Central bank digital currencies: Considerations on a not-too-distant future

Adriano Vilela Sampaio[1] e Vinícius Centeno[2]

Introduction

Technological innovations have been transforming the means of payment used by households, businesses, financial institutions, and, therefore, national and international financial systems for decades. The changes resulting from these transformations do not occur in a void but depend on the preferences and balance of power of the different parties involved.

In recent years, the emergence of cryptocurrencies has raised discussions about the possibility of sovereign currencies losing space in payment systems, a topic that gained greater relevance when Facebook, with its billions of users around the world, expressed its plans to have its own currency. Furthermore, "traditional" payment systems, such as transfers and cards, not only enjoy great trust and credibility but are also becoming increasingly faster and more secure. Instant payment systems that allow transfers any day and time, such as PIX in Brazil, reinforce this trend[3]. These factors raise questions about the role of physical currency issued by the central banks, as in many countries it no longer represents the main form of payment.

Central bank digital currencies (CBDC[4]) are one of the most recent elements in this discussion. The debate has been motivated by different factors, such as technological innovations in the financial sector, new entrants to payment and intermediation services, reduced use of currency in some countries and greater attention to so-called private digital tokens (Commission on Payments and Market Infrastructures - CPMI[5], 2018, p.3). CBDC would have the property of combining innovative technology with the trust and credibility of central banks, which can combine their functions of payment system supervisor and operator to develop a new set of payment arrangements based on digital currencies (BIS, 2020).

For now, the discussion around CBDC presents more questions than answers. That is, there are open gaps throughout all phases of the process, from the motivations that lead BCs to create their

[1] adrianovs@id.uff.br
[2] vinicenteno@gmail.com
[3] In 2020, such systems were present in 51 countries (CARSTENS, 2021).
[4] Despite having the same meaning, the term "central bank cryptocurrency" is no longer used. Here, the acronym CBDC is also used to refer to the concept in the singular.
[5] Linked to the Bank for International Settlements (BIS).

digital currencies, to the variety of designs that their configuration and operation can take, and finally, the possible impacts in the financial system arising from its implementation. Thus, the topic in question is very broad, involving aspects such as security and privacy, the role of private financial institutions, monetary policy, technical limitations, among others. Therefore, this article aims to organize the debate about what is understood by CBDC based on recent international literature, as well as to analyze possible impacts arising from the aforementioned transformations. Given the topicality of the subject, we understand that the development of such objectives can offer a relevant contribution as an introduction to the debate. As will be shown, the theme earns growing interest in the international literature and has been the object of study by several central banks (CBs) and the Bank for International Settlements (BIS), indicating the opening of a vast and fertile research agenda.

The article is divided into three sections. The first presents the definition of CBDC and a typology of currencies, in order to differentiate the CBDC from the others. The second section discusses how the CBDC are being seen by central banks, the research they have been carrying out, as well as their main motivations and intentions. The possible configurations and impacts of CBDC are discussed in the third section, with the final considerations closing the article.

1. Central bank digital currencies: definitions and comparisons

In the wake of the digital transformation of the economy, the wave of financial innovations gives great relevance to the debate about money and payment services. In the meantime, the CBDC are presented as another element of innovation with the potential to bring about changes in the means of payment in the not-too-distant future. Since it can take on very varied designs and formats, the definition of CBDC presented by the BIS is broad and refers to a form of digital currency, denominated in a national account unit, which is a direct liability of the central bank (BIS, 2021, p. 65). Thus, CBDC is legal tender, risk-free and can exercise the three traditional functions of money[6], contributing to an accessible and secure monetary system that accommodates financial innovations and meets the interests of consumers (BIS, 2021).

Considering the scope of the concept, it is necessary to understand what it has in common and how it differs from other types of assets, from paper money to those that, despite exercising some of

[6] The possible limitations of a given CBDC in being a risk-free asset and exercising these functions would be the same as the currency issued by the central bank in question.

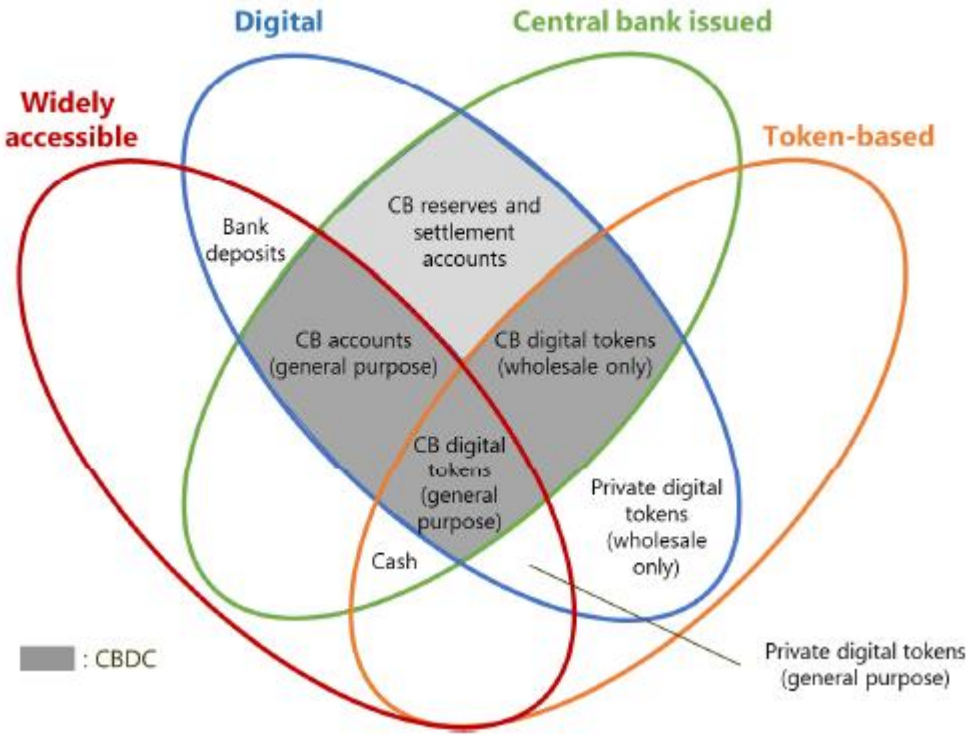
their functions, are not exactly currency. Such distinction will be necessary for the analysis of the possible impacts of the CBDC. Bech and Garratt (2017) present a typology of money that are classified based on four criteria: i) issuer, which may be the central bank or another; ii) form: digital or physical; iii) access, which may be retail, for general purpose for daily operations, or wholesale, for restricted use for large amounts; and iv) transfer mechanism, which can be intermediated or decentralized (peer-to-peer). Regarding the latter, an important criterion is the form of verification, that is, the way in which the settlement of a transaction or access to the resources takes place. The decentralized or peer-to-peer system would use a token, a representative object[7] such as paper money itself. In the case of CBDC, the token would be digital, generated by an encrypted system with a password to validate transactions, without the need to verify identities ("I know, therefore I own")[8]. On the other hand, a centralized system would be based on accounts[9] and validation would take place by confirming the identity ("I am, therefore I own"), ensuring that a certain person is the actual owner of the resources (AUER; BÖHME, 2020; CARSTENS, 2021).

