithm; 3) lack of an administrator responsible for generating, managing and transmitting data. Distributed ledgers are one of the nine most advanced cross-cutting technologies in digital economy defined by the Government of the Russian Federation in 2018.

<sup>2</sup> For more details, see: Central Banks and Distributed Ledger Technology: How are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 7. URL: <https://www.weforum.org/whitepapers/central-banks-and-distributed-ledger-technology-how-are-central-banks-exploring-blockchain-today> (accessed on 26.07.2019).

<sup>3</sup> Central Banks and Distributed Ledger Technology: How are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 5.

<sup>4</sup> For example, see: Bank for International Settlements, Basel Committee on Banking Supervision, Statement on Crypto-Assets, 13.03.2019. URL: [https://www.bis.org/publ/bcbis\\_nl21.htm](https://www.bis.org/publ/bcbis_nl21.htm) (accessed on 15.06.2019).

<sup>5</sup> Crypto-assets are a new class of financial assets that are created and operate on the basis of the distributed ledger technology. They may comprise assets of various economic and legal nature: monetary, equity, debt, etc. Crypto-assets may include virtual currencies, stablecoins, security tokens, utility tokens and others. In some countries, including Russia, the term "digital financial assets" is used as an equivalent to "crypto-assets".

virtual currencies<sup>6</sup> or cryptocurrencies have a special place.

Decentralized cryptocurrencies are not nominated in any national currency. In the future, they can become common means of payment, subject to the settlement of issues related to their legal status.

The widespread use of cryptocurrencies for payment purposes can significantly diminish the demand not only for cash, but also for funds in settlement accounts of the central bank [2, p. 10]. Despite the possible similarities in the technology for issuing central bank digital currencies and cryptocurrencies, they have many differences. The main one is that the central bank digital currencies have a central issuer represented by the national monetary regulator. It is the lender of last resort. This means high liquidity and stable purchasing power of digital currencies, as well as the possibility to regulate their issuing volumes based on the objectives of monetary and credit policy.

Also, CBDCs differ from the so-called national cryptocurrencies issued in countries in difficult economic and financial situations, compounded by economic sanctions. Examples of such countries are Venezuela (El Petro), Iran (PayMon)<sup>7</sup>. In such countries, the

decision to issue national cryptocurrencies is made by the political leaders, and the central banks are not actually independent monetary and credit institutions. At the same time, the central banks in these countries cannot ensure the stable purchasing power of the national currency. Therefore, they have to use physical commodity assets, such as oil in Venezuela or gold in Iran, as collateral for issuing national cryptocurrencies. The issuance of national cryptocurrencies is primarily aimed at attracting external financing and normalizing settlement relations bypassing economic sanctions, rather than increasing the efficiency of stable monetary and payment systems.

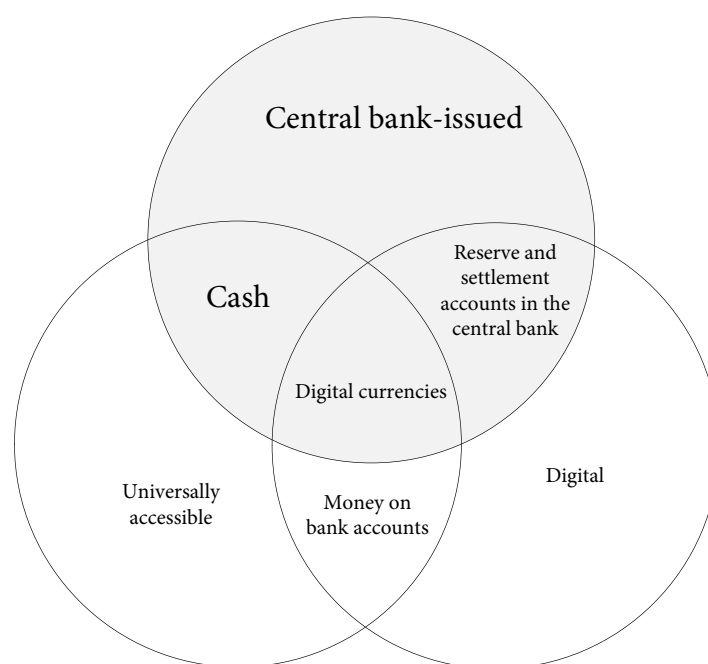
On the whole, the Bank of Russia adopts a negative attitude to cryptocurrencies. The regulator has repeatedly drawn attention of the financial market participants to enhanced risks associated with the use of and investment in cryptocurrency. It expressed the opinion of the premature admission of cryptocurrencies to circulation on the territory of the Russian Federation<sup>8</sup>. At the same time, the Bank of Russia economists believe that digital currencies issued by the central bank may potentially become the equivalent of cash if they turn out to be liquid and easy to use [3, p. 12]. The main incentives for issuing digital currencies by the central bank may be a low risk level and greater liquidity of the digital currency compared with other forms of money available to the general public. Under these terms, the scientific research on the rationale for issuing CBDCs and on the possible advantages and disadvantages of using CBDCs in calculations gain grounds and practical relevance.

The aim of the article is to interpret and classify central bank digital currencies, to identify key characteristics of digital currencies and possible models of their issue, as well as to define the main directions of influence

<sup>6</sup> Functionally, virtual currency can be defined as an electronic representation of monetary value that can be bought and sold in digital form and it functions as: 1) a means of exchange; and / or 2) a monetary unit; and / or 3) a store of value, but it does not have legal status in any jurisdiction (i.e., from a regulatory point of view, it is not a legal means of payment in most developed and developing countries). Institutionally, virtual currency can be interpreted as an electronic representation of monetary value issued by non-traditional issuers of modern forms of money — the central bank, credit institutions or specialized issuers of e-money — but can be used to a limited extent as an alternative to generally accepted forms of money in payments in electronic networks (for more details, see [1, p. 120]). Despite the fact that, from a formal point of view, the terms “virtual currency” and “cryptocurrency” are often used synonymously in economic studies, these terms are not identical. The term “virtual currencies” is broader and may include not only cryptocurrencies issued on the basis of the distributed ledger technology, but also currencies issued on the basis of other technologies, and may be inconvertible.

<sup>7</sup> In the beginning of July 2019, the political leaders of Cuba announced plans to issue a national cryptocurrency. See details: Cuba Considering Use of Cryptocurrency. SBS News. URL: <https://www.sbs.com.au/news/cuba-considering-use-of-cryptocurrency> (accessed on 20.07.2019).

