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THE NEED AND THE CHALLENGES OF THE INTRODUCTION OF CENTRAL BANK DIGITAL CURRENCIES

ПОТРЕБА И ИЗАЗОВИ УВОЂЕЊА ДИГИТАЛНИХ ВАЛУТА ЦЕНТРАЛНИХ БАНАКА

Summary: Central banks observe the impact of technological changes and digitalisation on economic activity and changes in preferences and behaviour of the general public which has been showing increased interest in digital assets. The desire to preserve monetary sovereignty and stability, at a time of sharp decline in the use of cash, leads central banks to launch projects aimed at introducing central bank digital currency (CBDC). This paper explains the incentives for the development of CBDC, analyzes the dilemmas in their design and conceptualization, gives an overview and presents the results of the ongoing CBDC projects. The introduction of CBDC entails controversial choices, potentially opens up risks for existing financial institutions and faces the challenge of achieving widespread acceptance. An approach to the development of CBDC that respects all participants in the financial system and assigns them operational roles in the functioning of the digital money system of central banks can prevent disruption and obstructions and at the same time strengthen its likely the benefits, since it is difficult to imagine the future of money without central bank digital money.

Keywords: central bank digital currency, monetary system

JEL Classification: E50, E42

Резиме: Централне банке опажају утицај технолошких промена и дигитализације на економску активност и промене преференција и понашања опште јавности која у растућем степену показује интерес за дигиталном имовином. Тежња за очувањем монетарне суверености и стабилности, у времену оштрог пада коришћења готовине, наводи централне банке да покрену пројекте увођења дигиталне валуте централних банака (ДВЦБ). У раду се образлажу подстицаји за развојем ДВЦБ, анализирају дилеме у њиховом дизајну и концептуализацији, даје се преглед и излажу резултати до сада покренутих пројеката увођења ДВЦБ. Увођење ДВЦБ носи собом контроверзне изборе, потенцијално отвара ризике за постојеће финансијске институције и суочава се са изазовом постизања широке прихватљивости. Приступ развоју ДВЦБ који уважава све учеснике у финансијском систему и додељује им оперативне улоге у функционисању система дигиталног новца централних банака може предупредити дисрупцију и опструкције и истовремено ојачати користи које се њиме постижу обзиром да је тешко замислити будућност новца без дигиталног новца централне банке.

Кључне ријечи: дигитална валута централних банака, монетарни систем

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INTRODUCTION

The COVID-19 pandemic has stimulated changes in the behaviour of consumers when paying, who have reoriented to cashless and contactless forms of payment for health reasons. According to research by the VISA Company (2020), the growth of contactless payment with their cards in Serbia increased by almost 70% in the first year of the pandemic compared to pre-pandemic 2019. Consumer preferences are moving towards digital financial transactions with an increasingly pronounced deviation from using cash and cash payments traffic. The use of cash is rapidly decreasing in Europe, where it has fallen by one-third between 2014 and

2021 (in Norway, only 3% of total payments are in cash). In light of the demands of the times, the needs of economic subjects and modern technological achievements, the central banks are deciding to launch a new form of money called central bank digital currency (CBDC).

1. INCENTIVES FOR THE DEVELOPMENT OF CENTRAL BANKS DIGITAL CURRENCIES

The broadly understood private sector is at the head of numerous technological projects and initiatives that pave the way for the complete digitization of money and the potential fundamental reconstruction of the monetary system. The original private digital currency - bitcoin - was created at the turn of 2008 into 2009. The existing financial order delimits the part of money in circulation that is directly emitted by the central bank (*outside money*), to which coins and banknotes belong, and the portion of the money supply that is created by the private banking sector through its credit activity through the creation of bank deposits (*inside money*). In the existing monetary order, the private sector is thus *de jure* recognized the right to be a co-creator of money together with the state.

The emergence of private digital currencies more than a decade ago laid the foundation for disruption in the monetary system and the current concerns of central banks having to rethink the design of the monetary system and their role in it. The digital-technological way of living in modern society has inevitably led to the emergence of digital assets and forms of value that also penetrate the monetary sphere. Recently, special laws on digital assets (entered into force in Serbia in June 2021) have been adopted, regulating its issuance, secondary trading, services provision related to this asset, and even the establishment of lien and fiduciary rights on it.

The Serbian Law on Digital Assets defines it as a digital record of value that can be digitally bought, sold, exchanged or transferred and that can be used as a medium of exchange or for investment purposes, whereby digital assets do not include digital records of currencies that are legal means of payment and other financial assets regulated by other laws. Conceptually, the law distinguishes between two forms of digital assets: virtual currency and digital tokens. Virtual currency is recognized as an innovative means of exchange, but there is a clear differentiation from the official money that it issues and whose general acceptability and value are guaranteed by the central bank.