Whether in account systems or via token, the architecture of the validation and registration system can be direct (single-tier retail) or indirect (two-tier retail). In the direct mechanism, the operationalization of the payment system (processing and recording) of all transactions with CBDC would be the responsibility of the central bank. In the case of indirect transactions[10], the intermediary may be a commercial bank or other financial institution. CBDC remains a liability of CB, but with a system for processing and recording transactions via messages by payment service providers (PSP) (AUER; BÖHME, 2020). Despite the different possibilities, the recommendation presented in BIS (2021) is that central banks and PSPs continue to act in a complementary manner[11].

Figure 1 illustrates the general scenario of the typology of money based on the four criteria mentioned above in a Venn diagram.

[7] CPMI (2018, p.4) refers to the token as a "payment object".
[8] In the case of the physical token, the verification is on the object itself (if it is not spoofed).
[9] In account-based systems, there would even be the option for individuals and companies to have accounts at the central bank.
[10] In this case, the mechanism can be intermediated or hybrid, a distinction that refers to the operationalization of the registration of transactions between intermediary institutions and the CB. See BIS (2021, p. 78).
[11] This issue is explored in section 3.3.

Figure 1: The money flower



Source: Bech and Garrett (2017, p. 60) and CPMI (2018, p. 5).

Entitled by Bech and Garratt (2017, p.59) as “money flower”, the figure allows observing four types of digital coins issued by central banks (shaded area). For the analysis of possible changes brought about by the CBDC, settlement or reserve accounts (light shaded area) are disregarded, after all, they have been in operation for a long time. Furthermore, the analysis of the diagram points to other assets that have money characteristics, with some distinct attributes, but also some in common with the CBDC.

On local currencies, coins that are complementary to the Real – not issued by the Central Bank – circulate in Brazil, such as the “Palma” and the “Mumbuca”, which have different designs and characteristics and circulate, respectively, in Fortaleza (CE) and Maricá (RJ). Unlike the Palma, the Mumbuca only exists in digital format. According to the Money Flower, the Mumbuca can be considered a digital local currency and would fit into the same subset of cryptocurrencies, differing from these by having guaranteed convertibility.

An example of a central bank that offers the public the possibility of having accounts is Ecuador, with its *Dinero Electrónico*, a mobile payment service that works as a sort of electronic wallet and is configured as a central bank account (general use). However, because it uses the US dollar, a currency

that is not a liability of the Ecuadorian central bank, the *Dinero Electrónico* could not be in the shaded area of the Money Flower. On the upper left petal are strictly virtual coins, which are issued and controlled by their developers and their use is restricted to a specific virtual community, such as in games (Bech and Garratt, 2017, p. 60).

The so-called cryptocurrencies, such as Bitcoin and Ethereum, fall into the general-use private digital token category, along with stablecoins. The main differences between them are that cryptocurrencies do not have an identified issuer nor are they backed by other assets. Stablecoins are backed by one or more assets (such as commodities and sovereign currencies), which would give greater stability to their value (G7-WGS[12], 2019), hence the nickname stable. With this, these "currencies" seek to address one of the main flaws that hinder the use of cryptocurrencies as means of payment, namely, the instability of value. In this group, Diem (previously called Libra[13]), a stablecoin issued and managed by The Libra Association (which includes, among other companies, Facebook, Spotify and Uber), stands out.

As will be seen in the following section, stablecoins have been raising concerns to central banks about their regulatory aspects, especially those with the potential to be used in international transactions and that is why they are called global stablecoins (FSB, 2020). This caution was made clear in the October 2020 report of the Financial Stability Board (FSB), which states that before they start operating, payment systems based on global stablecoins must conform to existing regulatory standards and to new ones that may be needed *(Ibid*).

2. Central banks and the CBDC: concerns, reasons, studies and actions

The CBDCs have been the object of growing interest on the part of central banks of both advanced and emerging economies. Different CBs around the world are at very different stages in their CBDC projects, from the initial research phase and generic expressions of intent to pilot projects and participation in development groups with other CBs and the BIS.