<sup>8</sup> Use of private virtual currencies (cryptocurrencies). Bank of Russia press release. URL: [http://www.cbr.ru/press/PR/?file=04092017\\_183512if2017-09-04T18\\_31\\_05.htm](http://www.cbr.ru/press/PR/?file=04092017_183512if2017-09-04T18_31_05.htm) (accessed on 15.06.2019).



**Fig. 1. The typology of modern central bank money in the general structure of the form of money taking into account release of digital currencies**

Source: compiled by the authors.

of digital currencies on the monetary and credit and payment systems.

### INTERPRETATION OF CENTRAL BANK DIGITAL CURRENCIES AND THEIR PLACE IN CONTEMPORARY TAXONOMY OF MONEY

Currently, there is no universally accepted definition of a central bank digital currency (CBDC) due to the different concepts underlying their issuance. In general, a central bank digital currency can be defined as an electronic obligation of the central bank expressed in a national monetary unit and acting as a means of exchange and store of value. At the same time, CBDCs should be considered as a new form of central bank money, different from traditional central bank money, and presented either as cash or as money on reserve and bank accounts in the central bank. Digital currencies, as a new form of central bank money, can take an intermediate place between traditional money forms as they can be universally accessible (like cash) and at the same time they can be issued electronically (like cash balances on

reserve and settlement accounts in the central bank). Fig. 1 presents a possible place for digital currencies between contemporary forms of central bank money.

Despite the similarity in the form of a value expression, CBDCs should also be distinguished from virtual currencies or cryptocurrencies issued, as a rule, in decentralized systems that do not have a clearly identifiable issuer, as well as electronic money<sup>9</sup> issued by clearly identifiable issuers, but on a private basis. Table 1 shows the comparative properties of CBDCs, central bank cash, electronic money of private issuers and cryptocurrencies.

As can be seen in Table 1, the CBDC properties have much more in common with the cash of the central bank than with the electronic money of private issuers or cryptocurrencies, since the issuer's legal status and its

<sup>9</sup> We consider electronic money in the narrow sense. According to the European Emoney Directive: "Electronic money means electronically, including magnetically, stored monetary value as represented by a claim on the issuer which is issued on receipt of funds for the purpose of making payment transactions, and which is accepted by a natural or legal person other than the electronic money issuer" [4, p. 27].

Table 1

**Properties of central bank digital currencies compared to other forms of money**

Factor	CBDC	Central bank cash	Electronic money	Cryptocurrencies
Demand factors				
Intrinsic value	No	No	No	No
Requirement for issuer	Yes	Yes	Yes	No
Means of exchange	Yes (or limited)	Yes	Yes (limited)	Limited but growing in a networked environment
Monetary unit (at national level)	Yes	Yes	Yes	No
Store of value facility	Yes, but with inflation risk	Yes, but with inflation risk	Yes, but with inflation and liquidity risks	Yes, but with great volatility
Supply factors				
Order of issue	Monopoly	Monopoly	Centralized	Decentralized
Source of issue	Public	Public	Private	Private
Volume of issue	Flexible	Flexible	Relatively flexible	Not flexible
Rules of issue	Not defined	Issuance based on inflation targeting	Issuance based on equivalent exchange for other monetary forms	Computer protocol with limits
Change of issue conditions	Yes	Yes	Yes	Yes, subject to agreement with main miners
Cost of issue	Low	Low	Low	High (due to the cost of electricity for computing)

Source: compiled by the authors.

ability to choose the order of issue and control currency supply are of key importance. At the same time, to determine the specific CBDC properties, it is necessary to identify models of their issue.

Currently, two main options for issuing a CBDC can be considered<sup>10</sup>:

- for retail (general purpose) payments<sup>11</sup>;
- for wholesale (specialized) payments<sup>12</sup>.

Technologically, digital currencies can be issued either in the form digital tokens<sup>13</sup>, or in the form of accounts. A key distinction between token- and account-based money is the form of verification needed when it is exchanged. Token-based money relies on the ability of the payee to verify the validity of the payment object. The problems for digital tokens are electronic counterfeiting and double-spending. There is a risk that a payer could try to use the “same” token on two different transactions. By contrast, systems based on account money depend on the ability to verify the identity of the account holder. A key concern is identity theft, which allows perpetrators to transfer or withdraw money from accounts without permission. Based on the empirical experience in the development of payment systems, it is most advisable to use a token-based digital currency for retail payments and an account-based digital currency for wholesale payments.

A general purpose CBDC could be made an alternative safe, robust and convenient payment instrument in the circumstances of fast displacement of traditional cash from circulation. Unlike non-cash payment instru-

ments, the digital currency of the central bank can inherit important characteristics of cash, namely: to be a legal means of payment and to maintain the anonymity of payment transactions. One of the main advantages of wholesale CBDCs is that they may enhance settlement efficiency for transactions involving securities and derivatives.

Currently proposed implementations for wholesale payments — designed to comply with existing central bank system requirements relating to economic efficiency, capacity and operational safety — look broadly similar to, and not clearly superior to, existing infrastructures.

Figure 2 presents a detailed taxonomy of contemporary forms of money, considering potential issue of digital currencies of the central bank and cryptocurrencies.

Figure 2 illustrates the contemporary taxonomy of money in the form of a diagram from the intersection of ellipses. It includes the four key properties of money: issuer, form, availability, characteristics of the network where money is issued. Therefore, either the central bank or credit and non-financial institutions can act as issuers of money. Money can be issued both in physical form and in digital form. Cash may be universally accessible or restricted. Money can be issued in a peer-to-peer or hierarchical network<sup>14</sup>.

Currently, the main projects of retail CBDCs are e-Peso, Jasper, Ubin and Fedcoin. Wholesale CBDCs are represented by CAD coin and Inthacoin (for more details, see Table 2). Besides, the central bank's money includes funds in the accounts of required reserves of credit organizations with the central bank, funds in correspondent accounts of commercial banks with the central bank, as well as funds that private individuals may deposit with the central bank in some countries. A striking example of universally accessible forms of money<sup>15</sup> not issued

<sup>10</sup> Central bank digital currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 7.

<sup>11</sup> Retail (general purpose) payments are universal payments between individuals and legal entities and banks.

<sup>12</sup> Wholesale (specialized) are payments of limited purpose between central banks or between the Central Bank and commercial banks.

<sup>13</sup> A digital token in CBDC systems can be a digital form of a national currency (a digital token of value) in the form of an electronic monetary obligation of the Central Bank, which can be used in retail payments by analogy to cash. Tokens can be stored on various electronic value storage devices.

