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Central banks digital currencies and prospects for the Ukrainian economy

Abstract

The article is devoted to the study of the main directions of research on the introduction of digital money of the world's leading central banks. The paper analyze the experience of the central banks of Saudi Arabia and the United Arab Emirates in implementing a single digital dual-issue currency and cross-border payment system (Aber project). Also we found the Helvetia project, a joint experiment of the BIS Innovation Hub, SIX Group AG and the Swiss National Bank. The project provided issuance of a new wholesale digital currency by the central bank and can be classified as a private permissioned peer-to-peer network with hierarchical access to the ledger. Interesting for our study was the experience of creating a CBDC in Uruguay (E-Peso), where CBDC have been issued in form of unique digital banknotes of several denominations. The article considers the main prospects for the implementation of CBDC in Ukraine. The paper studies the use and legal status of electronic digital signatures in Ukraine. Today, only reporting to regulatory authorities and document flow between users is carried out using electronic digital signatures. CBDC and blockchain network can provide secure storage of information by data centers of regulatory authorities and a common operational space in the financial information channels. The blockchain network should be token-based, and service providers could use an account-based retail payment system. The article defines the main characteristics of token-based and account-based distributed ledgers. Attention is also paid to the anonymity of transactions in payment systems, protection of personal data and the cultural component of cash circulation. Most likely the introduction of CBDC will reduce the total amount of bank financing and banks need to consider how to respond to potential loss of deposit funding. The most likely changes associated with CBDC is the redistribution of profits that banks receive from cheap liabilities in favor of customers. This applies to the owners of operating accounts, on which banks usually charge symbolic interest and which users keep in a liquid form for making payments.

1 Introduction

Modern central banks, being at the top of the money pyramid, offer a two-tier payment system and issue two types of money – paper money, which is a direct obligation of the central bank, and a system of accounts for commercial banks, which are essentially digital money issuers. The central banks of the world's leading countries are actively studying the benefits and problems of introducing a new format of money – central bank digital currencies (CBDC). The main purpose of central bank is to ensure the basic functions of money – medium of exchange, store of value and unit of account. But concerns arise from the structural dependence of the banking system on incomes and savings of their users.

Digital money of commercial institutions (banks, financial companies, trading platforms and international payment systems) has a number of risks for the national payment system, including: legal, operational, credit, liquidity, general commercial, settlement risks and the most destructive – systemic risk. Each country has its own characteristics of money circulation, monetary policy of the central bank and the availability of payment services. In different countries we can find different problems that

can be solved with digital money. Most central banks have noted a significant decline in the role of cash for payments in recent years, making commercial financial institutions an almost monopoly providers of money – digital money, which always has an intermediary for users. The decline in cash transactions and the growing popularity of e-wallets, cryptocurrencies and stablecoins in recent years have made it increasingly difficult to control the money supply of commercial banks.

One of the most likely changes associated with CBDC is the redistribution of profits that banks receive from cheap liabilities in favor of customers. This applies to the owners of operating accounts, on which banks usually charge symbolic interest and which users keep in a liquid form for making payments. Digital money will significantly change the rules for users – banks do not need to know who pays whom and for what, and they will not be the nominal holder of digital money. Banks have invested in today's infrastructure and will probably try to avoid additional costs against the background of a possible outflow of such a cheap resource for them as current accounts. Given the market share of state-owned banks in Ukraine, innovation issues are becoming political.

2 Key research areas for CBDC

Experts of the Bank for International Settlements noted that in some countries credit card fees reach more than 1% of GDP, but in most countries there are several payment systems, each of which provides different market segments. These systems can be classified into three main types: type of payment (wholesale or retail); operator (central bank or private sector); and the calculation mode (net or gross basis) (CBDCs: an opportunity for the monetary system). CBDC are mainly proposed as a complementary retail payment system, ie the third type of money for the general public, which will complement the paper cash system and the non-cash bank system.

R. Todd and M. Rogers combined the research of central banks into a single document, which somewhat simplified our study (Todd, Rogers, 2020). Most CBDC offerings support a two-tier monetary system architecture and mainly consider retail payment systems. Special attention of central banks is also paid to cross-border payments. Although only a few central banks are likely to progress to full project implementation and digital currency issuance over the next 5 years, a few have already completed or are in the process of initiating progressive pilot projects. The two-tier architecture assumes that financial intermediaries remain providers of payment infrastructure, and CBDC users can store digital money without the involvement of such intermediaries. The technological solutions under consideration are centralized infrastructure, permitted or permissionless blockchain protocols.