With the trend towards reduced use of cash and the increased preference for digital payments, a digital currency could serve as a safe, robust and convenient alternative payment instrument.

[12] The G7 Working Group on Stablecoins involves, in addition to the G7 itself, the International Monetary Fund (IMF) and the CPMI.

[13] Besides the name change, it will no longer be backed by a basket of coins, only the dollar, hence the name *Diem Dollar*. It is expected to start operating in 2021.

Therefore, the efforts of central banks around CBDC may also be seen as a strategy with multiple simultaneous objectives, such as financial inclusion, security and integrity of digital payments, establishing a resilient, fast and cheap payments system, and the encouragement of continuous innovation (BIS, 2020). Among the motivations and intentions of central banks in relation to CBDC, we can point out i) interest in technological innovations for the financial sector; ii) emergence of new participants in payment and intermediation services; iii) reduced use of cash in some countries; and iv) growing attention to so-called private digital tokens (CPMI, 2018).

The first CBDC in circulation was the Bahamas Sand Dollar, a general-use CBDC created in 2020. On October 2021, Nigeria launched its CBDC, the eNaira. In Brazil, the central bank announced, in August 2020, the constitution of a study group with the aim of creating a prototype and propose a digital currency model for the country and, in May 2021, released the general guidelines for a digital currency for Brazil[14]. As a general motivation, the central bank claims the intention to promote innovations in the means of payments, considering the environment of accelerated digital transformation in the global economy. The objectives of the creation of the CBDC were summarized in four items: i) to follow the dynamism of the technological evolution of the Brazilian economy; ii) increase the efficiency of the retail payments system; iii) contribute to the emergence of new business models and other innovations based on technological advances; and iv) favor Brazil's participation in the regional and global economic scenarios, increasing efficiency in cross-border transactions. Despite the numerous possibilities for configuring the CBDC, the guidelines published by the Brazilian central bank point to a well-defined design, and among them the following stand out: i) plan of use in retail payments; ii) ability to carry out online operations and possibly offline operations; iii) issuance by the Brazilian Central Bank, as an extension of physical currency, with distribution to the public intermediated by custodians of the National Financial System (SFN) and the Brazilian Payment System (SPB); and iv) lack of remuneration. Finally, the central bank warns that dialogue with the private sector and society in general will be necessary prior to presenting a schedule for the implementation of the digital currency. The guidelines presented allow us to conclude that the impact on the structure of the financial system will be small, with the maintenance of the functions of the CB and other financial institutions.

[14] The note may be found (in Portuguese) on https://www.bcb.gov.br/detalhenoticia/17398/nota, accessed on November 28, 2021.

Among the largest economies, the projects in the most advanced stage of development currently are the digital renminbi (e-CNY), which is already being tested and is expected to be launched in 2022, and the e-Krona, currency that will be issued by Sveriges Riksbank, the Swedish central bank. In addition to the operationalization of the e-CNY[15], its launch raises debate about the internationalization[16] of the Chinese currency and the maintenance of control of the domestic payments system by the Chinese government. As the use of bitcoin is prohibited, e-CNY can also be implemented in order to reduce the power of private electronic payment systems with wide use, mainly Alipay and WeChat, controlled by giants Ant Group and Tencent (KYNGE and YU, 2021). In the case of Sweden, the main motivation refers to the considerable drop in demand for cash in the last decade, causing several commercial establishments to no longer accept cash payments and some commercial banks having stopped collecting and distributing banknotes (Bech and Garratt, 2017). In this context, the Swedish central bank announced, in February 2020[17], a pilot project to test its digital currency, aiming to show how the general public could use e-Krona as a complement to physical money.

In addition, the European Central Bank (ECB) released in October 2020, a report on the digital Euro, but still without a defined operational design or technology. The ECB (ECB, 2020) understands that although cash is still the dominant mean of payment, the growth in demand for digital and instantaneous means is evidenced by the expansion of new technologies for such. In addition to being able to offer citizens a secure form of digital currency in a rapidly changing environment, the ECB also expresses concerns about significantly reducing the use of cash. One of the reasons would be the dependence on the operation of private electronic payment methods, which are beyond the operational control of the ECB and may be temporarily unavailable. Another concern expressed by the ECB is that, in the absence of the digital Euro, foreign digital currencies could end up replacing the existing means of payment. Last but not least, the ECB warns that the decline in the use of paper money can accentuate the financial exclusion of the unbanked population and social groups in vulnerable situations (ECB, 2020).

An interesting aspect about CBDC is that CBs are not working individually. This cooperation is mainly related to the possible implications that CBDC may have on international flows. In January 2020,

[15] In July 2021, People's Bank of China released a technical note pointing out some guidelines for its digital currency, in addition to communicating the stage of development of the process (PBC, 2021).
[16] For a more detailed debate on the topic, see Peruffo, Ferrari and Cunha (2020).
[17] See https://www.riksbank.se/en-gb/press-and-published/notices-and-press-releases/notices/2020/the-riksbank-to-test-technical-solution-for-the-e -krona/, accessed on November 28, 2021.

for example, a group was created[18] to share experience and jointly discuss the creation of a CBDC in their jurisdictions. The group's objective is to address economic, functional and technical design aspects, in addition to sharing knowledge about emerging technologies. Another joint initiative that deserves to be highlighted is the Multiple CBDC (m-CBDC) Bridge, a project to enable an international payments system that would work any day and time and would use a wholesale CBDC. The project gathers the central banks of China, the United Arab Emirates, Hong Kong, and Thailand in partnership with the BIS Innovation Hub[19].