<sup>14</sup> National cryptocurrencies were not included in this taxonomy.

<sup>15</sup> Universally accessible money are funds accessed and used in payments without restrictions, primarily for individuals and legal entities.



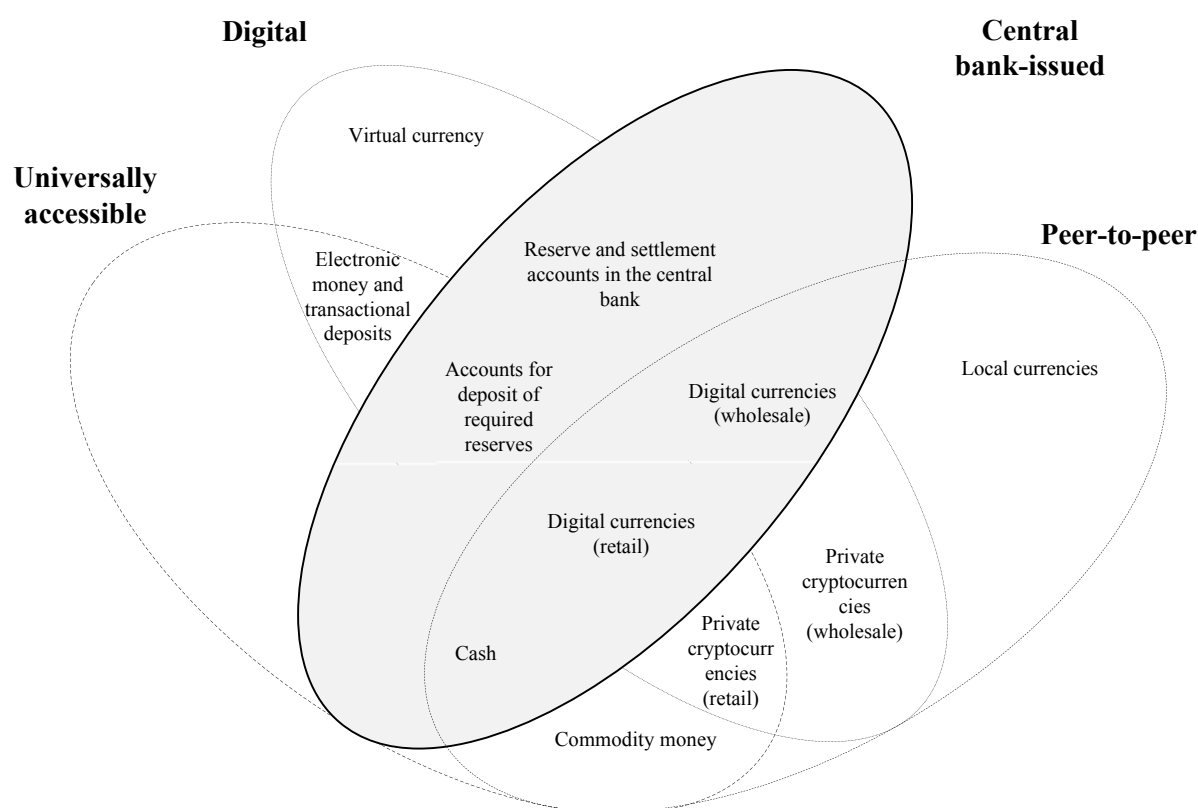


Fig. 2. Developed typology of modern forms of money

Source: [5, p. 60–61].

by the central bank are primarily decentralized cryptocurrencies: Bitcoin, Litecoin, Dash, etc., as well as electronic money systems: virtual wallets WebMoney (Russia) and Yandex.Money (Russia), Octopus e-wallets (Hong Kong), Ezlink (Singapore), Rakuten Edy (Japan) [6, p. 55–58] and others. Money, not universally accessible, is only available for and can be used by specialized institutions or participants of payment systems. For example, in the summer of 2019, the social network Facebook announced the launch of its own cryptocurrency Libra<sup>16</sup>, and the Telegram messenger is actively working on creating its own cryptocurrency GRAM. At the same time, the issue of cryptocurrencies of private issuers is assumed on a centralized basis, since they do not correspond to the characteristics of cryptocurrencies in the traditional sense [7].

<sup>16</sup> Libra White paper. URL: <https://libra.org/en-US/white-paper/> (accessed on 20.06.2019).

### KEY CHARACTERISTICS OF CENTRAL BANK DIGITAL CURRENCIES

Each of the CBDC forms may have different economic, functional and technological characteristics determining the specifics of their implementation and use. The analysis of CBDC specifics made it possible to identify seven key characteristics which include: 1) technology of issue; 2) currency storage; 3) anonymity; 4) transfer mechanism; 5) integration into the monetary and credit system; 6) availability; 7) interest payments.

*Technology of issue.* In most current cryptocurrency systems, the issue and accounting of transactions with digital tokens is based on the blockchain<sup>17</sup>. These tokens are issued as part of peer-to-peer horizontal networks that

<sup>17</sup> Blockchain, a DLT subtype, is a database consisting of a chain of blocks, each of them containing the information about previous ones. All this information is stored decentralized simultaneously on all computers of the system participants.

do not have a clearly identifiable issuer. New units of cryptocurrency are issued, as a rule, as a result of mining, forging or other procedures<sup>18</sup>. Apparently, in the case of the central bank, the issuance of token-based retail CBDCs can mainly be based on a private blockchain<sup>19</sup> or another technology, which would allow the central bank to centralized control and money supply management. At the same time, some key technological advantages of the decentralized DLT will be lost including complete anonymity of data, transparency of transactions and low transaction cost. Therefore, the central bank will have to choose a technology to issue digital currency that balances the ability to control the money supply, to maintain an acceptable level of anonymity and to ensure low transaction cost for its users.

It is believed that to issue wholesale digital currencies for interbank settlements, an open blockchain may also be of little use. At the same time, the DLT is actively developing which contributes to the emergence of new projects for issuing digital currencies. For example, the first development phase of Inthanon, the blockchain-based CBDC, that was successfully demonstrated in May 2019 by the Central Bank of Thailand. Within the frame-

work of the project, an open-source prototype of the Corda platform solution was created that automates the provision of liquidity to eight commercial banks participating in the project and providing 24/7 interbank settlements<sup>20</sup>.

*Currency storage.* In most cases, when digital currencies are issued for retail payments in the form of digital tokens, electronic wallets directly owned by the owner of the funds act as a storage device. In case of wholesale CBDCs, the currency can be stored in the form of accounts directly at the central bank.