Although the functions of medium of exchange and means of payment of money exist as two synonymous terms in the monetary economy, it seems that the emergence of digital currencies has created the necessity for a new definition of their meaning, which is the origin of their inconsistency.

Emphasizing the function of medium of exchange in digital currencies connects them to the first emerging form of money - commodity money. In that stage of development, specific goods represented money, which in their essence and appearance remained what they were even before being promoted to a medium of exchange - a property like any other. Virtual currency is classified as a digital asset, which is, to say, a new form of property, but it remains an asset like numerous other forms of property. The very name of virtual currency suggests that it represents a relatively preferable form compared to other properties, which is why it stands out and appropriates the function of a medium of exchange. However, it is not used for payment since it is not money. The willingness of someone to exchange their goods or services for a certain amount of virtual currency rests on the assumption that a wide range of other transactors will be willing to accept it in exchange for their products or services or for official money. The general acceptability of an asset in exchange is a necessary and sufficient prerequisite for it to be assigned the function of a medium of exchange.

The national currency is currently being reaffirmed as official money, and the virtual currency is being promoted as an (un)official medium of exchange.

Due to the emergence of new privately issued digital monetary instruments, central banks have a strong incentive to launch their own digital money projects to preserve the central role of sovereign money in modern and increasingly digitized economies. The digital money of central banks is a natural response to the general trend of money digitization.

Central bank money is the anchor of the monetary system. By definition, bank deposit money is convertible into central bank money, and the assumed convertibility also applies to virtual currencies. To maintain its relevance, central bank money must be ubiquitous so that all transactors, without exception, in all parts of the economy at all times can use it freely and unconditionally. With the change in public preferences and the shift from cash to non-cash forms of payment, there is a risk that the general public will break the tie with central bank money (given that there is no access to reserve accounts with the central bank) and completely reorient to privately generated currencies that possess the characteristics of *digital cash*.

The latter danger may call into question the unity of the monetary system and the integrity and uniformity of money in the eyes of the public with unforeseeable consequences. One can imagine a situation of the currently unified monetary sphere segmentation occurring. In that scenario, the monetary system would consist of mutually relatively isolated platforms within which particular private digital currencies function and circulate and the holders of the monetary authority in the country cannot influence them.

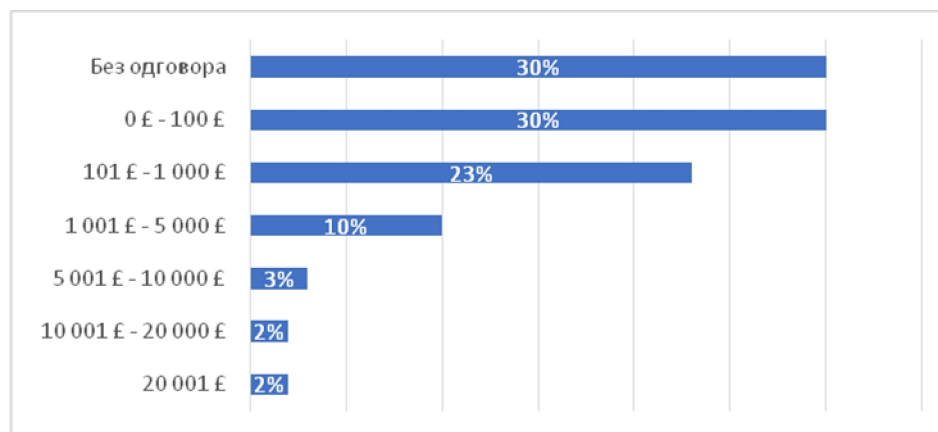
2. MARKET AND ACCEPTANCE OF DIGITAL (CRYPTO) ASSET

The digital asset market has grown exponentially in recent years. It peaked in November 2021 with a market capitalization of US\$3000 billion (The White House 2022). Regardless, the market has contracted since then. Its market capitalization is currently (March 2023) hovering around \$1000 billion, which means that since the beginning of the central bank's heavy crackdown on high inflation and geopolitical turbulence and tensions, the market has lost two-thirds of its capitalization. The decline in the market is directly proportional to the drop in the value of the most prominent digital asset - Bitcoin.

A parallel can be made with the monetary aggregates of the Federal Reserve (Fed - the central bank of the USA) to perceive the size of the digital asset market. In November 2021, the primary money of the Fed amounted to 6,390 billion dollars, of which 2,210 billion dollars were money in use, and 4,180 billion dollars were funds on accounts with the Fed. On the other hand, in the money supply, classic demand deposits in American commercial banks amounted to 4,760 billion dollars, and other liquid deposits amounted to 13,470 billion dollars (Federal Reserve 2022).