Boar and Wehrli (2021), in a survey involving 65 central banks in 2020[20], highlight that 86% (about 30% more than in 2017) of them developed some type of work (from initial research to implementation projects) associated with the CBDC, both retail[21] (mostly) and wholesale use. CBs without any interest would only be those from smaller jurisdictions. And in recent years, the number of CBs that advanced from the research stage to pilot projects has also increased (14% were in this stage). With regard to the motivations for adopting a CBDC, the research investigated the importance that CBs give to the following factors: i) financial stability; ii) implementation of monetary policy; iii) financial inclusion, efficiency of payment systems (iv) domestic and (v) external transactions; vi) security and robustness of the payment system and vii) others.

Considering the set of factors, in general, developing countries signaled greater motivation for the creation of CBDC, such that from 8 CBs in advanced stages of CBDC creation, 7 are developing countries (Ibid, p.9). This discrepancy is not surprising given that financial inclusion tends to be greater in high-income countries. It is also worth noting that in the “others” group, reasons such as protecting monetary sovereignty in the face of a possible “digital dollarization” were pointed out to provide a public alternative in the case of a possible adoption of private digital currencies (Ibid, p.8). Also, according to the report, interest in analyzing the impacts of stable coins is greater than that of

[18] Currently composed of the central banks of Canada, USA, Japan, UK, Sweden, Switzerland and the Eurozone (European Central Bank) together with the BIS. https://www.riksbank.se/globalassets/media/nyheter--pressmeddelanden/pressmeddelanden/2020/central-bank-group-to-assess-potential-cases-for-central-bank-digital-currencies.pdf. Accessed on November 28, 2021.

[19] See https://www.bis.org/press/p210223.htm. Accessed on November 28, 2021.

[20] Of which 21 are from advanced economies and 44 from emerging and developing economies, which represent 91% of global GDP. In addition to the ECB, the survey covered the “local” central banks of countries in the euro zone. In the 2018 and 2019 surveys, there were 48 and 54 institutions, respectively.

[21] Auer and Böhme (2020, p.97-98) accounted for 17 central banks with some type of project (in different phases) for general use CBDC.

cryptocurrencies (which would be used in niches and in more unstable countries), although there is no general concern about their use as an alternative means of payment.

3. CBDC: Possible designs and implications

The definition of CBDC based on the criteria presented in section 1 is useful to differentiate them from other types of currency and from those already issued by central banks (physical currency and bank reserves). The discussion, however, is far from being exhausted by this distinction. Based on additional criteria, we can make distinctions between the different forms that CBDC can assume as a means of payment and reserve of value. In other words, CBDCs can have very different characteristics and functions and, consequently, very different impacts on the payment system, monetary policy transmission mechanisms, user benefits, the role of the central bank and commercial banks in the system, financial stability, among others.

To be successful, a general purpose CBDC must perform at least the functions already performed by the current set of means of payment (cash and demand deposits), which include, among others: convertibility at par with cash and private currency (demand deposits); broad and permanent availability[22]; conveniency of use, ease of use even for different age groups; low or zero cost of use, there is also a need for minimal investments in technology; high resilience to system crashes and cyber-attacks, provide security and integrity to the payment system and ensure user privacy s (BIS, 2020; GROUP OF CENTRAL BANKS, 2020). In addition, it would have to comply with requirements regarding the identification of customers and combating money laundering and terrorist financing (KYC and AML/CFT[23]) (CPMI, 2018). For the general public, the use of combined with efficient private payment systems such as cards and real-time transfers is already a reality in several countries. In this sense, depending on the design and form of operationalization of the CBDC, it would not imply a major change, nor would it offer substantial benefits. For countries with efficient and reliable banking systems, it may be indifferent to the general public whether your electronic balance in an account is in CBDC or a demand deposit. On the other hand, there are configurations that can be truly innovative and could considerably change the role of agents in financial systems.

[22] Which includes the ability to make transactions offline, even if for limited time and amounts.
[23] *Know your costumer and anti-money laundering and combating the financing of terrorism*, respectively.

One of the choices for the CBDC architecture is between a system via accounts or (digital) tokens. In the case of a token-based system, it would be possible to keep transactions totally anonymous, as in the case of cash and cryptocurrencies, since access would be via password. In the case of accounts, as it is a system validated by identification (I am, therefore I own), there would be a record of all transactions of a person or company, but access to them could be protected with appropriate legislation. As seen in section 2, one of the goals of the development of a CBDC is to create a substitute for physical currency[24]. An effective substitute for physical currency, i.e., a de facto digital currency, would be closer to cash or digital wallets than to bank accounts, which requires guaranteeing anonymity and the possibility of direct transfers, dispensing with financial intermediaries. In this sense, a system via token is necessary. Furthermore, the main requirement is that it is not an exclusionary system, hence the even greater importance of complying with the requirements mentioned in the previous paragraph, especially in terms of availability, convenience, cost and resilience.

The other criteria would be: direct (peer-to-peer) or intermediated transfers and operational availability, whether instantaneous (accessible 24 hours a day, seven days a week – 24/7) or with limited hours and days. Another important feature would be whether, given that it is a liability of the central bank, the CBDC would bear interest or not, which would be possible for both tokens and accounts. In the case of paying interest, there would still be the option of the rate being equal or not to the base rate and being differentiated based on the nature of the holder, amount or other criterion, precisely as a way to encourage or discourage its use (CPMI, 2018). There is also the possibility of instituting CBDC retention limits, something whose feasibility would be greater in systems via accounts than via tokens. Table 1 below allows comparing the different types of central bank liabilities based on the criteria listed above.

