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Yuliia Shapoval¹

CENTRAL BANK DIGITAL CURRENCIES: EXPERIENCE OF PILOT PROJECTS AND CONCLUSIONS FOR THE NBU

An overview of the definitions of central bank digital currency (CBDC), formulated by researchers of the International Monetary Fund (IMF), the Bank for International Settlements (BIS), the Bank of England, is presented, and the essence of the CBDC is revealed. It is stated that the existing electronic money is a digital form of obligations of financial intermediaries, and CBDC is a form of emission and obligations of central banks. The types and forms of CBDC are generalized, namely: retail or wholesale, account-based or token-based ones. The structure and functionality of the register, payment authentication, access to infrastructure, and governance are defined as factors taken into account during CBDC designing. Similar models of launching national CBDC by the Bank of England (economy-wide access or financial institutions access, and financial institutions plus CBDC backed narrow bank access) and BIS (direct, indirect, hybrid) are under consideration. The synthetic CBDCs are marked as a theoretical concept of CBDC. The overview of projects of the People's Bank of China - "e-renminbi", the Central Bank of the Uruguay - "e-peso", the Central Bank of the Bahamas - "sand dollar" and the Eastern Caribbean Central Bank affirm the interest of developing countries in launching national retail CBDCs. It was found that apart from the Riksbank with the successful "e-krona" project, most of the monetary authorities of developed countries (BIS, Bank of Japan, Bank of Canada, Deutsche Bank, FRS) are just planning or starting to experiment with the issuance of digital securities, which demonstrates their concern about the restructuring of the banking system and the changes of global role of traditional currencies. Among the positive consequences of the introduction of CBDC for the domestic banking system are the emergence of an alternative payment instrument, the implementation of effective monetary policy through increased influence on interest rates, and regulation of the legal regime of crypto currencies. At the same time, the introduction of CBDC involves certain changes in financial intermediation

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(replacement of the deposits of commercial banks with the CBDC, the performance of functions inherent to commercial banks by the central bank or fintech companies), and will require powerful technical capabilities, including those related to protection from cyber risks. The results of the study point to the need for a cautious approach to the implementation of the Ukrainian CBDC only after the NBU assesses the public demand for new forms of money and the impact of the launch of CBDC models on price and financial stability, and compares available payment technologies that can achieve the same goals as the CBDC².

Keywords: digital currency, central bank, emission, design, payments

Introduction. The growing popularity of blockchain technology and decentralized issuance of cryptocurrencies, including bitcoins, have developed the idea of digital currencies of central banks. In addition, in response to the success of large technology companies in the development of stablecoins, such as Diem (Libra) from Facebook, central banks began to explore CBDC as an alternative to private digital currencies (decentralized cryptocurrencies) to strengthen monetary sovereignty. The fundamental feature of the CBDCs is that their issuance is controlled by the state. Although stablecoins are able to perform certain functions of money with some efficiency due to pegging to real currencies, there are problems with their regulation because they are independent currencies (they are denominated in their own unit of account and issuers are not legally obliged to maintain their convertibility into the currencies of their countries). Therefore, these cryptocurrencies may pose risks to financial stability and to the effectiveness of monetary policy. Accordingly, the promotion of a means of payment such as the CBDC could potentially counteract this threat.

Besides, the current payment environment that has changed in the last year due to COVID-19, emphasizes the value of access to a variety of means of payment and their technological resilience to such shocks as pandemics and cyber-attacks. The issuance of the CBDC can become an alternative tool for non-cash payments both by legal entities and individuals.

As a result, during the recent two years, many central banks in developed countries have intensified public discussion and research on launching their own digital currencies. Since 2019, the idea of the CBDC has spread to developing countries. For its part, the G20 Financial Stability Board, in coordination with international organizations, is developing regulatory requirements for the issuance of stablecoins [1], and is conducting research on CBDC projects to formalize the use of digital currencies in banking systems.

In Ukraine, a plan of CSDC issuance has not yet been developed, but in 2018 the National Bank of Ukraine (NBU) conducted a pilot project to issue "e-hryvnia" as

² The publication was prepared within research project on "Financial Services Industry in the" new reality" at the Department of Monetary Relations of the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine (state registration No 0118U003065).



an alternative to retail payments for individuals. There still remain open the issues of converting the CBDC into a cash and non-cash currency and determining how they differ from existing cash in use. Besides, the issue arises of ensuring the confidentiality and full access of the central bank to such transactions.