An interesting experience in Uruguay offers the concept of "digital banknotes". The Central Bank of Uruguay has already completed a general-purpose CBDC pilot program. In November 2017, the Central Bank of Uruguay launched a pilot program to issue, distribute and test E-Peso (Barontini, Holden, 2019). Unique digital banknotes of several denominations have been issued for distribution on the "electronic note manager platform". The platform acted as a register of ownership of digital banknotes. A total of 20 million electronic pesos were issued, of which 7 million were distributed by third-party PSPs that had the equivalent value of pesos in a central bank account. Transfers were peer-to-peer, via mobile phones, text messages or E-Peso applications. Individual users and companies in e-wallets held a maximum of 30,000 and 200,000 e-pesos, respectively.

The legal mandate of the Central Bank of Uruguay was sufficient to issue electronic pesos in addition to physical cash. The pilot was declared successful and closed in April 2018, after which all electronic pesos were canceled. The program is currently under evaluation and a number of issues are being considered before further testing and potential issuance can be decided. These include specific design tasks, such as how best to manage the stock of digital banknotes of different denominations, as well as the level of anonymity of E-Peso, whether it will have interest, the ultimate role of the central bank and wider business and economic impact.

Indeed, the design of coins and banknotes is a unique feature of paper money. And if digital technology is able to provide sufficient protection against counterfeiting, then transferring the cultural component of money is the next challenge for technology. The idea of creating digital banknotes was implemented on public blockchains in the Non fungible token (NFT) format. This format of cryptocurrencies became quite popular and led to the emergence of the digital art market (Makarov, 2021).

Central banks in their digital money research mainly mention the retail payment system which can be created in two versions – token-based or account-based distributed ledgers (Ghose, 2021). Citigroup researchers identified the main characteristics of each version (Table 1).

As an example of a wholesale payment system we found project Helvetia, a joint experiment of the BIS Innovation Hub, SIX Group AG and Swiss National Bank (Project Helvetia). The project provided issuance of a new wholesale digital currency by the central bank and establishing a connection between the new SIX Digital Exchange platform (SDX) and the existing central bank payment system (RTGS) and Swiss Interbank Clearing (SIC). Technically, the SDX platform can be classified as a private permissioned peer-to-peer network with hierarchical access to the ledger, which has three types of nodes:

- Participant nodes, that can store states, initiate new transactions and execute business logic;
- SDX node, that can store states, initiate new transactions, and execute special business logic available only to SDX. For example, organizes and executes multilateral instructions based on SDX Trading and executes business logic for the issuance or redemption of SDX coins;
- Notary node, which is also controlled by SDX and has two important functions: (1) prevention of double spending of assets in the network; and (2) ensuring the finality of the calculations.

Most cross-border payments today are paid using correspondent bank accounts. In this case, currency

TABLE 1 The main characteristics of token-based and account-based distributed ledgers

Tokens	Accounts
– Chains of digital signatures	– Double entry bookkeeping ledgers
– May be offered by unregulated entities	– Offered by regulated banks and non-banks
– Public or private DLT database	– Traditional database technology
– May or may not represent liability of an institution	– Liabilities of an institution to a depositor
– Programmable through 'smart contracts'	– Programmable through APIs
– Wallets may or may not be KYC'd	– KYC on the account holder
– May be pseudonymous or anonymous	– Not pseudonymous or anonymous
– Digital bearer instruments	– Not a bearer instrument
– Synthetic and national currency units	– Denominated in national currency units
– Atomic settlement – token transfer equals messaging & settlement	– Payment messaging and settlement are separate functions
– 'Always on' infrastructure	– Batch processing and 'store and forward' messaging

Source: generated by the author based on (Ghose, 2021)

conversion usually involves multiple parties, meaning fewer payments will be credited and hedged in the wholesale markets by banks. Payment systems and payment methods are different. Payment systems achieve cross-border and currency interaction in three different ways (Auer, 2021):

1. Compatible standards (eg similar regulatory frameworks, market practices, messaging formats and data requirements).

2. Interconnected systems through technical interfaces, common clearing mechanisms or appropriate schemes.

3. Establishment of a single multi-currency payment system.

The Aber project was an initiative launched by the central banks of Saudi Arabia and the United Arab Emirates to study the viability of a single digital dual-issue currency as a tool for internal and cross-border settlements between the two countries (Saudi central bank…). Aber propose the wholesale CBDC and uses a transaction model which is a hybrid between an account and token model. There are two types of digital currency transfer transactions: within a privacy group (sub-ledger) and across privacy groups. A token model is used for accounting movement of digital currency across sub-ledgers. Once the digital currency is moved into a ledger, it can be exchanged peer-to-peer using an account model. This allows to decouple the privacy and safety concerns and handle them in two different types of ledgers, using different transaction models.