[24] Although in the short term this seems to an objective restricted to the Riksbank (Sweden), in the medium term this may become a more relevant issue for other countries.

Table 1: Key design features of central bank money

	Existing central bank Currencies		**Central bank digital currencies**		
			General purpose		Wholesale
	Cash	Reserves and settlement balances	Token	Accounts	Only token
24/7 availability	☑	☒	☑	(☑)	(☑)
Anonymity vis-à-vis central bank	☑	☒	(☑)	☒	(☑)
Peer-to-peer transfer	☑	☒	(☑)	☒	(☑)
Interest bearing	☒	(☑)	(☑)	(☑)	(☑)
Limits or caps	☒	☒	(☑)	(☑)	(☑)

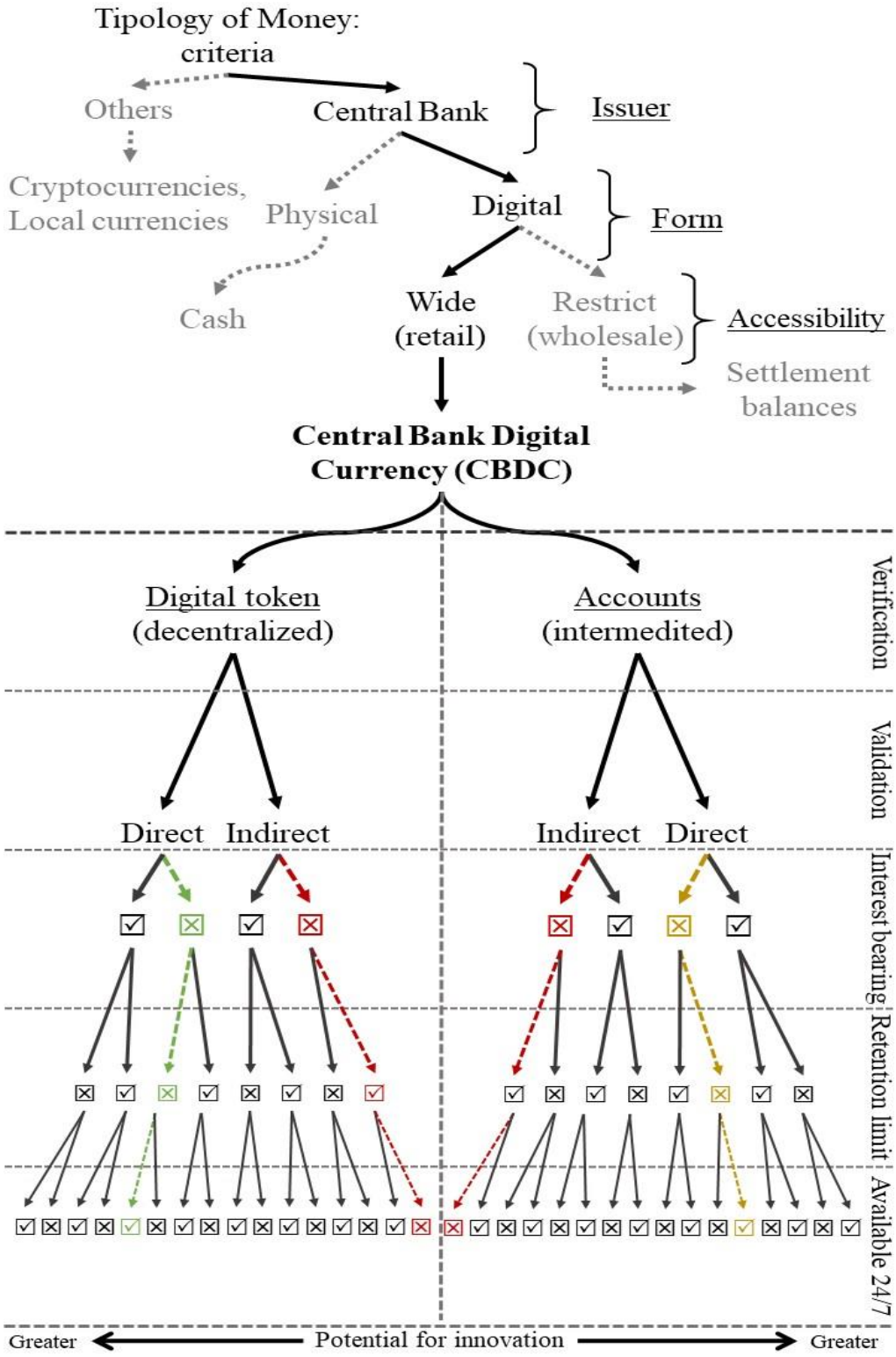
☑ = existing or likely feature; (☑) = possible feature; ☒ = not typical or possible feature.
Source CPMI (2018, p. 6).

As seen in table 1, some of the additional possibilities of general-purpose CBDCs over cash is to allow interest payments and impose retention limits[25]. On the other hand, the possibility of anonymity and direct transfers would be weakened. The availability of an instant payment system (24/7) is increasing in several countries but, unlike paper money, it is susceptible to failure.

These different criteria are not only similar but complementary and are useful in analyzing the implications of different forms of CBDC in the following section. The analysis carried out is based on some of the possible combinations and, given the high number they can reach, it is by no means intended to exhaust the discussion. Figure 2 below shows some of the different forms a CBDC can take. Some "paths" are highlighted and will be analyzed shortly.