Analysis of publications. The study of the CBDC phenomenon is a fairly new subject of scientific discussions and is presented mainly in the works of foreign scholars in the context of the impact of the CBDC issuance on the stability of the banking system. In particular, D. Andolfato [2], analyzing the impact of interest-bearing CBDCs on the banking sector with monopolistic competition, found that properly designed CBDCs do not threaten financial stability. Although the issuance of the CBDC reduces the profit of the monopolist bank, since it encourages the latter to raise deposit rates, more attractive deposit services expand access to financial services and reduce the demand for the CBDC. Similarly, researchers from the Bank of Canada J. Chiu et al. [3] note that the CBDC is able to limit the monopoly of banks in the deposit market and eventually increase the efficiency of banking intermediation. For their part, M. Brunnermeier and D. Niepelt [4] demonstrate that the issue of the CBDC will not undermine a country's financial stability. According to their concept, the exchange of CBDCs for deposits will not reduce lending and nor crowd out investments, but will only change the structure of bank financing, because the transfer of funds from deposit funds to CBDC accounts will cause an automatic replacement of one type of bank financing (via deposits) with another (via central bank financing).

Among domestic scientists investigating the development of the CBDC, we should highlight the work by A. Blinov [5], who considers CBDC as a new form of money, different from cash and non-cash ones, and A. Shkliar [6], who distinguishes such reasons for the establishment of the CBDC as approaching to non-cash economy, combating money laundering and tax evasion, increasing competition between private digital currencies, improving the transmission mechanism of monetary policy, and an increased higher technological level of means of payment. A few aspects of solving the problem of increasing the share of cash payments in Ukraine were revealed by E. Bublyk [7]. The expediency of servicing the synthesized CBDC by controlled financial institutions was argued by T. Gudima [8], who notes that in order to ensure the positive impact of the CBDC on monetary policy, a complete transition to this type of currency is needed. In general, given the initial stage of the research, a set of questions regarding the architecture of the CBDC needs further analysis.

In view of the above, **the purpose of the article** is to summarize the features of modern approaches to the issuance of CBDCs and highlight the potential consequences of their implementation for the banking system.

Designing central bank digital currencies

The design of the CBDC is a set of features of digital assets depending on the purpose and basic technologies used for production (for example, who and under what conditions has access to currency, whether the currency has collateral, and how to exchange it for other types of money).

According to the IMF, the CBDC is a digital form of fiat money issued by the central bank [9]. Due to the fact that the CBDC is expressed in the official currency of the issuing country, it will be only a new means of payment, not a new currency [10, p. 11]. In turn, scientists of the Bank for International Settlements characterize the CBDC as a new form of money issued by the central bank in electronic form and different from the reserves of commercial banks or balances on their current accounts [11, p. 1]. In the 2020 report, BIS researchers gave a clarifying definition of the CBDC as a digital payment instrument denominated in the national unit of account, which is a direct obligation of the central bank [12, p. 3]. At the same time, researchers of the Bank of England reveal the content of the CBDC as liabilities of the central bank denominated in national currency, which can act as a means of payment and a means of preserving value [13, p. 4]. The CBDC is the central bank's electronic money, which can be accessed more widely and which is much more functional than cash funds. CBDCs have a separate operating structure, different from other forms of central bank money [14].

In essence, the CBDCs are digital assets, in other words, money in digital form, which is a legal tender, i.e. is issued, controlled and regulated by the monetary authority. In the case of full performance of the functions of money, the CBDC belongs to fiat money. The CBDC is an additional form of national currency that combines the properties of cash and non-cash money. Both legal entities and individuals will be able to open appropriate accounts with the central bank. The nature of the CBDC as a form of money does not change, since only the calculation method is transformed.

Although CBDC technologies may be similar to those used for e-money, their key difference is that the central bank does not issue e-money and therefore the latter constitute a certain credit risk to the user. The intermediary may find itself in a difficult financial situation or suffer technical failures. In turn, the CBDC will be the central bank's liabilities in the same way as cash [15]. Thus, the crucial incentive for issuing retail CBDCs is that existing e-money is a digital form of financial intermediary's obligations and does not function as a digital form of cash.

Overall, there is no single common classification of CBDCs, but BIS scientists distinguish the following features: type of access (open or closed), degree of anonymity (from full to no), operational readiness (from several hours to "24 hours 7 days"), and the possibility to save. Representatives of the BIS define two types of CBDCs: *wholesale (general purpose) CBDC*, only intended for financial institutions, and *retail CBDC* [11, p. 1]. Retail CBDCs are a digital alternative to cash, available both to individuals and non-financial corporations, and can serve a widely accepted means of exchanging and accumulating value.

By access technology, there are two forms of CBDCs: those based on tokens (means of cryptographic protection of the accounting information) or those based on accounts, the critical difference between which is the method of user identification in the system. With token-based CSDC, the user who receives the token checks its authenticity. And in the case of account-based CBDCs, the intermediary verifies the identity of the account holder.

Account-based retail CBDCs are linked to identification data. The central bank keeps records of individual accounts. Transfers between accounts are made directly via central bank after verification of the claim through the central register. And token-based retail CBDCs stipulate the central bank's issuance of digital access tokens to a wide range of individuals. Token-based wholesale CBDCs are intended for interbank payments and settlements with securities [16, p. 4].