Multiple studies confirm the significant number and proportion of citizens who own and transact with digital assets. Research sponsored by the United Kingdom Government (Alice Fearn and Charlotte Saunders 2022) provided an estimate of the size of the population that owns digital (crypto) assets, the demographic characteristics of the owners of these assets and the patterns of their disposal. Around one in ten UK citizens have experience owning crypto assets. More than half (55%) have never sold the crypto assets they acquired. Ownership of crypto assets in the UK is skewed towards the male population (69%) and those of Asian or African descent (19%). A study by the European Central Bank (2022) in the six largest countries of the European Union confirmed an equal share of the population with digital assets - 10%.

An essential piece of information that can only be obtained from studies that include public surveys is the monetary value of crypto assets held by crypto asset owners. Figure 1 shows data for UK citizens. In addition to the UK Government study, another study (Financial Conduct Authority, 2021) confirmed that the median monetary value of crypto assets is between £200 and £300.

Figure 1 Value of crypto assets owned by natural persons in the UK (in %)

Source: Fearn, Alice and Charlotte Saunders 2022.

Only 7% of individuals in the UK hold crypto assets worth more than £5,000, while more than half (53%) hold no more than £1,000 in crypto assets. The percentage of respondents who did not express their opinion on the value of their crypto assets is high (30%). One part of the respondents did not want to comment for reasons of privacy, while the other, probably a larger one, is merely not sure that they know the exact value of crypto assets.

Studies conducted by consulting firms highlight a significant proportion of the population that holds digital assets as part of their financial portfolio, particularly in emerging market countries. Research by McKinsey (2022) indicates that 22% of the population in India and 20% of the population in Brazil hold digital assets in their financial portfolio, while this is the case with 14% of the US population.

3. DILEMMAS IN THE CONCEPTUALIZATION OF CENTRAL BANK DIGITAL MONEY

CBDC can be defined as a digital obligation of the central bank that is freely and unconditionally available to the general public. Currently, the only type of central bank bond obtainable to the general public is physical cash.

The fundamental difference between regular cash and digital cash (money) in general is, in addition to the fact that the newer one does not have a material character and that it is not only seen as a monetary object but equally as a complete infrastructure that is necessary to realize its transfer in space between remote transactors. As an obligation of the central bank, the CBDC does not require using a deposit insurance institute that supports public confidence in the security of the claims in question, and there is no need to form reserve assets that would guarantee their value. Essentially, CBDCs could be characterized as the safest digital assets available to the general public, as they are free from credit and liquidity risk.

The choice of emission design and mode of use is a fundamental issue for all CBDC deployment projects. Nevertheless, any combination of possible options available for developing CBDC must necessarily satisfy three foundational principles (Group of Central Banks, 2020).

First, CBDCs should not impact nor impede the central bank's ability to carry out its entrusted mandate of preserving monetary and financial stability. It implies the preservation of the uniformity of the monetary system and the equal use of all forms of the official national currency, which leads to a unified, effective and efficient financial policy.

Table 1: Core CBDC features

Instrument features	System features	Institutional features
Convertible	Secure	Robust legal framework
Convenience	Instant	Regulatory standards
Accepted and available (e.g. online and offline)	Resilient	
Low or no cost to users	Available (24/7/365)	
	Throughput	
	Scalable (system expansion)	
	Interoperable	
	Flexible	

Source: Group of Central Banks. 2020.

Second is the complementary nature of CBDCs. They should not aim to displace physical cash from circulation. They should coexist with cash and reserve accounts (current accounts) as existing forms of central bank money. The complementary character of the existence of the CBDC should be imperative when harmonizing with the coexistence of existing legitimized private money (bank deposits).

Third is encouraging innovation and efficiency of payment systems. Users will face the challenge of reorienting themselves to other, perhaps less secure, but more receptive and efficient payment alternatives if there is no progress in the established payment system's efficiency. Rade Stankić, Velimir Lukić and Svetlana Popović (2023) point out that the emergence and establishment of central banks was triggered, among other things, by the need to ensure a safe, reliable and efficient payment system in the country. Due to legislation such as the Open Banking Directive in the European Union, non-banking entities have successfully stepped into the field of providing payment services. Their payment services often represent the current boundary of payment innovation. CBDCs could be an incentive to continue the constant payment systems innovation.

Several relevant issues related to CBDC design will be elaborated beneath.

The first relevant choice concerns CBDCs' availability for use: the general public (retail central bank digital currency) or financial intermediaries (wholesale central bank digital currency). While the first option seems to be the logical alternative, there are proponents of the second option who believe that this could make wholesale payments and payment settlement systems more efficient (lower operating costs and simpler collateral management) and safer (better risk management) (Committee on Payments and Market Infrastructures and Markets Committee 2018). This option implies that CBDCs are used as a supplement to traditional reserve accounts with the central bank, traditionally used in the interbank settlement.