[25] Although not covered in the reviewed literature, CDBC could also have a limited period of time for use. Recently, China made transfers using its digital currency with a limited time period for use, which prevents recipients from using the resource for savings, making fiscal policy more effective. Ser: https://valor.globo.com/financas/noticia/2021/04/06/governo-da-china-cria-sua-propria-moeda-digital.ghtml. Accessed in 06/04/2021.

Figure 2: Different CBDC possibilities



Source: Authors' elaboration

The green path, for example, indicates the closest configuration of a digital currency that can replace paper money, as it would not pay interest, have no retention limits, have 24/7 availability and allow anonymity and direct transfers (see table 1). The combinations highlighted in red, on the other hand, would result in a CBDC with low attractiveness, as they would not have permanent availability, would not pay interest and would be subject to retention limits. Finally, with a CBDC whose elements are highlighted in yellow, the opening of central bank accounts would be allowed, something whose implications are not trivial, as discussed in the following subsections.

Wholesale-type CBDCs will not be analyzed, as despite expected efficiency gains in clearing and payment systems, they do not have the disruptive potential of general-purpose ones (CARSTENS, 2021). The use of digital currency would not represent such a big innovation for the so-called wholesale institutions, as central banks already provide digital money in the form of reserves or settlement account balances held by commercial banks and other financial institutions at the central bank (CPMI, 2018). So, the greatest potential for change comes from general-purpose CBDC, accessible to the general public, thus it will be our focus.

3.1. CBDC and monetary aggregates

First, it is possible to do an exercise on how monetary aggregates would be affected. Taking the traditional aggregates, the monetary base (B) would be composed of currency in circulation (CC), bank reserves and CBDC:

$$B = CC + reserves + CBDC$$

And the M1 money supply by:

$$M1 = CC + Demand\ deposits\ (DD) + CBDC$$

The CBDC could change the volume and/or composition of both and the possible implications of such changes are dealt with in the next paragraphs. Consequently, the calculation of the bank multiplier would be altered. In addition to the $\frac{DD}{M1}$ (d) and $\frac{CC}{M1}$ (c) ratios, we would also have $\frac{CBDC}{M1}$(f), where $\mathrm{d} + \mathrm{c} + \mathrm{f} = 1$. The demand for CBDC could occur with a corresponding decrease in CC ($\Delta c = \Delta f$), which would simply change the composition of the monetary base, without changing its stock, the same being true for the means of payment. On the other hand, if the demand for this new asset

occurred with a reduction in demand deposits or even in assets that do not make up the means of payment (outside M1), this would affect the base and the means of payment more substantially.

And how would CBDC be seen in relation to CC and DD, or: how does CBDC place itself in the liquidity spectrum of different asset classes? This question can be answered based on Keynes's concept of monetary interest rate on assets (1996, p.223), given by the sum of yield or output (q), liquidity-premium (l), expected percentage appreciation (a), deducted carrying costs (c):

$$r = q + l + a - c$$

The expected percentage appreciation would be the same for the three assets (CC, DD and CBDC): zero in nominal terms and negative (positive) in real terms, in the same magnitude as inflation (deflation). The CBDC rate is expected to be higher than that of cash because it has an equally high *l* (since it is issued by the central bank), but, due to the functionality of being virtual, an even smaller *c*, especially for large values. In comparison with demand deposits, the *l* of CBDC would be higher. The carrying costs of the CBDC in relation to the DD will depend on the functionality and costs of the CBDC system[26]. Starting from an intermediated system, that is, an account based CBDC, one option would be for the CB to administer them itself (direct system). Ultimately, an individual could have a central bank account and for those whose only bank account functionality is to receive and make payments, the banking system would become virtually irrelevant. On the other hand, the difference between the liquidity premiums could be very low in the case of a resilient financial system that enjoys the confidence of agents (due to the existence of deposit insurance, for example), making the two types of assets almost perfect substitutes. It should also be taken into account that banks offer a set of services that go well beyond demand deposits, such as credit cards, loans of different types, insurance, among others. (CPMI, 2018). Therefore, the agents' preference will fundamentally depend on the CBDC architecture. The comparison between the yields (q) of the three assets is made in the next section.

3.2. Interest bearing

Regarding the choice between cash, demand deposits and CBDC based on the interest rate, there is no possibility that the yield (q) is different from zero for the former, while for CBDC and demand deposits, it is a matter of choice. In the case of remunerated CBDC, we would have q≠0, so these would

[26] Comparing the CBDC via token (direct transfers) and accounts, a higher *c* is expected in the first case, due to the functionality of transferring CBDC via accounts.

become more (less) attractive than bank deposits whenever the interest rate was positive (negative), unless these also started to pay interest. There could, however, be a positive differential in the remuneration of CBDC and demand deposits without this leading to a flight to the former. Due to the aforementioned services provided by commercial banks, which go beyond the movement of funds, depositors tend not to be as sensitive to small differences in costs or remuneration (CPMI, 2018). Furthermore, there would be an option for the rate to be equal or not to the basic rate and to be differentiated based on the nature of the holder, amount or other criterion, precisely as a way to encourage or discourage its use (*Ibid*).

The possibility for the central bank to pay interest on CBDC opens up some possibilities in terms of monetary policy. First, it would be easier to work with negative interest rates, breaking through the "zero lower bound" represented by cash[27] (CPMI, 2018).

They could also enhance the efficacy of monetary policy transmission, as the base rate would even affect M1, but, according to the report, the effectiveness of current transmission mechanisms is satisfactory and improvement could come without the need for the adoption of CBDC. In addition, an interest-bearing CBDC could become more attractive than government bonds for institutional investors (even if the interest is lower than the base rate), affecting the Treasury's financing conditions. (*Ibid)*.