Meanwhile, the BIS, together with the Bank of Canada, the ECB, the Bank of Japan, the Bank of Sweden, the Swiss National Bank, and the Bank of England, have already formulated the basic principles of CBDCs and factors to be taken into account in their development. First, the registry structure can be centralized, decentralized, or combined, for example, a centralized registry can only register the total amount of CBDCs issued, while individual balances are stored locally on a smartphone or card. A centralized registry requires an intermediary to manage and transfer responsibilities, which facilitates the use of anti-fraud tools, while a decentralized registry can simplify P2P (*peer-to-peer*) networking and offline payments. Second, the payment authentication design (for example, one based on identification data or a token-based one) will manage the data structure of the CBDC system, for example, for digital verification of user identification as part of the *know your customer* (KYC) procedure or to monitor transactions. Third, the CBDC register can either serve only as records of central bank liabilities or perform more complex functions, such as the ability to synchronize payments. Fourth, the requirements for access to the infrastructure (the ability to obtain information from the register or make entries in it) may affect the security and efficiency of the entire CBDC ecosystem. Fifth, the CBDC system will need instructions that define the roles and responsibilities of the participants [12, p. 12-13].

For its part, the Bank of England has developed three possible models for launching a national CBDC. First, under the financial institutions access model, banks and non-bank financial institutions will have access to bank accounts with the central bank, which will allow them to buy/sell, lend and trade in the central bank's currency with the central bank in exchange for assets, in particular for banknotes. That is, banks and other financial institutions will receive an alternative method of payment. Second, according to the economy-wide access model, all businesses will be able to open CBDC accounts with central bank. However, only banks and other financial institutions will be allowed to trade directly with the central bank, and all other entities - only through the CBDC exchanges to convert digital currency into fiat money. The exchange may be a separate organization or one managed by a bank or other financial institution. Third, the "financial institutions plus CBDC backed narrow bank access model" will allow buyers to use banknotes to buy/sell "indirect CBDC" [14].

Similarly, the BIS classifies three CBDC design models depending on the structure: direct (single-level, retail), indirect (synthetic, two-level, wholesale) and hybrid (two-level, retail) ones. In all approaches, central bank is the sole participant who issues and repurchases the CBDC. All three models stipulate access based on

an account or token, and can operate in different infrastructures. The key differences lay in the structure of claims and records maintained by central bank.

In the direct model, the CBDC is a direct liability to central bank, which keeps records of all CBDCs, i.e. is the only institution that processes all payments in real time. The advantage of the direct CBDC model is independence from intermediaries. At the same time, doubts may arise about the reliability, speed and stability of such a payment system. Participation in all payments requires from the central bank's server a solid technical infrastructure. However, even if the central bank provides necessary technological capabilities, the CBDC payment system still may be less attractive to consumers than modern payment systems. The central bank will have to organize a proper inspection of customers in accordance with the KYC principle, which will require a large-scale expansion of central banks' operations [17, p. 90].

In the indirect model, central banks issue CBDCs indirectly. The client makes claims on banks and non-bank financial institutions, and the central bank only monitors wholesale accounts. For consumers, this type of CBDC is not a direct liability to the central bank, and the intermediary (i.e. the issuing company) is authorized to completely fulfill its obligations to retail customers. The disadvantage of the model is that central bank does not keep records of individual claims (this is only done by intermediaries, while central bank only keeps records of wholesale holdings), and that there is no direct confirmation of cash claims [17, p. 89]. Thus, central bank cannot satisfy consumer demands without information from the intermediary. This model is characterized by problems with regulation and supervision in the banking system.

The hybrid model means that central bank issues the CBDC, and intermediaries facilitate payments for general public. That is, the CBDC is a direct liability to central bank. The hybrid model has better resilience compared to the indirect CBDC model, as central bank maintains a register of all transactions and manages the backup technical infrastructure. Central bank keeps a copy of the balance of holdings in retail CBDCs, which allows it to transfer these assets between payment service providers (PSPs) in case of technical failure. In addition, in case of the intermediary's bankruptcy, the assets of the holdings in the CBDC are not considered part of the PSPs' assets, which are available to creditors. At the same time, the hybrid CBDC model is easier to operate than the direct model. Since the central bank does not interact with retail users directly, it can focus on a limited set of key processes, such as payment settlements, while intermediaries can manage other services, including confirmation of instant payments [17, p. 90-91].