An important aspect of the project was the active business and technical participation of commercial banks from the earliest stage. In total, six commercial banks (three from each jurisdiction) participated in all stages of the project. Research has focused on cross-border payments, interactions between multiple ledgers or technologies, tokenization of multiple asset types, and atomic swaps. Aber uses automated fund management features. This works by predicting the liquidity shortage for the next cycle, based on demand in the previous N cycles and the state of input and output flows. This predicting is done for each channel in which the bank participates.

Similar liquidity pools can be found in so-called decentralized finance (Defi) on the Ethereum blockchain. According to DeFi Pulse total value locked in DeFi is $ 69.56 billion (as of 1.08.2021). Figure 1 shows the growth of the DeFi market in the last year (Total Value Locked in DeFi, 2021).

The privacy of user data and transactions in all studies of central banks is determined by an important element of

payment security. The choice between complete anonymity and user transparency is always a compromise. Experience in the cryptocurrency market shows that anonymous settlements create a favorable field for illegal activities. First of all, this concerns drug traffick and cyber fraud, as well as a wide range of services offered by the Darknet.

For CBDC implementation, the issues of the level of anonymity, the process of identifying new users, the format for accumulating and storing confidential data must be resolved. For instance in the European Union, the General Data Protection Regulation, GDPR (REGULATION (EU) 2016/679, 27 April 2016) came into force in May 2018. Companies that process and collect personal data must be built on the principle of "privacy by purpose and by default", which means that personal data must be stored using pseudonyms or complete anonymization. The business must be able to deny such permission at any time. Businesses must also report any data protection breach that negatively impacts user privacy within 72 hours.

Programmable money is the next object for central banks research. Companies often may have supply chains, which waiting for products to be sold. Programmable money will not only optimize payments for the end consumer, but also for product producers in the supply chains. Also the money reservation may allow pre-order products format. Today, many companies are trying to work in direct sales and pre-order deliveries.

Programmable money can also be in the form of mass payment systems and micro payments. Large companies often have to send a significant number of payments at once, for instance, making wages to hundreds or thousands of employees. These mass payments are usually not critical, but require time to process. This is a question of database compatibility. Micropayments – payments for small amounts, the processing cost of which may be greater than the cost of the payment itself. Micropayments can support alternative revenue models for digital media (such as moving away from existing subscription and advertising models). They can also support the development of Internet-of-Things (IoT) programs that connect networks of physical devices.

3 Prospects for the implementation of CBDC in Ukraine

In Ukraine, the official use of digital signatures began in 2004 with the entry into force of the Law of Ukraine
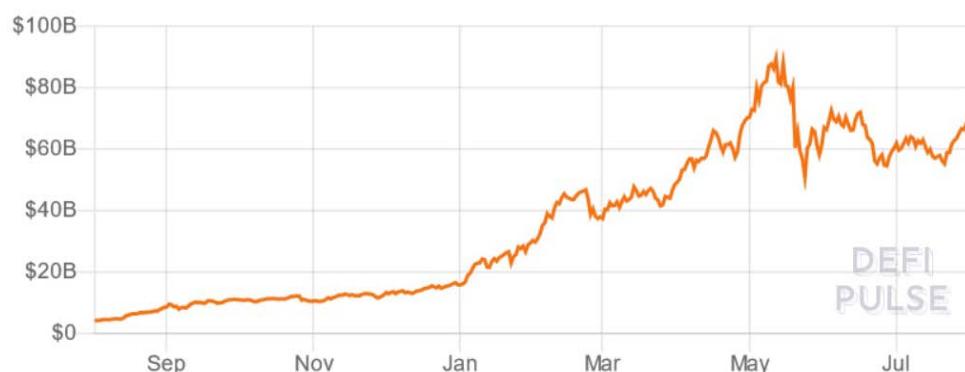
FIGURE 1 Total value locked in DeFi, USD billion