It is clear, therefore, that decisions on the configuration of a CBDC directly condition its role in the economy, a topic addressed in the next section.

3.3. The role of the central bank and commercial banks in the financial system

As previously seen above, factors such as the functionality of the payment system, interest payments, retention limits, among others, influence agents' choice between keeping their resources in the form of demand deposits or in CBDC. Even starting from a specific configuration, it would be difficult to predict how this distribution would take place. This does not, however, prevent inferences about possible impacts of a hypothetical significant migration to CBDC at the expense of demand deposits, which could significantly impact the role of different institutions in the economy's financial system.

In the same way that they passively accommodate the public demand for cash through the conversion of demand deposits (and subsequent adjustment of the level of reserves in the interbank

[27] Simply speaking, the zero rate would be the minimum limit (frontier) of monetary policy, as this is the nominal rate of money, a safe asset to which agents could direct their wealth if the central bank instituted negative rates. If there were still significant circulation of high-value notes, the zero boundary would still be relevant.

market), commercial banks would have to do the same for CBDC. If the demand for CBDC were to occur at the same time as a drop in deposits (that is, without a reduction in the demand for physical currency), there would be a drop in bank reserves, which would resort to the interbank market[28]. The central bank, in turn, would have to increase the monetary base so that banks could meet their liquidity requirements and/or so that there is no increase in the base rate. As the raising of reserves in this market is done using government bonds as collateral, an increase in demand for reserves could require central banks to expand the types of assets accepted as collateral in their monetary policy instruments. (CPMI, 2018). This in itself means that the central bank would affect the liquidity and pricing of a broader spectrum of assets, that is, its importance in the financial system would be increased.

Another potential consequence for commercial banks is that in episodes of instability, the flight to these assets, in the form of digital bank runs (as the CPMI (2018) calls it), could be facilitated, given the lower cost of retaining these assets (compared to physical currency) and the higher ease of movement, even more so in the case of an instant payment system. The scale and speed that these movements can assume would represent risk factors for the stability of the financial system.

The structure and functioning of the financial system, particularly the granting of credit by commercial banks could also be affected. In the event that bank deposits have to remunerate their holders at a rate above of that of the CBDC (whether zero or positive), there would be a lower supply and higher cost of demand deposits, the main source of funds for commercial banks, which could reduce the volume and increase the cost of credit. In other words, there would be a reduction in the bank multiplier, both due to changes in the public's preference for liquidity (DD/M1 ratio) and due to the lower demand for credit if its cost were to rise. This cost increase would be even greater if the CBDC paid interest. Thus, these preferences, together with the possibility for CBDCs to pay interest, can have a significant impact on the volume and cost of credit (CPMI, 2018). We can extend this reasoning to term deposits and other types of investments, as rising funding costs could affect different asset classes.

Therefore, the possible implications of implementing the CBDC depend on factors other than how the public chooses to maintain the means of payment. The decision of a peer-to-peer or accounts system is politically relevant, as it is a choice of the central bank to have a new and bigger role in the payments system. According to CPMI (2018), a system in which central bank accounts are allowed

[28] Given a fractional reserve banking system, a withdrawal proportionally affects more the reserves than the demand deposits of a bank, so that such operation can take the reserve requirement or any other liquidity requirement below the minimum.

would technically be feasible, the question is more about the impacts that this would bring to financial intermediation. If, with regard to means of payment, the central bank could replace commercial banks without major consequences, the same cannot be said for the credit system.

In this sense, the recommendations have been very clear in preserving the two-tier system. In such system, the central bank maintains its role as regulator and supervisor, in addition to executing monetary policy, and banks and payment service operators would be responsible for operating the payment system and financial intermediation, maintaining the division of functions (BIS, 2021; Carstens, 2021). Initial proposals from central banks go in the same direction[29]. One of the reasons is the alleged expertise and ability of financial institutions to operate efficiently and promote innovations in this segment. The handling of retail accounts by central banks, in turn, would bring a series of additional attributions and costs, especially in complying with the standards KYC e AML/CFT standards (BIS, 2021).

3.4. Anonymity x identification

The choice of the degree of anonymity of transactions of CBDC involves several factors, such as the citizens' right to privacy vis-à-vis the State and the regulation of data usage by private institutions. With a completely anonymous system via tokens, privacy would be fully preserved since, like cash transactions, they would not leave any records about the parties and the transaction itself. At the other extreme, a system via accounts would allow the State to monitor transactions to different degrees. In favor of identification would be the need to combat fraud and money laundering operations. The defense of a system with some degree of identification also involves facilitating financial inclusion, as for banks and financial institutions in general, the history of customers is essential for granting credit and other financial services (CARSTENS, 2021). Furthermore, financial inclusion can be of great value for the operationalization and control of payment of social benefits and other types of transfers by the State (*Ibid)*. Another possible risk of a completely anonymous system is that the loss of a digital token password would imply the loss of the CBDC balance, something that has already occurred with holders of cryptocurrencies.

The BIS has defended the account-based system (and consequently identified) and existing projects indicate this to be the trend. The concern in this case is with the use of transaction data by

[29] Like the BCB, mentioned earlier, and the e-CNY (PBC, 2021).

private or public institutions, so access would have to be regulated along the lines of bank secrecy (BIS, 2021). In each country, the value placed on civil society for privacy is different, as is the state's willingness to grant it, so the type of CBDC implemented tends to reflect these preferences.