For their part, in 2019, the IMF representatives formulated the concept of synthetic, i.e. artificial digital currencies (sCBDC), which are neither stablecoins nor CBDCs, but rather a new type of public-private hybrid CBDC. The design is similar to the indirect CBDC model. According to the concept, if stablecoin suppliers are allowed to use central bank reserves to maintain their tokens, then stablecoins can become safer and better regulated [18]. That is, according to the concept of the sCBDC, fintech companies that have accounts with central banks issue digital currencies, which in turn are fully backed by the central bank's reserves and are under

its supervision. This is a two-tier CBDC system, where payment services are provided to customers by commercial banks, who pay in the process with the central bank's funds. Although the sCBDC is less costly and risky for the central bank, its impact on demand for the national currency will depend on whether the CBDC, like the national currency, is included in the investment portfolio [19]. In addition, if the demand for liquidity increases, fintech companies will not be able to expand their balance sheets and create additional liabilities, because each liability must be covered by funds held by central bank. Therefore, according to BIS researchers, the regulatory framework should ensure that the liabilities of payment service providers will always be fully consistent with the central bank's reserves. For their part, payment service providers receive a commercial benefit from CBDC issuance, which could potentially lead to concentration and monopoly on the financial market [12, p. 4].

On the whole, given that central banks play a key role in the economy, the introduction of the CBDCs will contribute to the development of the financial ecosystem (which means a set of financial market participants that interact with each other and with the operating environment). The launch of retail CBDCs will expand the access of non-banking people to financial services through the modernization of the payment system with the use of the cooperation of fintech companies with central banks, in particular via distributed ledger technology (DLT). Retail CBDCs may attract digital payments to the ecosystem of user groups (e.g. migrants) with limited access to banking services (due to the lack of reliable financial institutions, high cost of banking services or high costs of remittance services offered by banks and post offices, etc.). The issuance of the CBDC will reduce the cost of managing cash and will largely encourage its replacement by digital currencies. Moreover, CBDCs have fewer barriers to new entrants into the payment system, which will reduce concentration and increase competition and innovation in the payments and remittances market.

The BIS researchers see a key advantage of launching the CBDC in the possibility to replace deposits as the primary and reliable source of financing for commercial banks, as currently cryptocurrencies such as bitcoin cannot effectively replace traditional money due to legal restrictions [20]. The use of the CBDCs as national digital payment instruments will increase technological efficiency and security of private monetary systems and the overall confidence in the national payment system. The CBDC as a liquid and creditworthy asset available to institutional investors could function as a safe asset compared to government bonds [11, p. 2]. In addition, the CBDC will compete with guaranteed bank deposits, which in turn will affect the banks' pricing. The CBDC will be able to help counter the banks' monopolistic position, which will contribute to reducing transaction costs for individuals and small and medium-sized businesses with limited access to banking services due to their high cost, and ensure long-distance operations. Unlike cash, digital currency will not be limited in the number of denominations [21, p. 16].

At the same time, launching the CBDC may increase instability due to the withdrawal of deposits from commercial banks [11, p. 16]. The latter will no longer

be able to completely rely on customers' deposits, because in times of crisis, funds from such accounts can be easily transferred to central banks. It should be noted that for currencies that are widely used in international transactions, introduction of the CBDC in one country might have a negative effect on other currencies [11, p. 2]. The central bank, which issues the CBDC, will have to ensure compliance with the requirements for combating money laundering and terrorist financing. In addition, in some countries, central banks may have no legal authority to issue the CBDC and ensure reliable functioning of such an ecosystem [11, p. 1].

Initiatives to issue digital currencies of central banks: foreign experience

First of all, in order to maintain control over the national money supply in the context of the growing popularity of cryptocurrencies, the use of the CBDC is becoming an increasingly popular concept among the monetary regulators. According to a BIS survey, in 2019, approximately 80% of the world's central banks (or four out of the five central banks, which account for 90% of the world economy) investigated the potential impact of the CBDC on their economies. Although half of regulators consider both wholesale and retail CBDCs, central banks are more motivated to launch wholesale CBDCs. About 40% of central banks are engaged in experiments or concept development on the topic, only 10% (namely - institutions in the developing countries) are actually engaged in the development or implementation of pilot projects [22, p. 3].

According to 2019 surveys, developing countries tend to be more motivated to develop retail CBDCs (in order to improve the efficiency of internal payments, security of payments and financial inclusion) and wholesale CBDCs (to improve the efficiency of domestic payments, security of payments and financial stability) than developed countries (the goal of the development of retail CBDCs consists in improving security of payments, and that of wholesale ones – in increasing the efficiency of cross-border payments). For many central banks, a key factor in the launch of the CBDC is the excessive use of cash. In developing countries with a high level of cash use, central banks seek to reduce costs and improve the mechanism of fighting money laundering and terrorist financing through the issuance of CBDCs. In developed countries with a low level of cash use³, central banks are researching the CBDC, which would expand public access to central bank's money [22, p. 4-5]. About 70% of central banks consider it hardly probable that any type of CBDC will be issued in the future. However, about 10% of the surveyed central banks (mostly in developing countries) plan to issue retail CBDCs in the short term (within three years) and 20% - in the medium term (within six years) [22, p. 7]. Preparation for the issuance of CBDCs requires the study of all possible models due to the current lack of interest of the population in the national CBDCs (compared to the accumulation of savings in dollars) and the users' unwillingness to full transparency of their payments.