*Anonymity.* A token-based CBDC can, in principle, be designed to provide different degrees of anonymity in a way that is similar to private digital tokens. A key decision is the degree of anonymity vis-à-vis the central bank, balancing, among other things, concerns relating to money laundering, financing of terrorism and privacy which is a technologically challenging task<sup>21</sup>. An account-based CBDC, as a rule, does not imply any anonymity.

*Transfer mechanism.* The transfer of cash is conducted on a peer-to-peer basis, while central bank deposits are transferred through the central bank, which acts as an intermediary, and only after that the settlement is complete. In this regard, a retail CBDC may also have to provide direct transfer by analogy to cash. The only difference will be that such a digital currency will be transferred by electronic storage devices. A CBDC may be transferred either on a peer-to-peer basis or through an intermediary, which could be the central bank, a commercial bank or a third-party agent.

*Integration into the monetary and credit system.* Digital currencies can be implemented in the existing monetary and credit system in three ways. First, as a replacement for cash in

<sup>18</sup> "Mining" is a process for obtaining new units of cryptocurrency based on the "proof-of-work" algorithm. The algorithm is based on rewarding participants who proved the hash function by means of computing tools, thereby signing the block and making the transaction. Forging is an alternative mining process for obtaining new units of cryptocurrency. It is based on the "proof-of-stake" algorithm. The algorithm is based on rewarding participants who by means of computing tools managed to confirm the share of cryptocurrency stored in their account of the total volume of cryptocurrency mined, thereby signing the block and making the transaction.

<sup>19</sup> Private (closed) blockchain is a blockchain where access permissions to data and transactions are restricted to a certain narrow circle of organizations or one organization. Private blockchain is centralized. Federal blockchain is a private case of this blockchain with no mining. To find a consensus on transactions, the "proof-of-authority" algorithm is used here with authorized validators as participants. In such a way, the speculative-commercial interest of this blockchain is eliminated for market participants, and it is replaced by a reputation interest, since the validators are motivated to maintain the transaction process in order to keep their validation status.

<sup>20</sup> The Outcome and Findings of Project Inthanon Phase I and the Project's next steps. URL: <https://www.bot.or.th/Thai/PressandSpeeches/Press/News2562/n562e.pdf> (accessed on 26.07.2019).

<sup>21</sup> The Riksbank's E-Krona Project. Sveriges Riksbank, Report 2. 2018. p. 23.



circulation (the transition from cash to digital currencies as a legal means of payment). Second, as an addition to cash while keeping cash in circulation (competition with non-cash payment systems). Third, as a form of money as the equivalent to cash (competition with deposits in commercial banks). How a digital currency can be transformed into cash and non-cash money and interact with them depends on the chosen issuance model of digital currency.

*Availability.* Currently, access to traditional central bank money, except cash<sup>22</sup>, is limited to central bank operating hours. In the case of digital currency for retail payments, it seems that the central bank will need to provide mandatory access to such funds 24/7. A wholesale CBDC could be available only during certain specified times (such as the operating hours of wholesale payment systems)<sup>23</sup>.

*Interest payments.* As with other forms of digital central bank liabilities, it is technically feasible to pay interest on both token- and account-based CBDCs. The positive interest rate (for example, with a fixed interest below the key rate or differentiating interest depending on the amount of funds in the account) on CBDCs can encourage demand for CBDCs, especially at the stage of their initial integration into the monetary and credit system, and stimulate competition with deposits of credit institutions. The ability to charge interest for the central bank has its additional advantages, since a change in the rate on CBDCs would make it possible to vary the cost of money and, as a result, the demand for it<sup>24</sup>.

<sup>22</sup> It goes about funds in settlement accounts and accounts of required reserves at the central bank.

<sup>23</sup> In real-time gross payment systems (RTGS), it is generally accepted that money transfer orders and money transfers are made in real time, however, the processing time of money orders and transfers themselves is usually limited to the operating hours of the systems, i.e., they do not work 24/7.

<sup>24</sup> Central Bank Digital Currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 6. URL: [https://www.bis.org/list/cpmi\\_all/sdt\\_1/page\\_2.htm](https://www.bis.org/list/cpmi_all/sdt_1/page_2.htm) (accessed on 26.07.2019).

## MODERN PROJECTS FOR ISSUING DIGITAL CURRENCIES OF THE CENTRAL BANK

Historically, the Bank of England was the first central bank to initiate a global discussion about the prospects for introducing central bank digital currencies in 2014 [8, p. 276]. Then, the central banks of other countries, including the Bank of Sweden, the Bank of Canada, the Bundesbank, the US Federal Reserve and the Monetary Authority of Singapore began to study possible and legal issuing of CBDCs. At the beginning of 2019, 70% of central banks conducted research on the issue of CBDCs [9, p. 7]. Of the 63 central banks participating in the BIS survey in 2019, each regulator at least conducts research on the feasibility of issuing CBDCs. Nevertheless, among the central banks which began to study CBDCs in 2019, more than half have moved on to experiments or more “hands-on” proof-of-concept activities to test new technologies [9, p. 7]. However, this work is only investigative in nature and do not imply plans to issue a CBDC. Only 8% of regulators have progressed to running pilot projects, while successful projects include the digital currency model of the Central Bank of Sweden, the Central Bank of Uruguay, as well as the Central Bank of Canada and the Monetary Authority of Singapore.

The Central Bank of Sweden (Riksbank) has come closest to creating a model for issuing a retail CBDC, electronic krona (e-Krona). The initiative of the Bank of Sweden is largely due to a sharp decrease in cash use [10, p. 11]. According to Riksbank forecasts, the share of cash operations in Sweden should be reduced to 0.5% by 2020, which will allow Sweden to come closer to the idea of creating a cashless society [11, p. 107]. The e-Krona project is also supported by a significant number of representatives from the banking sector and business in Sweden. Riksbank suggests two possible models for issuing e-Krona: based on distributed ledgers and account-based<sup>25</sup>.

<sup>25</sup> The Riksbank's E-Krona Project. Sveriges Riksbank, Report 1. 2017:4–5.

The first model provides for a system where private or legal entities can open an account in e-Kronas directly at Riksbank and gain access to a single database allowing for the exchange of information and transfers in the interface of the payment system of the Central Bank of Sweden. A model can also be implemented with only the main functions provided by Riksbank, such as storing e-Kronas in their accounts, operations for crediting and withdrawing funds from accounts and transfers between accounts. Responsibility for direct communication with account holders in e-Kronas will remain with external payment service providers<sup>26</sup>.