"On Electronic Digital Signature", which established the legal status of electronic digital signatures and defined the conditions of its use. In 2017, this law was replaced by the Law of Ukraine "On Electronic Trust Services" (Law of Ukraine "On electronic trust services", 2017). Ukrainian legislation provides for the operation of state-licensed certificate issuing centers that issue (generate) digital signatures and guarantee their authenticity. The user submits documents to the certification center for confirmation of identity and authority and receives a pair of keys – public and private. A copy of the public key is stored in the certification center, which acts as a guarantor of the authenticity of the issued key. Reporting to regulatory authorities and interaction (now only document flow) between users is carried out through electronic services and software.

The emerging network of relationships is increasingly becoming decentralized. In practice, users create their own databases and have to take care of database backups on their own. Also there are a number of state institutions that issue digital signatures for their own usage, as well as a number of digital services for tax reporting and the state services provision. For instance, access to a personal account on the official website of the State Fiscal Service of Ukraine is carried out only using a digital signature. State institutions act as public nodes, and users store their pieces of the database.

Blockchain technology may ensure the formation of a common database and verifiability of users without their identification. The proof-of-database concept can provide advanced features for private databases such as ledger and CBDC. The database can contain not only tax reports and commercial documents, but also digital money. Thus, payments to counterparties and taxes can be programmed. For instance, the use of smart contracts can provide guaranteed peer-to-peer payment against delivery. A digital VAT report in the form of a smart contract could periodically conduct clearing calculations and payments according to the data of the Unified Register of Tax Invoices.

It should be noted that the legislation also requires the use of secured physical devices for storing private keys, which allow to protect the key from copying and transferring to third parties – the signature is generated and exists only for one specific device. According to the Central Certification Body of the Ministry of Digital Transformation of Ukraine, 7.2 million qualified certificates of electronic signatures were generated in 2020, of which 822,800 were generated on secured devices (Official site of the Ministry of Digital Transformation of Ukraine). Table 2 shows the number of digital signatures issued by authorized providers in 2020.

According to the National Bank of Ukraine, as of April 1, 2021, UAH 550.2 billion banknotes and UAH 3.6 billion coins were in circulation (The main indicators of the banks of Ukraine, 2021). The growth of cash in circulation began at the beginning of quarantine and did not stop during 2020. The largest number of banknotes with a face value of UAH 200 and coins with a face value of 10 kopecks is in circulation (23.7 % and 29.1 %, respectively). A significant part of banknotes with a face value of UAH 100, 200 and 500 are placed in the network of ATMs. As of the end of 2020, commercial banks held cash and cash equivalents in the amount of UAH 73.2 billion (Table 3). Over the past 5 years, cash balances in banks have doubled. We also note a significant and stable share of foreign currencies in the assets and liabilities of banks. Ukraine has a widespread market for the exchange of foreign currencies, which is essentially one more payment system in Ukraine.

The National Bank of Ukraine conducted a survey of market participants on the potential demand for the digital currency of the central bank – E-hryvnia and possible options for its use (The results of the survey on the possibility of introducing e-hryvnia, 2021). 100 financial market experts took part in the survey, which ended this year. According to experts, the most promising "use case" of the E-hryvnia could potentially be a retail payment system (primarily – P2P transfers between individuals and e-commerce transactions). In second place in terms of the number of survey points – E-hryvnia as a tool for cross-border payments (primarily – P2P transfers between individuals).

The results of the survey will be the basis for further research by the National Bank of Ukraine. The following areas are considered:

TABLE 2 The structure of the qualified digital signature service providers in 2020

	Qualified provider	Users	Users share, %	Total number of keys	Including on secured physical devices
1	2	3	4	5	6
1	"PRIVATBANK", JSC	3 010 554	66,7	5 284 751	412 253
2	"Key Certification Center "Ukraine", LLC	546 733	12,1	608 313	54 936
3	Information and reference department of the State Tax Service	444 236	9,8	534 089	37 155
4	"Ukrainian special systems", SE	112 534	2,5	285 805	369
5	"UkrSibbank", JSC	79 871	1,8	92 684	72 852
6	"DIYA", SE	67 201	1,5	82 305	32 194
7	State Treasury Service of Ukraine	57 127	1,3	85 281	85 281
8	"State Savings Bank of Ukraine", PJSC	56 073	1,24	92 586	92 586
9	"Art-master" (MasterKey), LLC	53 061	1,18	74 306	3 245
10	National Bank of Ukraine	1 159	0,03	1 279	756
	Total:	**4 510 880**	**98,2**	**7 243 966**	**822 764**