³ Cash is mainly used not as a means of payment, but as a means of saving, because most of the cash in circulation is represented by high denomination banknotes.

Besides, the BIS researchers note that CBDC projects are more often implemented in "digitalized" economies, where there is a strong potential for innovation. Such countries may also have higher public demand for new digital means of payment supported by the central bank. Central banks in countries with large-scale shadow economies are more interested in retail CBDCs to foster the use of digital payments. On the other hand, the development of wholesale CBDCs is more common in countries with developed financial markets [23].

Overall, most central banks have not yet defined their CBDC design. The interest of central banks in issuing digital currencies is currently under discussion about methods for implementing CBDC versions and pilot trials. While the use of CBDC will mean faster, cheaper and less risky cross-border payments, simplification of the latter is not a priority for central banks that rather focus on launching their own digital currencies, i.e. ones denominated in national currencies. Monetary authorities are interested in maintaining proper control over the payment system via increasing the attractiveness of their national currencies [24].

In turn, the issuance of international CBDCs could contribute to dedollarization in countries with "weak" monetary institutions, high inflation and volatile exchange rates, and increase the transparency of international capital flows. On the other hand, countries may face digital dollarization, as the CBDCs will be connected to the use of a certain digital network and the national currency will be replaced by the currency of the digital platform. In addition, international CBDCs can be used to evade control.

One of the leaders in the development of CBDC is China. It is worth noting that China is considering the introduction of Asian digital common currency [25], as the US dollar still remains the main currency in international trade and East Asian countries continue to be affected by US monetary policy, particularly in connection with sanctions. The CBDC is entering the market of electronic payments, which is already full of digital wallets such as WeChat Pay and Alipay. The People's Bank of China currently prioritizes the dominance of the digital yuan.

The People's Bank of China in its CBDC model plans to issue and buy "retail" CBDC through the network of domestic commercial banks. The acceleration of the People's Bank of China's work on the development of the digital yuan led to the testing of new digital fiat money in early October 2020 in Shenzhen. More than 47,000 consumers spent 8.8 million yuan (\$ 1.3 million) during a weeklong pilot trial of the "e-renminbi". In total, about 1.9 million applications were submitted, but more than 50,000 consumers participated, who received Luohu Digital RMB Red Packets, each containing 200 digital yuan (US\$ 30). The money could be spent in one of the 3,389 companies involved in the project, but could not be transferred to another person or to a bank account. As a result, about 62 thousand transactions were performed. Companies report minimal differences in the processing of payments in digital currency compared to available mobile payment products. However, unlike with WeChat Pay and Alipay, no additional service fee was charged [26]. Thus, the fact that the People's Bank of China is already testing the digital yuan in four cities (Shenzhen, Suzhou, Chengdu and Xiong'an), involving local businesses and international firms, testifies about the final stage of the project before the actual

launch of the national CBDC [16, p. 5]. Therefore, the release of the "e-renminbi" may remove the need for China to use the SWIFT system, which would help this country become more independent of international systems of money exchange and control.

From November 2017 to April 2018, the Central Bank of Uruguay conducted a testing of retail CBDCs. Under the controlled framework of the "e-peso" pilot project, the users could exchange real pesos for retail CBDCs in addition to digital ones, and then convert electronic pesos into cash. Instead of distributed registry (DLT) technologies, the existing mobile technologies were used. A total of 20 million electronic pesos (\$ 650,000) were issued. Individuals could use up to 30 thousand electronic pesos (and companies - up to 200 thousand electronic pesos) through Global e-Note in their digital wallets and on the Manager platform [27, p. 20].

During 2020, the Central Bank of the Bahamas conducted a pilot project to launch retail CBDCs ("sand dollar") based on accounts and for domestic use only. The owner of the digital currency received a direct claim to central bank, which was legally equivalent to the account. At the same time, restrictions were set on the amount of digital currency in possession of citizens and businesses, as well as on interest-free CBDCs. For its part, in 2019-2020, the Central Bank of the Eastern Caribbean conducted a pilot launch of retail CBDCs based on DLT tokens. The central bank issued, redeemed and verified all tokens through established financial institutions that provide services directly to wallet owners and to non-bank institutions that can also offer e-wallet services. Tokens were treated as digital cash funds, and represented claims to the central bank. As in the project of the Central Bank of the Bahamas, a limit was established on the amount of interest-free CBDC [28, p. 10].