The second model provides for a system where digital currencies will be stored locally on — in an electronic wallet or in an app on a mobile phone. Payments and transfers will go through card readers or contactless payments, ensuring offline payments. As in the case of electronic money<sup>27</sup>, the value-based e-Krona stored on the device can ensure anonymity of payments within the framework established by laws on combating money laundering and limits. The responsibilities of Riksbank will include: developing and testing the system, ensuring the protection of payment information, developing technical specifications of cards, issuing cards, currency exchange and customer service.

The Central Bank of Norway is also considering the possibility of issuing CBDCs in two models — based on distributed ledgers and account-based. However, the regulator is not yet ready for a complete replacement of cash and is considering CBDCs as an additional means of payment<sup>28</sup>.

The Central Bank of Uruguay was the first in the world to introduce an experimental model of a retail CBDC — electronic peso (e-

Peso)<sup>29</sup>. Launched in October 2017, the six-month pilot programme was implemented among 10 thousand users of the ANTEL mobile operator, who were asked to download a mobile application to get access to a digital wallet. The platform made it possible to make payments in a number of outlets and make money transfers to other registered users through the national Red Pagos payment card system. Moreover, the e-Peso digital notes circulating in the pilot programme had their unique serial numbers and corresponding registration with the Central Bank of Uruguay, and also fell under the same legal rules with cash<sup>30</sup>.

The regulator and the participants in the pilot project appreciated the experience of the e-Peso experimental use in retail payments and noted the high coordination of work and the absence of technical incidents during the entire testing period. At the same time, the head of the Central Bank of Uruguay, M. Bergara, expressed the opinion that at present, the full-scale issue of e-Peso in circulation to replace paper banknotes is not demanded. If the regulator decides to switch to digital banknotes, the citizens will be offered a transition period to get used to the new payment technology<sup>31</sup>.

The intentions to develop CBDCs based on the distributed ledger technology have already been published by the Bank of Canada (CAD coin) [12, p. 12], the Bank of Thailand (Project Inthanon)<sup>32</sup>, the US Federal Reserve (Fedcoin) [13, p. 4–6] and the Monetary Authority of Singapore (Project Ubin) [14, p. 12]. At the beginning of March 2019, the Bank of

<sup>29</sup> El BCU Presentó un Plan Piloto Para la Emisión de Billetes Digitales. Central Bank of Uruguay, November, 2017. URL: [https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete\\_Digital\\_Piloto.aspx](https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete_Digital_Piloto.aspx) (accessed on 15.06.2019).

<sup>30</sup> Licandro G. Uruguayan e-Peso on the context of financial inclusion. Basel, November, 2018. URL: [https://www.bis.org/events/eopix\\_1810/licandro\\_pres.pdf](https://www.bis.org/events/eopix_1810/licandro_pres.pdf) (accessed on 01.05.2019).

<sup>31</sup> El BCU presentó un plan piloto para la emisión de billetes digitales. Central Bank of Uruguay, November, 2017. URL: [https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete\\_Digital\\_Piloto.aspx](https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete_Digital_Piloto.aspx) (accessed on 14.03.2019).

<sup>32</sup> Thai Economy: The Current State and the Way Forward. Dr. Veerathai Santiprabhob's speech for BIS, Nomura Investment Forum Asia. 2018. p. 2.

<sup>26</sup> Directive 2015/2366 of the European Parliament and of the Council on Payment Services in the Internal Market, 25 November 2015. URL: <https://eur-lex.europa.eu/eli/dir/2015/2366/oj> (accessed on 15.06.2019).

<sup>27</sup> For more details, see: [4, p. 123–140].

<sup>28</sup> Central Bank Digital Currencies. Norges Bank Papers. 2018. No 1. p. 47.

Canada and the Monetary Authority of Singapore completed a joint test of cross-border payments using their own digital currency systems “Jasper” and “Ubin”, built on two different networks of distributed ledgers. The tests showed great potential for increasing efficiency and reducing risks when using different systems of digital currencies in cross-border payments<sup>33</sup>.

In *Table 2*, we summarized the results of our study of the characteristics of the main projects on issuing digital currencies of the world central banks in 2019.

As follows from *Table 2*, the issue of CBDCs is provided for both retail and wholesale types. At the same time, some central banks assume that CBDCs will be a substitute for cash (the Central Bank of Sweden, the Central Bank of Norway, the Central Bank of Uruguay), while others believe that digital currencies will complement the existing forms of central bank money (Central Bank of Canada, Monetary credit management of Singapore, etc.). Also, the vast majority of the projects stipulate that digital currencies will be issued based on distributed ledgers and to use digital currencies, users have to open accounts that will be managed by the central bank<sup>34</sup>.

Besides the projects discussed above, the plans to issue CBDCs are currently published by the Central Bank of Pakistan. At the beginning of 2019, it announced the intention to completely switch to central bank digital currencies by 2030<sup>35</sup>. The People’s Bank of China also unveiled the plans to issue central bank digital currencies, though not using the dis-

tributed ledger technology<sup>36</sup>. According to his chapter, CBDCs will not work on a peer-to-peer basis ensuring anonymity of transactions. The regulator will be able to track all transactions using digital currencies in order to prevent money laundering and illegal activities with digital currencies.

In Russia, the intentions to develop a national digital currency and conduct research in this area were first announced at the St. Petersburg International Economic Forum in summer 2017<sup>37</sup>. Later, the Bank of Russia put forward an idea to develop a single supranational digital currency of Russia and the partners from the Eurasian Economic Community<sup>38</sup>. In general, despite the fact that the Russian regulator considers cryptocurrencies as a highly speculative and volatile asset, it sees great prospects for using the distributed ledger technology, including in its own activities, and therefore, tests these technologies together with other market participants<sup>39</sup>. In June 2019, the Bank of Russia announced that it was considering an option to issue its own digital currency while assessing the technology maturity and public willingness to accept non-anonymous means of payment<sup>40</sup>.

Some international financial institutions, such as the IMF, also support the central bank’s idea to issue digital currencies. At the fintech festival in Singapore in November 2018, the IMF Managing Director C. Lagarde suggested that such projects will help increase the availability of financial services, security and consumer

<sup>33</sup> Central Banks of Canada and Singapore Conduct Successful Experiment for Cross-Border Payments Using Distributed Ledger Technology. Monetary Authority of Singapore. URL: <http://www.mas.gov.sg/News-and-Publications/Media-Releases/2019/Central-Banks-of-Canada-and-Singapore-conduct-successful-experiment-for-cross-border-payments.aspx> (accessed on 15.06.2019).