In one variant, non-banking financial entities, highly active in the financial markets, can be given full access to the CBDC for payment settlement purposes. Also, benefits from relying on the new technology on which CBDCs are based can arise in the financial assets transfer, authentication, record keeping and data management. CBDC can also be used for securities settlement since a significant part of the work is performed by commercial banks and particular service providers from this domain through their mechanisms and market infrastructure. In theory, transactors with securities or financial derivatives could execute transactions directly, i.e. bypassing intermediaries such as central securities registries or *central counterparties* that are required to guarantee that each party will fulfil its obligation under contracted securities transactions. In the most favourable variant, this would result in the calculation of securities transactions in real-time, which means without or with an

insignificant time delay when contracting the transaction. Settlement employing CBDC could significantly contribute to reducing *counterparty risk* with better monitoring of financial transactions by the central bank.

The Bank of England (2020) highlights three essential design aspects: 1. the division of responsibilities and functions regarding the CBDC system between the public (central bank) and the private sector (financial institutions, payment service providers, fintech and technology companies), 2. the functional design (types of payments that can be made with CBDC, user interaction with the CBDC system and their user experience, expanding the functionality of CBDC in the future) and 3. economic design - access (who can own CBDC?), compensation for users (should interest be paid on CBDC?), amount limits (should the amount of CBDC that an individual subject may own be limited), convertibility (should free convertibility into other forms of central bank money or into bank deposits be foreseen?).

Raphael Auer and Rainer Böhme (2020) highlight four main design choices of CBDCs aimed at the general public: 1. direct or indirect claim from the central bank and its operational role, 2. conventional or distributed central ledger technology, 3. token or account format, and the issue of privacy and 4. coverage of the system (national and/or cross-border payments).

Group of Central Banks (2021a) points out that in order to provide additional access to central bank money to the general public, the CBDC ecosystem should more closely define the cases and examples of payments it wants to support and promote.

The central bank retains the monopoly right to issue and withdraw CBDCs, but the construction of the public's claims on CBDCs and the records and execution of payment transactions in which they are used may vary.

Table 2: Legal and accounting elements of constructing CBDC circulation

Synthetic CBDCs	Direct CBDCs	Hybrid CBDCs
The general public has a claim against financial intermediaries (banks)	The general public has a claim against the Central bank	The general public has a claim against the Central bank
Banks perform the work of customer identification (Know Your Customer) and process their retail payments	The central bank or banks perform the task of customer identification (Know Your Customer).	Banks perform customer identification (Know Your Customer) and process their retail payments
The Central Bank handles interbank settlements based on payment transactions with CBDC	The central bank processes the customer's retail payments	The Central Bank periodically checks the balance of CBDC on individual user accounts

Source: Author's adaptation

Synthetic CBDCs are also called a model of indirect CBDCs, where the general public has a claim that goes to the commercial bank, while only the bank has a direct claim from the central bank based on the CBDC. With this model, financial intermediaries are promoted to facilitators and mediators between the central bank and the general public to dispose of and transfer CBDC. The model can be labelled as two-tier due to double claims. Synthetic CBDCs are issued to economic entities by a commercial bank based on CBDCs held by the bank at the central bank. In financial terms, there must always be 100 per cent coverage of synthetic CBDCs by source and original CBDCs issued directly by the central bank.

The model of synthetic CBDCs completely imitates the existing payment system model in which intermediaries service client payment instructions and perform clearing and

netting with other banks based on payment transactions. The final settlement of payments is made in cash and through accounts with central banks.

Central banks only have insight into the state of CBDCs owned by commercial banks, while they do not have insight into the individual balances of synthetic CBDCs held by economic entities at banks. This deficiency is counterbalanced by the fact that central banks are not responsible for actions such as: verifying the identity of users, providing mobile wallet services, managing user data, independently developing technology, monitoring transactions, resolving user objections and complaints and answering their questions, etc., which are entrusted to banks. Tobias Adrian and Tommaso Mancini-Griffoli (2019) point out that synthetic CBDCs are a cheaper and less risky model for central banks.

The model of direct CBDCs is highly disruptive, as it discharges financial intermediaries from any role in the functioning of CBDCs. The Central Bank assumes full and undivided responsibility for the functioning of the CBDC payment system. It means that it must possess or develop technical capacities that guarantee the reliability, speed and efficiency of CBDC transactions. The central bank independently processes all payments, while users directly own claims on the central bank. The central bank legitimizes itself as a direct competitor to private retail systems such as card systems that have proven robust and efficient in processing a large number of retail payments so far.

Managing the payment network is a demanding task that the private sector has successfully carried out through its initiatives and the technical-technological and human capacities at its disposal. The central bank's success in overcoming the challenge of developing a retail payment network may be devalued by its weaker market success in terms of the reluctance of the general public to abandon private sector retail systems and migrate to a competitive central bank solution. As in any retail system, the central bank is at risk of system interruptions and outages, problems with network access, etc. In addition, organizing the management of the CBDC payment system exceeds the existing organizational capacities of central banks (which causes the employment of new human, material and infrastructural resources) and, in certain cases, the current mandate of central banks.