While central banks in developing countries are actively exploring the issue of CBDCs, regulators in developed countries are more cautious about switching over digital currencies, despite benefits such as improved monetary policy targeting and improved national payment systems. This is due to the fact that in some countries the monetary authorities are interested in receiving income from seigniorage, and in others - in maintaining stable exchange rates of their currencies [24].

Against the background of the achievements of the People's Bank of China as to readiness to issue the CBDC, the Bank of Japan only plans to begin experiments with the CBDC of retail digital yen in the spring of 2021. First, the technical feasibility of the main functions required from the CBDC will be examined, and then the need for a pilot program will be considered in connection with the impact of innovation, price and financial stability, ability to ensure confidentiality and processing of end-user information, and relationship with the price of cross-border payments. Due to the high level of public demand for cash, the Bank of Japan plans to introduce the CBDC as an additional payment instrument. An indirect model of the CBDC issue will be chosen – i.e. through intermediaries. Experiments have already been conducted to study DLTs that can be used for the CBDC in a joint project with the



ECB, and the Bank of Japan is in dialogue with private companies and experts about the benefits and risks of retail CBDCs [29].

In March 2019, A. Carstens, general manager of the BIS, noted that if the CBDC is issued, the transition to one-tier banking system will actually take place, as central banks will perform the functions of commercial banks for lending and accepting customer deposits [30, p. 6]. At the same time, a year later, B. Cœuré, head of the BIS Innovation Hub (at the Bund Summit in Shanghai, on October 23-25, 2020) announced that by the end of 2020 an experiment would start on the use of CBDC in retail trade. BIS will also consider how a digital currency can interact with existing payment systems and how to facilitate cross-border payments using digital currency between central banks, namely the Monetary Authority of Hong Kong and the Bank of Thailand. According to B. Cœuré, the BIS Innovation Center is already conducting experiments in Singapore, Switzerland and Hong Kong and plans to expand testing in Germany, France, Great Britain, Sweden and Canada [31].

In turn, the Deutsche Bank researchers in November 2020 called national governments and private companies to cooperate in the development of regional digital payment systems, because in the long run the CBDC will replace cash. The researchers emphasize the acceleration of the development of a European own CBDC in order to strengthen the euro. However, the leaders of developed countries are currently facing such key problems as the environment with low interest rates and confidentiality standards, which hinder the promotion of the CBDC among the population [32, p. 49-50].

In October 2020, J. Powell, a chair of the Federal Reserve, stated that the Fed was applying a cautious approach and had not yet decided to implement the CBDC. He stressed that until the risks of cyber attacks are eliminated and the impact on monetary policy and financial stability is assessed, the US government would not decide to issue a digital dollar [33]. For its part, the Bank of Canada plans to issue a CBDC based on tokens (private key protection), because in this case the Bank will not be responsible for checking and supporting users in the system during transactions [34, p. 1].

Among developed countries, one example of the progressive development of the CBDC project is Sweden. Given that the use of banknotes and coins in Sweden is declining (as of 2019, cash was used in only 13% of payment transactions), the Riksbank launched a study on the introduction of a retail CBDC (the "e-krona" project) due to concerns that the existing payment systems were mostly private [10, p. 10]. Currently, work on the "e-krona" is in the phase of analysis and experiments and the decision to issue a CBDC has not yet been made. E-krona is designed as a digital payment tool for which the payment ecosystem must have a "plug-in" and thus provide public access to central bank money. The expected design involves the use of decentralized technologies (DLT) and the propagation of digital fiat money through intermediaries (PSPs), including commercial banks [35, p. 42]. If the "e-krona" is launched, all EU citizens could gain access to the digital currency, as Sweden is covered by the law on free movement of capital in the euro area.

Prospects for the implementation of the CBDC in Ukraine

Since 2016, the NBU has been studying the possibility of issuing its own CBDC. Definition of digital money of the National Bank of Ukraine and reservations about the right of the NBU to issue it are included in the draft Law on Payment Services № 4364 of November 12, 2020. Given the conducted by the NBU pilot project on the arrangement of the Electronic Hryvnia platform and NBU electronic money ("e-hryvnia") [36], one can expect development of the Ukrainian CBDC (centralized or decentralized) for the public. However, it should be noted, that while issuing accounts-based CBDCs may be simpler for the central bank, the issuance process itself would be technologically complex. To maintain anonymity, as in the use of cash, CBDCs can be issued based on tokens, but this form will be decentralized, while for the central bank it is difficult to ensure a high level of security and control over the amount of money.

Despite the NBU's testing of the "e-hryvnia", the prospects for CBDC introduction in Ukraine still raise considerable concern due to the risk that the CBDC may crowd out commercial banks' deposits. If the CBDC has the same characteristics as traditional money, bank depositors can withdraw funds in times of crisis by converting their savings into digital cash. The central bank will be forced to provide liquidity to banks, which will experience a rapid and significant outflow of funds. Besides, the relocation of individuals and legal entities as bank customers may have a negative impact on bank incomes.