<sup>34</sup> In fact, this means that being advantageous for regulators, CBDCs will not be able to provide the same anonymity for economic agents as cash does.

<sup>35</sup> State Bank of Pakistan Eyes Issuance of Digital Currency by 2025. URL: <https://www.dawn.com/news/1473310/state-bank-eyes-issuance-of-digital-currency-by-2025> (accessed on 15.06.2019).

<sup>36</sup> Official report of the People’s Bank of China. URL: <http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/3008070/index.html> (accessed on 15.06.2019).

<sup>37</sup> Bank of Russia started development of a virtual national currency. Interfax News Agency. URL: <https://www.interfax.ru/forums/564986> (accessed on 15.06.2019).

<sup>38</sup> Bank of Russia will begin discussion of a single digital currency with partners in the EAEU and BRICS in 2018. Interfax News Agency. URL: <https://www.interfax.ru/business/593815> (accessed on 15.06.2019).

<sup>39</sup> E. Nabiullina: Attempts to anonymously use cryptocurrencies are suspicious. Interfax News Agency. URL: <https://freedman.club/glava-cb-rf-elvira-nabiullina-schitaet-cto-v-kriptovalyutah-bolshe-nedostatkov-chem-polzi/> (accessed on 16.06.2019).

<sup>40</sup> Central Bank is considering to launch a digital currency. RIA Novosti. URL: <https://ria.ru/20190615/1555596009.html> (accessed on 15.06.2019).

Table 2

## Characteristics of the main projects on the issuing digital currencies of the Central Bank in the world in 2019

Name of regulator	Name of project	Type of digital currency	Integration method	Technology of issue	Storage method	Settlement mechanism	24/7 availability	Anonymity
Bank of Sweden (Riksbank)	e-Krona	Retail	Potential cash replacement	Account-based / based on distributed ledgers	Users open accounts managed by the central bank / on debit cards or mobile applications	Possible without intermediaries in a value-based model	Provided	Possible
Central Bank of Norway	CBDC	Retail	Potential cash replacement	Account-based (centralized and decentralized models) / based on distributed ledgers	On debit cards or mobile applications / on prepaid cards or sim cards	Possible without intermediaries in a decentralized value-based model	Provided	Possible
Central Bank of Uruguay	e-Peso	Retail	Potential cash replacement (limited issue in test mode)	Account-based	On digital wallets on mobile phones	Impossible without intermediaries	Provided	Partially provided
US Federal Reserve	Fedcoin (USD tokens)	Retail	Additional to cash	Based on distributed ledgers	Users open accounts managed by the central bank	Possible without intermediaries	Provided	Not provided
Central Bank of Canada	CAD coin (in terms of Jasper Project)	Wholesale for settlements in financial markets	Additional to cash	Based on distributed ledgers (Platform Corda)	Users open accounts managed by the central bank	Impossible without intermediaries	Not provided	Provided
Central Bank of Thailand	Project Inthanon	Wholesale for interbank settlements	Simultaneous existence	Based on distributed ledgers (Platform Corda)	Users open accounts managed by the central bank	Impossible without intermediaries	Not provided	Not provided
Monetary Authority of Singapore	Project Ubin (SGD tokens)	Retail	Additional to cash	Based on distributed ledgers (Platform Ethereum)	Users open accounts managed by the central bank	Impossible without intermediaries	Provided	Not provided

Source: compiled by the authors.



protection, while maintaining confidentiality of payments<sup>41</sup>.

According to a more conservative point of view of the BIS Committee on Payment and Settlement Systems, implementing CBDCs in the existing monetary and credit system can lead to instability in financing deposits in commercial banks<sup>42</sup>.

### ISSUE INCENTIVES AND INFLUENCE OF DIGITAL CURRENCIES ON MONETARY AND CREDIT AND PAYMENT SYSTEMS

#### Value of issue of digital currencies for payment systems

Discussing the operation of payment systems in terms of issuing central bank digital currencies, it is important to identify potential scenarios for the impact on the population — the holders of payment instruments and the payment system architectures.

One of the main incentives to issue a central bank digital currency for the population can be a safe and universally accessible payment instrument at declining demand for cash (Fig. 3). Despite the fact that technological innovations on the whole have significantly increased the convenience and efficiency of electronic tools compared to cash in retail payments at the national level, this trend is not observed at the cross-border level. As a rule, cross-border payments are slower, less transparent and more expensive than domestic payments. In this regard, digital currencies seem to be the most perspective in this area.

As follows from Fig. 3, an important incentive to issue a central bank digital currency is the possibility to increase the stability of existing retail payment systems. For example, if the functioning of a private retail payment system is disrupted due to a technical malfunction or sanctions imposed on a payment

service provider, economic agents will be able to make electronic payments by a central bank digital currency. In this case, central bank digital currencies can increase liquidity and reduce credit risk in payment systems.

At the same time, using central bank digital currencies in wholesale payments can increase efficiency and improve risk management in interbank settlements. The potential benefits of using CBDCs can increase even more if non-bank credit institutions are involved in the calculations by facilitating the use of new technologies for transferring assets, verifying their authenticity and managing risks.

However, a number of legal, technical and operational restrictions must be removed so that CBDCs became widely accessible. In particular, it is necessary to resolve the issue of whether CBDCs will be legal tender in national jurisdictions. Another important condition for issuing CBDCs is the development of reliable mechanisms to mitigate cyber risks, especially in systems based on the distributed ledger technology. The potential consequences of violating the integrity of the CBDC accounting system as a result of cyber attacks can be significant due to the universal use of digital currency. The projects on issuing CBDCs should be developed considering the international requirements of the Group for the Development of Anti-Money Laundering and Terrorist Financing measures (hereinafter — the FATF), since the number and the volume of transactions using digital currencies may be significant and used not only in national, but also in cross-border payments.