In addition to these two sharply contrasting models, various hybrid CBDC models can be developed as intermediate solutions where users enjoy direct holding of central bank claims. In these solutions, the private banking sector is not entirely excluded from CBDC functions (e.g. generation and circulation of payment messages). The central bank has a significantly better overview of the payment transactions, although it is not provided in real time. Immediate insight into transactions allows the central bank to occasionally check the current balances of individual CBDC participants. The architecture of the distribution of payment functions and operations between commercial banks and the central bank can be structured in different ways, increasing or decreasing the role and influence of one or the other.

A hybrid model might be the optimal solution for central banks. It avoids the necessary interaction with end-users, which is potentially massive and burdensome, and shares the tasks and jobs related to the maintenance and operation of the system with the private sector so that central banks can focus on fulfilling the primary purpose of introducing CBDC (creating a digital claim on the central bank) and smooth execution of essential processes for the functioning of the CBDC payment system.

The selection of another design element - the technological and computer infrastructure - directly depends on the operationalization of the public claims model based on CBDC. CBDCs can be based on the available infrastructure, i.e. on proven technologies and established computer networks that rely on centrally administered databases. *Distributed ledger technology* (DLT) is most often considered an alternative.

The way the transaction master record is entered and updated differs between the two technologies. Conventional technology uses a rigid hierarchy in the network where there is a master node at the top of the network that intervenes and controls every change in the

transaction database. There is no central node in DLT. Each node is equal in importance and the rights in making changes in the database. DLT has a decentralized character, and for each change in the base, it is necessary to reach a consensus of the nodes in the network, i.e. a general agreement to make the change.

Decentralized systems are slower in performing tasks due to the delay in deciding what to do while waiting for nodes to declare, as in any decentralized decision-making in general. The validation can be left to anonymous validators, since it is an open DLT, but it is unlikely that central banks will allow it. Closed DLT, where the validator participant (node) status is separately assigned, are more acceptable. Existing DLTs, such as blockchain, have incomparably less transaction processing capacity than conventional technologies, so it is difficult to presume that they can serve a direct DVCB model. Therefore, indirect and hybrid DVCB models would be more suitable for this technology.

If CBDCs are realized as tokens, the right and ability to dispose of them will be regulated by cryptographic knowledge and techniques (public and private keys). A token is a monetary instrument representing a monetary value that can be transferred directly between the parties involved without third-party validation (Marcus Brunnermeier and Jean-Pierre Landau 2022). Cash is a form of physical token. Cryptography is to ensure user anonymity, which is why token holders cannot be identified in the real world. The link between the user identity and digital token ownership is not present. The fact that the user has demonstrated knowledge of his public and private key verifies him as a subject who can perform the transaction, while his identity remains unknown.

If the balance and consumption of CBDC are monitored through the user's account, then it is a known mechanism of functioning of the bank account. The user's identity is known and confirmed, based on which the right to dispose of CBDC is appropriated. A specific part of the world's population, even in the most developed countries, is out of the reach of banks and does not use bank accounts. It can be a problem for CBDCs that aspire to universal access to the general public.

The token form satisfactorily fulfils the CBDC's privacy and general access goals and expectations.

The Central Bank may stipulate that users enjoy partial anonymity (concerning third parties, but not the authorities), to set a transaction value threshold below which anonymity is guaranteed, or to make anonymity conditional (only with the order of the judicial authorities is the identity of the user revealed) (Itai Agur, Anil Ari Giovanni and Dell' Ariccia 2019).

A final design issue is the coverage of CBDC payments. They can be suitable for domestic payment transactions but also for international ones. They can be available only to residents and to non-residents too. Despite many improvements, cross-border payments are still expensive, as seen in the costs of remittances and expenses during tourist trips. Payment service providers for cross-border payments charge an additional commission, and each one includes exchange rate differences.

If the basic format is a CBDC account, then the chances of international coverage are restricted. However, if a digital token is used, then there are no obstacles for use by non-residents and, therefore, for cross-border payments.

It is necessary to emphasize the interoperability of the CBDC system within the consideration of the coverage issue. It refers to the features of the system that enable a simple flow of funds into or out of the CBDC system. Interoperability brings the coexistence of the CBDC system with the broader payment ecosystem (Group of Central Banks, 2021b).

Interoperability implies that payments are made smoothly between CBDC users and bank deposit users, and between users of different national CBDC systems in the future, including cross-border payments.

Instinctively, CBDC is associated with physical cash. However, some CBDC design options are not available for physical money. One such option is the interest payment on CBDC. If no interest is paid on CBDCs, they consistently mimic physical cash in the most

vital dimension. Such CBDCs design puts intense pressure on the physical cash demand, which in a particular scenario can fall below the critical level that would justify further widespread use of ATMs. At the same time, traders prefer to make payments with CBDCs instead of cash, the manipulation of which represents a significant cost for them.