Source: generated by the author based on (Official site of the Ministry of Digital Transformation of Ukraine)

TABLE 3 Assets and liabilities of Ukrainian banks in 2016–2020

	Balance sheets	2016	2017	2018	2019	2020
1	*2*	*3*	*4*	*5*	*6*	*7*
1	Number of operating banks	96	82	77	75	73
2	Assets, UAH bln	1 256,3	1 333,8	1 359,7	1 493,3	1 822,8
3	*including in foreign currencies*	*519,1*	*506,9*	*494,6*	*492,2*	*585,5*
4	Cash and cash equivalents	36,2	44,1	46,9	56,3	73,2
5	Funds in the National Bank of Ukraine	40,8	37,4	35,5	76,1	37,6
6	Loans provided	1 005,9	1 036,7	1 118,9	1 033,4	960,6
7	*including business entities*	*847,1*	*864,4*	*919,1*	*821,9*	*749,3*
8	*including individuals*	*157,4*	*170,8*	*196,9*	*206,7*	*199,6*
9	Bonds and long-term investments	332,3	425,8	480,6	539,5	791,4
11	Net capital	123,8	161,1	155,0	199,9	209,5
12	Liabilities of banks	1 132,5	1 172,7	1 204,7	1 293,4	1 613,4
13	*including in foreign currencies*	*644,2*	*613,7*	*587,9*	*568,6*	*648,0*
14	Funds of business entities	369,9	404,0	406,4	498,2	646,5
15	Funds of individuals	437,2	478,1	508,5	552,1	681,9

Source: generated by the author based on (The main indicators of the banks of Ukraine, 2021)

– E-hryvnia for retail non-cash payments with the possible functionality of "programmed" money and the ability to make targeted social payments;
– E-hryvnia for use in the field related to the circulation of virtual assets (for example, for exchange, issuance and other transactions with virtual assets);
– E-hryvnia for cross-border payments.

4. Conclusion

The widespread adoption of digital money from central banks requires a detailed analysis of a number of technical, economic and legal issues. These issues include impact on monetary policy, financial stability, business models of banks, international cash flows and supervision of service providers. Unification of user identification process on the basis of digital signature can lead to the emergence of lending, compliance, borrower evaluation, project financing services. Such services will be provided by financial institutions and this adds value to interest-bearing commercial banks' money and expands opportunities for joint investment and profit sharing. But most likely the introduction of CBDC will reduce the total amount of bank financing. Banks need to consider how to respond to potential loss of deposit funding.

Decentralized transactions require the central bank to establish basic standards (cryptography, user verification and distributed ledger security) that will allow the use of central bank money. Blockchain technology and proof-of-database concept can provide (1) secure storage of information by data centers of regulatory authorities (with appropriate access mode) and (2) a common operational space in the financial information channels. The blockchain network should be token-based, and service providers could use an account-based retail payment system.

The current sectors of NFT and DeFi in decentralized payment systems need further research. Non fungible token format can provide design and presentation of money to the user on the smartphone screen not in the form of written numbers with two decimal places, but as a set of banknotes and coins of the usual denominations for paper money. The programmed design of digital banknotes can add collectible value to them. Defi is a relatively new market for digital assets and demonstrates the example of creating liquidity pools in currency pairs that can be used for cross-border settlements.

The appropriate degree of anonymity in the CBDC system is a political and social issue, not just a technical. The CBDC must comply with anti-money laundering regulations that exclude completely anonymous payments. However, CBDC can be designed to protect privacy and give users control over their personal data. A number of CBDC studies suggest that CBDC is equivalent to cash, and therefore it should offer the same degree of anonymity. But anonymity of cash was not a basic necessity when cash appeared. Many years ago, when digital payment systems did not exist, the characteristics of paper money, such as simplification of transportation, accountability and public acceptance were more important than anonymity. Although only a few central banks are likely to progress to digital currency issuance over the next 5 years, a few have already completed or are in the process of initiating progressive pilot projects. But, nevertheless, in our opinion, paper money will remain in the economy for a long time.

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