In addition, the development of a crypto-ecosystem will require adaptation of all sectors of the economy to support these currencies, because the number of users who will use blockchain technology will increase. Thus, the technological readiness of the domestic banking system to launch electronic hryvnia is questionable, since additional robust technical infrastructure will be required. Technical failures in information security, cyber-attacks or threats due to the human factor during the implementation of the CBDC can undermine confidence in the central bank, which threatens with a reputational risk for the monetary authority. In addition, with the launch of CBDC, the task of its propagation among the population will arise. However, currently cryptocurrencies need encryption, the use of which is still quite unclear to the majority of Ukraine's population. These risks necessitate a cautious approach to the decision to issue a CBDC.

Thus, it is only possible to determine the feasibility and timeliness of the implementation of Ukrainian CBDC by first overcoming the problems that need immediate consideration and identifying the range of available payments technologies that can attain the same goals.

Conclusions

With the growth of digital payments, central banks are responding to the change in the role of traditional money by developing the idea of issuing CBDCs. In recent years, interest in the CBDC among monetary authorities has grown, but views on this instrument remain quite mixed. Although there is no unanimous decision among central banks on CBDC issuance and design, in general, the idea of CBDC is considered by various countries as a way to promote their currencies in conditions

of digital economy. At the same time, while developing countries are interested in the CBDC as a tool to increase financial inclusion, developed countries see the CBDC as an opportunity to improve the security of payment systems.

World practice shows a cautious approach to the shift over digital currencies. While some countries have conducted studies on the feasibility of using the CBDC, others have tried to implement small pilot projects of their issuance. At the same time, key central banks are increasingly considering issuing retail CBDCs. And these are no longer just hypothetical ideas of regulators, as evidenced by the successful results of CBDC pilot tests, which in turn were favorable for economies where the payment industry lags behind consumer needs. Analysis of international experience has shown that the design of CBDC is developed for domestic users and national payment systems. That is, it will depend on the legal framework and regulation in a particular country, as well as on the extent to which the CBDCs will become a new way to achieve a more inclusive money circulation through diversification, acceleration and reduction of transfers.

Given the active progress of China and Sweden in testing the CBDC, the representatives of the European central monetary authorities insist on accelerated development of the CBDC. At the same time, in the United States and Europe, the actual development of CBDC is too slow. Although the central banks of developed countries remain open to further advances in payment technologies and actively participate in studies on CBDC issuance potential, they are not ready to issue CBDCs, whose emergence may change the nature of currency competition and the role of traditional global currencies. In addition, the replacement of cash, in particular, thanks to CBDC, is becoming increasingly unnecessary in most developed countries.

In general, despite the successful completion of CBDC testing in both developed and developing countries, central banks do not decide on the introduction of CBDCs, but continue to study their risks and benefits. Among the positive consequences for the banking system from the introduction of the CBDC are the following.

First, CBDCs can serve as an alternative secure and reliable payment instrument. On the whole, CBDCs are seen as a potential tool for international settlements due to their speed and simplicity and the transparency of digital currency transactions. Cross-border retail CBDCs will be able to reduce the cost of transfers for users even in countries that already have efficient payment systems.

Second, the issuance of the CBDC can contribute to attaining the objectives of monetary policy in times of crisis, when central banks have to rely on non-traditional instruments. The introduction of CBDC can increase the impact of monetary policy. Central banks will accrue interest on the CBDC balances, thereby changing the value of the CBDC, which will directly affect the demand for the CBDC and other interest rates, and on the quantitative easing programs.

Third, the launch of the CBDC legitimizes digital assets. Thus, the issuance by central banks of their own digital currencies can affect the level of competition and, at the same time, solve the problem of regulation on the crypto currency market. This



will lead to emergence of a new payment infrastructure, where the central bank will have much more control.

In general, on the one hand, the CBDC should supplement, rather than replace, the existing forms of money, but on the other hand, they expose the existing two-tier banking system to risks due to changes in financial intermediation. The negative consequences for the banking system from the introduction of the CBDC include the following.

First, if central bank sets an interest rate that is higher than that of commercial banks, it will be extremely difficult to compete with the latter. Withdrawal of deposits from banks by depositors will affect the credit capabilities of commercial banks and raise their dependence on interbank borrowing, which will result in increased cost of financing with a negative effect on lending to the real economy.

Second, with the introduction of CBDC, the functions of commercial banks in lending and accepting customer deposits, and providing the settlement and payment mechanism will be transferred to central bank or to fintech companies, which will cause risk of disintermediation of banks.