On the other hand, if interest was paid on CBDCs, they would be more similar to bank deposits than to physical money. The narrowing of the banks' deposit potential caused by introducing the CBDC would harm the volume of bank loans and, consequently, the economic activity level. It can create unwanted repercussions for countries whose economy relies more on bank financing than financial markets.

Therefore, it can be expected that countries that focus more on the sustainability and development of banking financial intermediation will tend to have their CBDCs imitate physical money to a greater extent and bank deposits to a lesser extent.

Banks will respond to the CBDC introduction, but their ability to preserve their business model depends on their market power (Tommaso Mancini-Griffoli et al. 2018). It is inevitable that a part of the public will migrate to CBDC after their introduction and abandon the banking system. Banks' response may be to increase interest rates on deposits, but banks can also make their deposits more appealing through additional financial services. With higher interest rates on deposits, banks' interest margins narrow, which forces them to increase interest rates on loans. Central banks can lower benchmark interest rates and provide refinancing to banks during the transition period of the CBDC introduction to mitigate the potential rise in interest rates on loans and economic contraction resulting from higher rates. However, the banks will pay a sure price, in the form of lower demand for loans, for introducing CBDC. The greater the banks' market power in the credit market, the smaller the drop in demand will be, and the banks will preserve their profit margins and the stability of their business model. Banks whose market power is insignificant will experience a more intensive quantitative adjustment expressed in the contraction of the quantum of deposits and loans.

Anyways, bear in mind that the general public generally appreciates a broader spectrum of payment instruments available to them due to the heterogeneity of its members' preferences. The effect of crowding out the demand for physical money or bank deposits produced by the introduction of CBDC lowers the level of well-being of the general public in this sense. It would be ideal if the CBDC design was such that it could be differentiated as clearly as possible from physical money and bank deposits, so that it would not be too harsh a competition for them.

4. OVERVIEW AND RESULTS OF PROJECTS ON CENTRAL BANKS DIGITAL MONEY

The interest of central banks to work on CBDC projects has grown in parallel with the proliferation of private digital currencies. As of May 2020, only 35 countries were developing CBDC projects. In April 2023, as many as 114 countries had CBDC research and development projects while being behind 95% of the world's gross domestic product. Eighteen countries from the G20 group are in the advanced stages of CBDC development, while all members of the G7 group have entered the development stage. There are four phases of research work on CBDC, depending on progress: initial research phase, development phase, pilot (trial) phase and introduction phase. A summary of countries' progress by phase is given in Table 3.

Eleven countries have completed the development and pilot phase by 2022 and officially put CBDC into circulation. The largest pilot project is currently implemented in China with the digital Yuan (e-CNY). So far, through several iterations, it included 260

million inhabitants, with the tendency of further expansion. In 2023, 20 new countries are expected to introduce their projects in the pilot phase.

Table 3: Overview of progress in projects aimed at the CBDC development

	December 2021	December 2022
Introduced CBDC	9	11
Pilot phase	14	18
Development phase	14	34
Initial research phase	40	31
Inactive	8	15
Remaining	5	5
Number of countries	90	114

Source: Author's calculation based on data from [Atlanticcouncil](#) 2023

There is an increased interest in CBDC development projects aimed at financial intermediaries with the purpose of cross-border payments, which coincides with the introduction of economic sanctions against Russia. These projects include Multiple CBDC Bridge, Project Dunbar, Project Sela, Project Jura, Project Aurum, Project Helvetia, Project Jasper, Project Aber, Project Rosalind and others. All projects are characterized by partnerships of national central banks with the private sector (Accenture, JP Morgan Onyx, SIX) or research departments of supranational institutions (Bank for International Settlements' Innovation Hub, Eurosystem Innovation Hub).

Countries that have introduced the CBDC are Nigeria, the Bahamas, Jamaica and the countries of the Eastern Caribbean Monetary Union (Dominica, Montserrat, Grenada, Anguilla, Saint Vincent and the Grenadines, Saint Lucia, Antigua and Barbuda and Saint Christopher and Nevis.)

The Bahamas is the first country in the world to launch a CBDC. Amid the corona crisis, Sand Dollar was launched in October 2020. Sand Dollar is available to all citizens and is expected to increase financial inclusion and prevent money laundering and illicit economic activities. It is developed based on blockchain technology. There are currently 303,785 Sand Dollar units in circulation. There are 32,736 mobile wallets, and the Sand Dollar adoption rate is 8%. The speed of Sand Dollar's population penetration can be explained by the slightly later integration with commercial bank applications and third-party mobile wallets, the work on interoperability of which has not yet been completed.