Due to the limitations of the scope of the article, another aspect that was not addressed is the possibility of international transactions with CBDC. It is worth pointing out, however, that the possibility of a CBDC being used outside its jurisdiction as a means of payment or store of value would make the issuing entity's control over money laundering and other related matters even more compromised. In addition, the possibility that a resident of a certain country could legally and inexpensively hold a CBDC from another country could generate a strong demand for internationally accepted currencies and an abandonment of the local currency, especially in emerging countries, compromising the capacity of local monetary authorities to stabilize the financial system and the foreign exchange market, what Cohen (1998) called monetary substitution. A CBDC via accounts, however, would make it more difficult, as the holding of foreign currency balances by a resident would have to be permitted and regulated both by the issuer and the domestic regulators (BIS, 2021, p.86).

Final remarks

Payment habits and systems have been undergoing profound transformations and digital private currencies, cryptocurrencies and instantaneous means of payment are gaining more and more space and trust among agents. Several central banks, individually and jointly, have been seeking alternatives to accompany the digital evolution of the means of payments, with the CBDC being the way in which they plan to enter this changing environment. However, there are still many uncertainties about the potential costs and benefits of CBDC. These, in turn, are directly linked to the different configurations they can assume. It will still take time for CBDCs to become widespread, if at all, as each central bank has to consider different design options according to the specifics of their jurisdictions.

In this sense, it is not possible to approach the CBDC in a general and homogeneous way, much less present an assertive answer about its consequences. The definition of how the CBDC will be will have profound implications on different aspects, such as the resilience of the domestic financial system, the effectiveness of monetary policy, the role of financial intermediaries, among others. A relevant political issue is that the role of the central bank in financial systems can change considerably depending on the configuration assumed by the CBDC. Issues such as the balance between privacy and oversight

of illegal practices and financial inclusion also lack simple solutions and have been the object of great attention.

One of the aspects to be taken into account is that some of the possible benefits of CBDC do not represent significant advances in relation to existing options, such as instant payment systems, especially where financial systems are sound and efficient. In these cases, what additional benefit could CBDC bring? This question raises an even broader question, which is: are CBDC necessary or desirable? The answer certainly requires a cost-benefit analysis, but it goes much further. In economies with a significant share of informal workers, such as Brazil, the use of cash continues to be a relevant alternative. Except for countries like Sweden, an end or a drastic reduction in the use of paper money is not yet on the horizon. For now, it seems that the development of CBDC by central banks is not intended to replace physical money, but to expand the range of possibilities for users and accompany the wave of financial innovations and technological transformations in financial markets. If or when the creation of a substitute for paper money is a more direct objective of central banks, it is essential that this process is not exclusionary, ensuring access and ease of use for different income and age groups, in different regions, etc.

Thus, despite the CBDC appearing as a reality on the horizon of the international monetary and financial system, the tendency to adopt account-based systems indicates that the objectives of their issuance are not intended to cause major changes, but to ensure that the current design of the banking system and financial support is maintained. In this sense, the movement of central banks can be seen as a defensive strategy, so that they are not excluded from payment systems (and eventually lose the capacity to fulfill other functions). If the world is becoming increasingly digital and new generations tend to use less and less cash, it is up to central banks to monitor and even lead this process. Therefore, far beyond the costs and benefits in isolated aspects, the creation of CBDC must be thought of as the only possible action for the State, and the monetary authority in particular, to continue to play a relevant role in economic systems.

References

AUER, R; BÖHME, R. (2020). The technology of retail central bank digital currency. *BIS Quarterly Review*, março, pp.85-100.

Bank for International Settlements (BIS) (2020). Central banks and payments in the digital era. *In: BIS Annual Report 2019/20. Promoting global monetary and financial stability*, pp.67-96.

Bank for International Settlements (BIS) (2021). CBDCs: an opportunity for the monetary system. *In: BIS Annual Report 2021*, pp.65-95.

BECH, M.; GARRET, R. (2017). Central bank cryptocurrencies. *BIS Quarterly Review*, setembro, pp 55–70.

BOAR, C.; WEHRLI, A. (2021) Ready, steady, go? – Results of the third BIS survey on central bank digital currency. BIS Papers, n.114.

CARSTENS, A. (2021). Digital Currencies and the Future Monetary System. Hoover Institution policy Seminar, 2021. Disponível em: <https://www.bis.org/speeches/sp210127.pdf>

COHEN, B.J. (1998). The geography of money. Ithaca: Cornell University Press.

Committee on Payments and Market Infrastructures and Markets Committee (CPMI) (2018). Central bank digital currencies.

European Central Bank (ECB) (2020). Report on a digital euro, October.

Financial Stability Board (FSB) (2020). Regulation, Supervision and Oversight of "Global Stablecoin" Arrangements. *Final Report and High-Level Recommendations*, October.

G7 Working Group on Stablecoins (G7-WGS) (2019). Investigating the impact of global stablecoins, October.

KEYNES, J.M. (1996) A Teoria Geral do Emprego, do Juro e da Moeda. Nova Cultural: São Paulo.

KYNGE;, J.; SUN YU; Virtual control : the agenda behind China ' s new digital currency. Financial Times, p. 1–11, 17/02/2021.

PERUFFO, L.; FERRARI, A.; CUNHA, A.M. (2020). Criptomercados, o Iuane Digital e o Futuro do Dólar". Disponível em https://www.ufrgs.br/fce/criptomercados-o-iuane-digital-e-o-futuro-do-dolar/. Acessed in 14/10/2020.

PEOPLE'S BANK OF CHINA (PBC) (2021). Progress of Research & Development of E-CNY in China. Disponível em http://www.pbc.gov.cn/en/3688110/3688172/4157443/4293696/2021071614584691871.pdf. Acessed in 18/08/2021