

Carmen Pastor Sempere *Editor*

Governance and Control of Data and Digital Economy in the European Single Market

Legal Framework for New Digital Assets,
Identities and Data Spaces

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Current and Future Central Bank Digital Currency (CBDC) Projects



Pablo Sanz Bayón

Abstract Central Bank Digital Currencies (CBDCs) are monetary projects of digital public money at different stages of development, whose issuance corresponds to central banks. It is a digital representation of money with fiat currency's legal nature. Still, like cash, and unlike electronic bank money, it has the guarantee of a central bank and not a deposit guarantee fund. This means that the monetary authority is responsible for the conditions of its issuance, distribution and value, as well as the network or infrastructure that supports its operation and possible programmability, whether retail (rCBDC) or wholesale (wCBDC). Among the most important examples of CBDC projects are the Chinese digital yuan and the digital euro, the latter still undergoing the study (or preparation) phase by the European Central Bank. The objective of this paper is to carry out a conceptual and comparative study on the development of these and other CBDC projects, providing a regulatory analysis of the consequences that the implementation of this new monetary and technological reality will bring to the banking system, as well as the impact that these digital currencies have on the banking market, the protection of users and their relationship with the rest of the Fintech environment. It will also discuss some of the initiatives taking place at the international level, such as the projects within the BIS *Innovation Hub* to address different issues that will define the final configuration of CBDCs in the near future.

This paper expands and updates the text of a lecture delivered at the III International Congress entitled "Present and future of crypto-assets regulation in the European Union," held at the University of Alicante (Spain) on December 13, 14, and 15, 2023. This work is funded within the framework of: Proyecto CIPROM/2022/26 "Presente y futuro de la regulación de los Criptoactivos en la UE [Legalcripto]". Proyecto Prometeo CIPROM/2022/26, grupos de investigación de excelencia, de la Generalitat Valenciana (P.I. Carmen Pastor).

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1 Introducción

Money, like any element present in society, has evolved. Among the changes, it is essential to emphasise the latest and most disruptive transformation of money, the one brought about by the digital age. While plastic money is progressively displacing cash (metal and paper), we find the appearance of Bitcoin in 2008. This milestone marked a before and after in the history of humanity, being the origin of a new *crypto* ecosystem in which thousands of cryptocurrencies have been supporting projects with different characteristics but with a common philosophy: to dispense with financial intermediaries for the sake of financial decentralisation (*DeFi*).

With the prospects of reinventing the financial system at a global level—and supported by *Distributed Ledger Technology* (DLT)—we will probably find ourselves, together with the emergence and implementation of Artificial Intelligence, facing the greatest challenge that we face as a society: designing the legal framework in which the most powerful phenomena discovered to date will operate. CBDCs arise in a context of digital transformation in which there is a relatively widespread social awareness of the idea of decentralised finance (*DeFi*), with cryptocurrencies and, especially, Bitcoin as the greatest exponent of these. Society is changing, technological development is a reality that multiplies exponentially daily, and the world of new technologies applied to the financial industry (Fintech) has revolutionised the economic system that integrates our transactions and payments.¹

In this context, central banks have been forced to act with the aim of, on the one hand, adapting to the phenomenon of the digitalisation of the economy and, on the other, facing the threat of the loss of monetary sovereignty that they have always held historically. In response to this phenomenon and motivated by the aim of maintaining monetary sovereignty, central banks have been forced to work on developing monetary assets with the potential to be programmable and cryptographic, projects known as “Central Bank Digital Currencies” (CBDC). As the historian Theodor Mommsen said, control of the currency is a manifestation of the power struggle for political hegemony.²

This paper aims to make a precise delimitation of the concept of CBDCs, establishing the differentiation concerning other digital assets, as well as between the different projects of digital currencies issued by central banks. Specifically, the various situations in which some projects find themselves will be compared at a technological and economic level. Likewise, the legal framework currently regulating this phenomenon at the European Union level will be analysed, the role of monetary authorities in distributing this type of digital currency to the public and the alternatives presented to carry out this distribution.

Finally, the advantages and disadvantages of central bank digital currencies will be examined in detail, with special reference to the potential problem of user privacy loss in financial transactions. In terms of its objectives, this study aims to establish a

¹ At this point, we refer to a previous work: Sanz Bayón (2020a), pp. 69–110.

² Zunzunegui (2023).

broad and precise view of CBDCs' current situation, the advantages they can provide over other alternatives, and the potential risks that may arise from their adoption. Specifically, it will attempt to present an overview of where our financial system currently stands and where it is headed.

2 Conceptual Delimitation of Central Bank Digital Currencies (CBDCs)

2.1 Concept and Common Features of CBDC Projects

It is not easy to select a particular milestone as a proxy for the origin of central bank digital currencies. Surely, the first to approach the concept of what we now consider a digital currency issued by a central bank (from now on, "CBDC") was the American economist James Tobin in 1987. However, the idea behind this concept did not develop solidly until, eleven years after Bitcoin appeared in 2008, Facebook announced its future project to launch its digital currency, known as Libra, and later called Diem (a concept that will be analysed *below*). It is then that the main central banks, representing 20% of the world's population, reacted by announcing that they were working on their respective CBDC projects with the intention of a medium-term issuance.³

The origin of CBDCs responds to the need for central banks to preserve their monetary sovereignty that of the State. This involves an effort at the supranational level to provide a solid and coordinated response to alternative financial assets, especially decentralised crypto assets and *stablecoins*. At the end of 2019, the *Bank for International Settlements* (from now on referred to as "BIS"), based in Basel, Switzerland, surveyed 76 banks representing 75% of the world's population, including 21 banks from advanced economies and 45 from emerging economies. The results indicated a promising future for CBDC.⁴

1. 25% of the central banks in the study considered that they had the authority to issue their digital currencies or would soon have them.
2. 80% of central banks were researching their digital currency projects.
3. 60% of central banks were already considering the impact that *stablecoins* such as Facebook's Libra could have in the future.
4. Some 10% of the central banks surveyed expected the adoption of a global purpose around CBDCs in the short term (i.e., in the next three years).