The Eastern Caribbean Monetary Union consists of eight countries, half of which initially decided to launch a CBDC called DCash in March 2021. The goal of introducing DCash is to promote financial inclusion. Consumers and sellers can dispose of DCash through a unique mobile application (mobile wallet) or the applications of financial institutions. In January 2022, the operation of the DCash system was interrupted due to technical problems. DCash, like Sand Dollar, uses blockchain as its technology base. The system operation was restored in March 2022, when the last country of this monetary union (Anguilla) joined the DCash system. The system was upgraded in November 2022 when two new functionalities were added – government payments and integration of third-party mobile wallets.

The largest CBDC project implemented so far is e-Naira. Nigeria issued the e-Naira in October 2021. At that time, 500 million e-Nairas (approximately US\$1.21 million) were in circulation. Nigeria highlighted the increase in financial inclusion from 64% to 95% as a motive for the e-Naira launch, on the basis of which it projected an additional growth of gross domestic product of 29 billion dollars in the next ten years. Lower transaction costs, faster payments settlement, better payment monitoring and enhanced security against fraud were highlighted as relevant during the introduction of e-Naira. e-Naira specifically targets beneficiaries of social programs. Initially, only bank account holders were allowed to use e-Naira. About 2/3 of e-Naira were issued to commercial banks. The number of users reached

close to one million, and in the first year of e-Naira's existence, there were about 700,000 transactions with a total value of about 18 million US dollars. Predominantly, transactions take place in the consumer-seller relationship (90%).

The number of issued e-Naira increased consistently until the end of 2022 (3,292,430 million), only for the amount to rapidly decrease in 2023. So, at the end of March 2023, there was 982,097 million of e-Naira in circulation. According to some estimates, almost half of the users who downloaded the e-Naira application never activated it. Also, the number of retailers accepting e-Naira is significantly below expectations. Penetration of the e-Naira is modest, considering the size of the Nigerian economy. In response to the low penetration so far, the government plans to extend the functionality of the e-Naira to a USSD communication channel that does not require internet access or a smart mobile phone.

In collaboration with the technology company e-Currency Mint from Ireland, the Central Bank of Jamaica has worked intensively on developing its CBDC. The project ended with the pilot phase in the second half of 2021, so the CBDC, known as Jamaican Digital Exchange (JAM-DEX), has been in circulation since May 2022. Transactions with JAM-DEX are possible through mobile wallets. In addition to unique JAM-DEX mobile wallets, two mobile wallet providers have been granted permission to integrate JAM-DEX into their wallets. The primary goal of introducing JAM-DEX was the high cost of storing and handling cash, estimated at seven million US dollars yearly. Transactions in which JAM-DEX should be used the most, according to the central bank of Jamaica, are those between individuals directly (peer-to-peer) and between individuals and small businesses (entrepreneurs, micro and small businesses). JAM-DEX relies on distributed network technology but does not use blockchain. It is a classic example of the CBDC synthetic claims model in which the private sector develops and implements the user interface and opens digital wallets, while the central record of transactions is the central bank's responsibility.

JAM-DEX is the first CBDC to be officially declared a legal means of payment and circulation, which underlines the project's ambition in terms of rapid diffusion of use. On the other hand, the project does not have the ambition to be a pioneer in terms of its innovative functionalities because it was developed in such a way that it does not provide the convenience of cross-border payments. It also takes a conventional attitude towards privacy and anonymity, implying that all users must undergo the identity determination procedure (know your customer).

Of the on-going CBDC projects, China is stealing the spotlight with E-CNY. A massive E-CNY pilot project was launched in 15 cities in 2019 in China. China has taken a different approach compared to other countries. It has prioritized the development of the E-CNY acceptance network, so around 5 million retailers have opened mobile merchant wallets to accept E-CNY payments. The number of transactions in E-CNY is in the hundreds of millions so far. Emphasis is on paying for transportation services, services provided by the government and state-owned enterprises, and consumer goods with E-CNY.

The E-CNY project has a unique design. The People's Bank of China opens accounts for financial intermediaries, while end users dispose of E-CNY in token form. The E-CNY project envisages a significant role for all participants in the financial system (state-owned commercial banks, private commercial banks, and payment service providers), which means that their interests are considered. All affairs related to the wallets of individuals and companies in which tokens are deposited are entrusted to commercial banks.

E-CNY eligibility verification for cross-border payments is being tested through a sub-project involving the second-largest commercial bank in Hong Kong with its selected corporate customers. Although officially part of China, Hong Kong has retained the specifics of its banking environment, which implies a separate legal framework and market infrastructure. Therefore, payments between China and its particular administrative region can practically be characterized as cross-border payments. If this sub-project is successful, it would mean that E-CNY can be successfully integrated with other payment systems in other

countries. Hence the international reach of E-CNY, which can become one of the applicable payment settlement solutions in global trade currently dominated by SWIFT and the US dollar.