Third, the public may be ambivalent to the digital currency offered by the central bank, rather than by a private company, because of the risk of losing anonymity when making payments and accumulating funds. The CBDC provides only a partial possibility of ensuring the anonymity of settlements. True, information on low-cost CBDC balances or transactions may remain anonymous. Besides, although account-based CBDCs do not allow completely anonymous transactions, payments from token-based CBDCs can be made without remote verification of the account holder's identity. However, the risks of data confidentiality will increase if, in addition to the implementation of the CBDC, the use of "physical" money is banned.

Thus, granting the right to open accounts in the central bank to both legal entities and individuals is a move towards a one-tier banking system. For such a restructuring of the banking system, a strong technological infrastructure is required. On the other hand, the two-tier banking system is maintained with indirect and hybrid CBDC models, when accounts are opened in the central bank with customers' access through commercial banks.

Today, the introduction of the Ukrainian CBDC is still only an idea, not a decision of the NBU. The issuance of CBDC in Ukraine requires a balanced approach and is possible only after the NBU has assessed the impact of the models of CBDC launch on the central bank's strategic goals, in particular, ensuring price and financial stability. Although a pilot test of "e-hryvnia" has already been conducted in Ukraine, there are doubts about technical possibilities for large-scale implementation of this project. In addition, the CBDC issue will require additional assets from the central bank, such as government securities, loans to commercial banks, or international reserves. In parallel with the NBU's CBDC experiments, it is necessary to deepen the understanding of the CBDC design (limits on the volume of issuance/possession, accrual of interest, and degree of anonymity) and confidentiality and data protection. In general, the issue of CBDC implementation in Ukraine requires further research on the possibilities of issuing "e-hryvnia" and technological experiments of



compatibility of digital hryvnia with existing payment services and assessment of potential population's demand for CBDC.

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ЦИФРОВІ ВАЛЮТИ ЦЕНТРАЛЬНИХ БАНКІВ: ДОСВІД ПІЛОТНИХ ПРОЄКТІВ ТА ВИСНОВКИ ДЛЯ НБУ

Представлено огляд визначень цифрових валют центральних банків (ЦВЦБ), сформульованих дослідниками Міжнародного валютного фонду (МВФ), Банку міжнародних розрахунків (БМР), Банку Англії, та розкрито сутність ЦВЦБ. Зазначено, що існуючі електронні гроші є цифровою формою зобов'язань фінансових посередників, а ЦВЦБ – формою емісії та зобов'язань центральних банків. Узагальнено типи та форми ЦВЦБ, а саме: роздрібні або гуртові, на основі рахунків або на основі токенів. Відзначено структуру та функціональність реєстру, автентифікацію платежу, доступ до інфраструктури, управління як фактори, що враховуються при розробці дизайну ЦВЦБ. Проаналізовано схожі між собою моделі запуску національних ЦВЦБ Банком Англії (доступ широкого загалу або тільки фінансових інститутів та доступ фінансових інститутів плюс обмежений банківський доступ до ЦВЦБ) та БМР (пряма, непряма, гібридна). Відзначено синтетичні ЦВЦБ як теоретичну концепцію ЦВЦБ. Розгляд проєктів Народного банку Китаю – "e-renminbi", Центрального банку Уругваю – "e-peso", Центрального банку Багамських островів – "піщаного долара" та Центрального банку Східно-Карибського басейну засвідчив інтерес країн, що розвиваються, до запуску роздрібних національних ЦВЦБ. З'ясовано, що окрім Ріксбанку з успішним проєктом "e-krona", більшість монетарних органів розвинених країн ((БМР, Банк Японії, Банк Канади, Дойче Банк, Федеральна резервна система США (ФРС)), лише планують або розпочинають експерименти із випуску ЦВЦБ, що демонструє їх занепокоєність щодо перебудови банківської системи та зміни ролі глобальних традиційних валют. Серед позитивних наслідків

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для вітчизняної банківської системи від впровадження ЦВЦБ відзначено появу альтернативного платіжного інструмента, реалізацію ефективної грошово-кредитної політики через посилення впливу на процентні ставки, врегулювання правового режиму криптовалют. Водночас впровадження ЦВЦБ ознаменується змінами у фінансовому посередництві (заміщення ЦВЦБ депозитів комерційних банків, виконання центральним банком або фінтех-компаніями функцій, притаманних комерційним банкам) і потребуватиме потужних технічних можливостей, у т.ч. через кіберризики. Результати дослідження підводять до необхідності виваженого підходу впровадження української ЦВЦБ лише після оцінки НБУ впливу моделей запуску ЦВЦБ на забезпечення цінової та фінансової стабільності, порівняння доступних технологій у сфері платежів, які можуть досягти тих же цілей, що і ЦВЦБ, та попиту населення на нові форми грошей⁵.

Ключові слова: цифрова валюта, центральний банк, емісія, дизайн, платежі

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