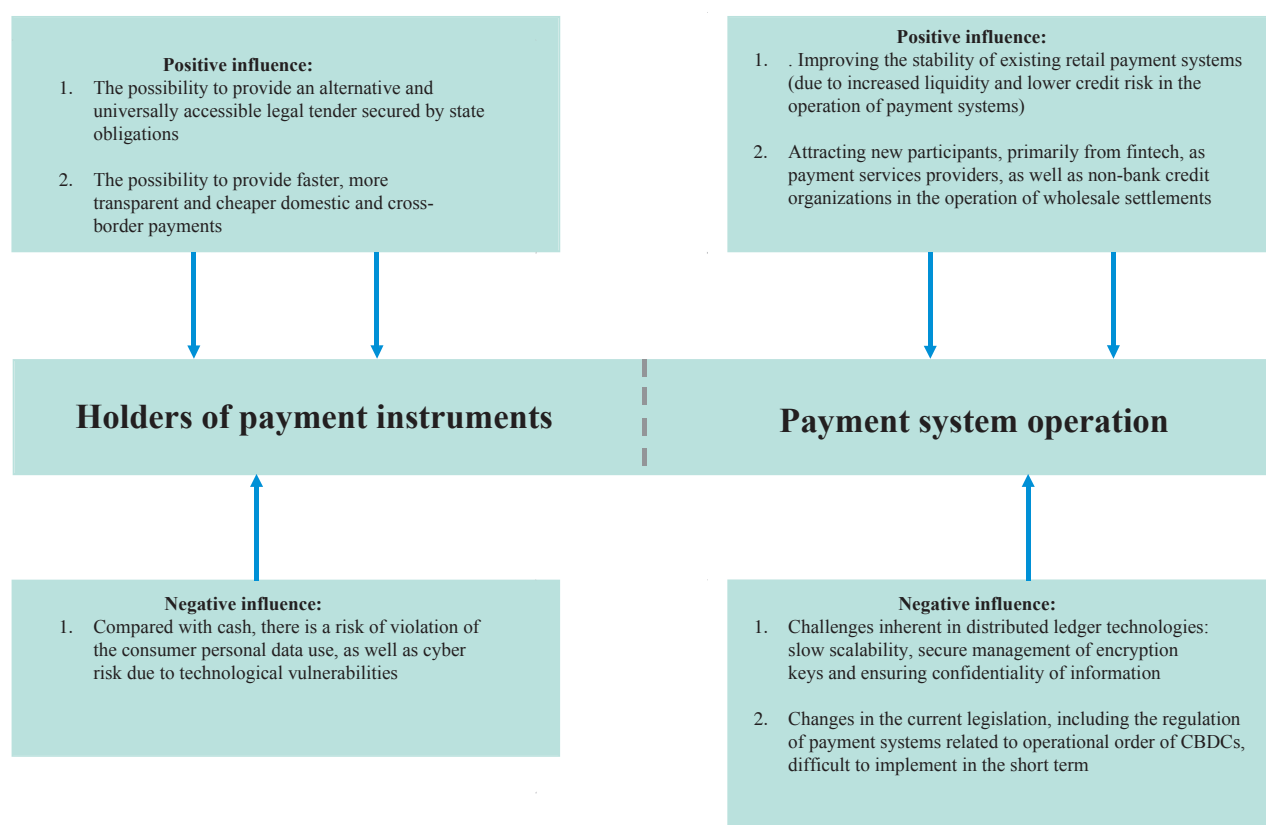
#### Influence of digital currencies on monetary and credit system and monetary and credit policy of the central bank

The issuance of a CBDC is unlikely to change the basic mechanism for implementing the monetary and credit policy of the central bank, including using open market operations and regulating the key interest rate. However,

<sup>41</sup> Lagarde C. Winds of Change: The Case for New Digital Currency. IMF Managing Director Singapore Fintech Festival. 2018. p. 4.

<sup>42</sup> Central bank digital currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 2.





**Fig. 3. Incentives for issuing central bank digital currencies**

Source: compiled by the authors using the data of Central Banks and Distributed Ledger Technology: How Are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 9.

if the volumes of CBDCs keep growing and are not compensated by a corresponding decrease in cash circulation, there may be problems concerning the need to expand assets that the central bank can hold as collateral<sup>43</sup>. At the same time, introducing a CBDC in one country may have negative effect on the countries that do not use such currencies. There may be an overflow of deposits in the country that issued the digital currency, especially if they bring interest income. Therefore, to maintain financial security, it may be required to coordinate monetary and credit policy at the international level, involving not only central banks, but also the IMF and the FATF.

The influence of CBDCs on the monetary and credit policy will largely depend on the

form and method of their integration into the monetary and credit system. *Table 3* presents scenarios for introducing digital currencies and groups them in increasing order of influence of the central bank's regulatory role in the monetary and credit sphere.

As follows from *Table 3*, CBDCs can substitute cash, complement cash, or be simultaneously used with cash. In case cash is replaced, the effect on the monetary and credit policy of the central bank will be insignificant. A more significant effect will be observed when CBDCs are issued complementary to cash or used simultaneously with cash. The opportunity for individuals to store digital money directly in the central bank can lead to two main areas of influence on the monetary and credit policy: 1) to strengthen the transmission mechanism of the monetary and credit policy; 2) to reduce lending volumes provided by credit institutions.

<sup>43</sup> This is about providing additional cash issuance, i.e. an increase in liabilities on the balance sheet of the central bank should be compensated by an increase in assets.

Table 3

## Scenarios for the introduction of central bank digital currencies

Method to integrate digital currencies	Description of integration scenario	Digital currency profits	Influence on monetary and credit system	Influence on monetary and credit policy
1. Cash replacement (competition and replacement of cash in circulation)	Transition from cash to CBDC	Usability and possible anonymity in payments	Component replacement in MO unit	Insignificant
2. Addition to cash (competition with payment systems)	Outflow of funds from current accounts in the digital currency of the central bank	Easy payments for goods and services and improving stability in the operation of payment systems	Possible impact on the structure of components in M1 aggregate	Significant: the growing role of the central bank in the market of payment systems
3. Simultaneous use of cash (competition with deposits in commercial banks)	Outflow of funds from deposits in the digital currency of the central bank	Easy payments for goods and services, as well as possible interest accrual	Possible impact on both the structure and volume of the components of aggregates M1 and M2	Significant: change in liabilities of the central bank and commercial banks

Source: compiled by the authors using the data from the Bank of Russia Research and Forecasting Department.

Strengthening the transmission mechanism of monetary and credit policy can be achieved by a direct impact on the value of money. Usually, there is a time lag between the change in the key rate of the central bank and the change in deposit and lending rates. If interest income linked to the key rate is accrued on the CBDCs stored in the central bank, the reaction of economic agents will be faster, especially if the CBDCs imply both settlement and deposit accounts. Growing rates will stimulate demand for digital currency, leading to a corresponding decrease in investment in other forms of money or assets and vice versa [15, p. 4]. The interest accrual on current and / or deposit accounts in a CBDC may attract depositors of credit institutions. As a result, a change in the key rate of the central bank will affect economic agents directly, and not through intermediaries represented by commercial banks.