CONCLUSION

Technological innovations have triggered a wave of digital asset creation with the characteristics of monetary assets. Central banks need to think about their response to the new digital reality that surrounds them and consider how to integrate their digital assets (digital money) into it, which would strengthen the monetary system and improve the payment system of countries.

Central banks should finely weigh their desires to enable digital payments directly in their money, increase financial inclusion, stimulate innovation in payments, open new channels to increase the effectiveness of monetary policy and prevent money laundering activities, with the pitfalls that the introduction of CBDC opens such as the outflow of deposits from the banking system, contraction of bank credit placements and weakened financial stability. Central banks should find a middle ground between a radical redesign of the existing monetary and financial arrangements and an over-commitment to their continuity, which would prevent the necessary economic progress from being realized. An approach to the development of CBDC that respects all participants in the financial system and assigns them operational roles in the functioning of the digital money system of central banks can prevent disruption and obstructions and, at the same time, strengthen the benefits achieved by it, since it is difficult to envision the future of money without central bank money in digital form.

REFERENCES

- Adrian, Tobias, Tommaso Mancini-Griffoli. 2019. *“The Rise of Digital Money”*. Fintech Notes, Washington: International Monetary Fund.
- Agur, Itai Anil Ari Giovanni, Dell’Araccia. 2019. *„How Could Central Bank Digital Currencies Be Designed?“*. SUERF Policy Note, Issue No 129.
- Alice and Charlotte Saunders. 2022. *Individuals holding cryptoassets: Uptake and understanding*. HM Revenue & Customs, UK government. February 2022.
- Atlanticcouncil. 2023. Accessed on March 15 <https://www.atlanticcouncil.org/cbdctracker/>
- Auer, Raphael, Rainer Böhme. 2020. *„The technology of retail central bank digital currency“*. *BIS Quarterly Review*. Basel: Bank for International Settlements.
- Bank of England. 2020. *„Central Bank Digital Currency: Opportunities, challenges and design“*. Discussion paper. London: Bank of England.
- Brunnermeier, Marcus, Jean-Pierre Landau. 2022. *„The digital euro: policy implications and perspectives“*. Brussels: European Parliament, Directorate-General for Internal Policies of the Union. <https://data.europa.eu/doi/10.2861/279000>
- Committee on Payments and Market Infrastructures and Markets Committee. 2018. *“Central bank digital currencies”*. Basel: Bank for International Settlements.
- Denecker, Olivier, Arnaud d’Estienne, Pierre-Matthieu Gompertz, and Elia Sasia. 2022. *„Central bank digital currency: An active role for commercial banks”*. McKinsey and company. October 2022.
- Enaira. 2023. Accessed on March 11. <https://www.enaira.gov.ng/>
- Federal Reserve. 2022. *„Money and payments: The U.S. dollar in the age of digital transformation”*, New York: FED.
- Financial Conduct Authority. 2021. Research Note: Cryptoasset consumer research 2021. <https://www.fca.org.uk/publications/research/research-note-cryptoasset-consumer-research-2021>
- Group of Central Banks. 2020. *“Central Bank Digital Currencies: foundational principles and core features”*. Basel: Bank for International Settlements.
- Group of Central Banks. 2021a. *„Central bank digital currencies: user needs and adoption“*. Basel: Bank for International Settlements.
- Group of Central Banks. 2021b. *„Central Bank Digital Currencies: system design and interoperability“*. Basel: Bank for International Settlements.
- Hermans, Lieven, Annalaura Ianiro, Urszula Kochanska, Veli-Matti Törmälehto, Anton van der Kraaij and Josep M. Vendrell Simón Hermans. 2022. *“Decrypting financial stability risks in crypto-asset markets,”* in *Financial Stability Review*, European Central Bank. May 2022.
- Mancini-Griffoli, Tommaso, Maria Soledad Martinez Peria, Itai Agur, Anil Ari, John Kiff, Adina Popescu, and Celine Rochon. 2018. *„Casting Light on Central Bank Digital Currency“*. *IMF Staff Discussion Note, SDN/18/08*. Washington: International Monetary Fund.
- Službeni glasnik Rs. 2020. Zakon o digitalnoj imovini. Broj 153. Beograd.
- Stankić, Rade, Velimir Lukić i Svetlana Popović. 2023. *Elektronski platni sistemi*. Beograd: Centar za izdavačku delatnost Ekonomskog fakulteta u Beogradu.
- The White House. 2022. *“Fact Sheet: White House Releases First-Ever Comprehensive Framework for Responsible Development of Digital Assets”*. September 16, 2022.
- Visa. 2020. *„U korak sa digitalnom budućnošću“*. <https://rs.visa.com/about-visa/newsroom/press-releases/prl-23072020.html> (pristupljeno 20.3.2023.)