Apparently, central banks will be able to compensate for the reduction in deposits in the accounts of credit institutions by providing them with liquidity. This process will be largely similar to the balance sheet changes of the central bank and commercial banks with an increased cash demand. If the demand for a CBDC is significant in terms of insufficient liquidity from commercial banks, the central bank will have to increase its balance sheet assets by acquiring additional assets from the non-financial sector [16, p. 14]. Thus, issuing a CBDC can increase the effectiveness of traditional instruments for influencing interest rates in the financial system.

However, the benefits of such centralization of banking assets in the central bank are not obvious. First, the monetary and credit policy implementation will be more complex with the growth of the balance sheet, which can lead to increasing number and volume of operations carried out by the regulator. Besides, an increase in net assets may lead to changes in the debt market and the capital market. Second, digital currency will compete with the money of commercial banks. Due to growing CBDCs, an ongoing decrease in bank

deposits may reduce the size and change the structure of liabilities of commercial banks, and hence the cost of funding [17, p. 92]. This may lead to a decrease in the volume of assets of commercial banks intended for lending to individuals and legal entities.

### **Influence of digital currencies on the activities of credit institutions**

Of note, in most cases, an ill-conceived approach to issuing CBDCs can lead to a decrease in lending by banks to the real sector and have a negative impact on the real sector of the economy. Nevertheless, some studies show that a CBDC does not necessarily affect the amount of lending by banks to the real sector. So, economists M. Kaphof and K. Nun admit that with a certain method of issuing digital currency, the amount of loans issued by commercial banks to the private sector can remain unchanged [18, p. 20]. This may happen if a CBDC is provided with government bonds, and it will be acquired only in exchange for such bonds. Thus, either banks or non-bank financial institutions will sell assets (for example, through repo transactions) and purchase digital currency for themselves or their customers. As a result, government bonds disappear from private sector assets, and liabilities — from bank deposits. Lending to non-financial organizations is not affected, instead, the volume of circulating state debt is reduced; some of it is transferred to the balance sheet of the central bank through intermediary of banks, reducing rates on public debt [19, p. 40].

A CBDC implementation may also affect the competitiveness of various credit institutions. As a highly liquid and risk-free asset, the CBDC may start competing with deposits in large, systemically important commercial banks. These banks are considered the most stable, and therefore offer low deposit rates in exchange for low risks. Given the low nominal interest rates on deposits with systemically important banks, a CBDC may become an alternative to many fixed-income deposits. This will make the central bank a competitor

to commercial banks in terms of raising funds even when interest on the digital currency of the central bank is not paid. The similar situation is with cash.

Medium and small banks, on the one hand, can benefit from the issuance of digital currencies, and the traditional advantage of large banks will be largely leveled. Their competition with systemically important banks will move from the risk-profitability to the price-quality category. On the other hand, trust in deposit insurance systems, and therefore in small banks, has been growing in many countries in recent years, regardless of central bank digital money. Despite the fact how close the substitutes are for commercial bank deposits and the central bank digital currency, the deposit insurance system will keep playing an important role in the operation of any banking system. This is especially important during banking crises, accompanied by an active transfer of deposits both in traditional cash and foreign currency, and in CBDCs.

Due to increasing use of decentralized and private cryptocurrencies, as well as stablecoins, implementing CBDCs has more potential advantages than disadvantages. When solving legal, technical and operational issues and mitigating cyber risks, digital currencies issued by the central bank can increase the efficiency and security of operations of the monetary and credit and payment systems.

## CONCLUSIONS

As a result of research and analysis of the world big factual material, we came to the following original conclusions:

1. The issuance of digital currencies by central banks based on the distributed ledger technology<sup>44</sup> or another information technology may cause emerging a new form of central bank money. It will differ both from cash and from traditional cash balances on reserve or settlement accounts in the central bank. Of

note, high liquidity combined with low risk of digital currencies, while ensuring their usability in payments and savings in terms of the expanding use of decentralized virtual currencies and cryptocurrencies of private issuers, which are highly volatile and risky assets, can be the main incentives for central banks to issue digital currencies.

2. As the study showed, digital currencies can be issued and used not only for retail payments, but also for wholesale payments. The issue of digital currencies can be technologically implemented either through the issue of digital tokens, or based on the accounts opened with the central bank. At the same time, the characteristics of digital currencies for token-based retail payments can largely coincide with modern characteristics of cash, except ensuring complete payment anonymity.

3. The key characteristics of central bank digital currencies that may influence the positioning of digital currencies in the monetary and credit system are: technology of issue; currency storage; anonymity; transfer mechanism; integration into the monetary and credit system; availability; interest payments. Most of the projects on issuing digital currencies, analyzed as part of the study, are characterized by using the distributed ledger technology to issue digital currencies when funds are stored either in accounts with the central bank or in electronic wallets of users. Most systems do not provide an opportunity to transfer funds without an intermediary. Today, the most advanced projects on retail CBDCs are e-Krona (Central Bank of Sweden), e-Peso (Central Bank of Uruguay) and others. Wholesale CBDCs are developed as part of CAD coin projects (Central Bank of Canada), Inthanon (Central Bank of Thailand) and etc.

4. The introduction of both retail and wholesale CBDCs can bring a number of potential benefits to payment, clearing and settlement systems. When considering the development of CBDCs, it is necessary to compare this decision with existing payment and settlement decisions. It is also necessary to consider the influence that

<sup>44</sup> In this case, it is most likely that central banks will use a closed or so-called federal blockchain.

digital currencies can have on the competences of the central bank both when implementing monetary and credit policy and ensuring financial stability. The main advantages of issuing CBDCs are the ability to provide an alternative and universally accessible legal tender and to provide faster, more transparent and cheaper domestic and cross-border payments. The main disadvantages of issuing digital currencies are the possible violation of the financial stability of credit institutions, the reduction of their liquidity level in the stock market, as well as emerging cyber risks.

5. The study showed that the influence that CBDCs can have on the contemporary monetary and credit system largely depends on the way they are integrated in the system. In our opin-

ion, when replacing cash in circulation with central bank digital money, the effect on the monetary and credit system and policy of the central bank will be insignificant. The greatest effect will be achieved in the case of simultaneous circulation of central bank digital money and cash, since the ability to store money directly with the central bank can strengthen the transmission mechanism of the monetary and credit policy and reduce the volume of loans provided by commercial banks. This will lead to a change in the structure of liabilities both of the central bank and credit institutions. However, in our opinion, these changes are not critical and can be offset by monetary and credit regulation and the availability of bank deposit insurance systems.

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