However, even if this large number of central banks acknowledged that they were advancing their CBDC research, the purposes guiding their research were not the

³For more on this question, see Auer et al. (2020), pp. 9–19.

⁴BIS Innovation Hub (2020) BIS: A fifth of world's population soon to have central Bank digital currency.

same. While banks in emerging countries understood (and continue to understand) that CBDCs were a mechanism aimed at improving the efficiency and security of national payments and promoting financial inclusion, advanced economies were motivated by improving payment security and financial stability. Due to their situation, the former are the ones who are taking the lead in their implementation. Emerging countries typically have vulnerabilities in terms of cash control, with large social layers excluded from the financial system. Moreover, these countries tend to experience difficulties in preventing money laundering and it is a challenge for them to rapidly implement the digitisation of their financial services sector.⁵

Regardless of the Central Bank's approach to adopting CBDCs, one thing is clear: these digital currencies have to be stable and serve not only as a store of value but as a means of payment, with the same capacity as cash has. In addition to the above findings, the BIS released the charts related to the survey, which show the boom in central bank commitment to CBDCs. In turn, the knowledge that the world population was acquiring about the concept of CBDCs was *in crescendo*, as observed by the growth in the number of public conferences organised by representatives of the main central banks, as well as in the volume of searches carried out in the main Internet browser, *Google*.

Likewise, the COVID-19 pandemic brought a series of social distancing measures that caused undoubted social concern about the health risks associated with using cash in economic transactions. Medical recommendations by the authorities to reduce the number of cash transactions to contain the spread of the virus led to a large increase in electronic payments. As a result, digital assets (including CBDCs, even if they were at the project level) benefited until they reached the stage at which they are currently.⁶

According to the *Atlantic Council*, around 90 countries are considering introducing their form of digital money soon, of which forty announced they were in a research phase in 2021. There are also experiments with wholesale CBDCs, such as the Helvetia project, in which the BIS and the Swiss National Bank participate. Thus, according to the previously mentioned source, at the beginning of 2023, up to 119 countries were involved in studies with CBDC projects in different phases, and a year later, the number of countries rose to more than 130 from countries that have started some research CBDC to nations that have already issued them. These countries represent 98% of the world economy.⁷

⁵Generally, we refer to documents authored by: (i) BIS (2020) Central bank digital currencies: foundational principles and core features, and (ii) BIS (2021) Central bank digital currencies for cross-border payments. Report to the G20. See also Nabilou (2019).

⁶Many central banks have initiated projects to understand DLT technology for wholesale and retail purposes. The first work to be published on retail CBDCs gave rise to "e-krona" in Sweden, while in China "e-CNY" (better known as the Chinese digital yuan) has been tested in several cities for four years. In 2020, the Central Bank of the Bahamas issued what many consider the first live retail CBDC, the Sand Dollar. To delve into these key points: Arner et al. (2020a).

⁷With all this, according to *Statista*, it is estimated that by 2030, the CBDC market will go from being worth \$100 trillion (in Anglo-Saxon terminology, i.e. one hundred billion dollars) to

In recent years, more voices have been raised calling for central banks to evolve and implement the possibilities that new technology, including *Distributed Ledger Technology* (DLT), provides them.⁸ In particular, the Institute and Faculty of Actuaries of the United Kingdom advocates avoiding moving away from the legal tender in favour of a private electronic money issuer since this would seriously undermine the main monetary authorities, i.e., the central bank's ability to apply its policies.⁹

Once the origins of CBDCs have been exposed, it is possible to conceptualise them based on their characteristics (which will be explained *below*) and always be aware that it is a dynamic concept about which there are still many unknowns since it may present various variants, as will be explained later. They are digital currencies issued by central banks, backed by them (which would provide them, a priori, with great security and stability) and supported by DLT technology. However, the type of technology could depend on whether it is a retail or wholesale CBDC.¹⁰

In this regard, we must establish the appropriate differentiation between the two classes above of CBDCs. While retail CBDCs allow for widespread use and refer to all payments between individuals, consumers, and merchants, wholesale CBDCs are designed to make transactions in the interbank market, between commercial banks, and clearing houses more efficient.

As Ashley Lannquist, Head of the Blockchain and DLT Project at the World Economic Forum (WEF), says, retail CBDCs have as their main purpose, among others, to potentially increase financial inclusion and be a strategic alternative to physical money in economies where cash is reduced. They also can improve payments between individuals in the same country and from different countries, as well as know-your-customer (KYC) and *anti-money laundering* (AML) processes to curtail money laundering. Moreover, let's consider that CBDCs were born as a reactive mechanism of central banks in the face of the rise of privately developed decentralised alternative means of payment such as cryptocurrencies. We can conclude that the phenomenon the latter were enjoying would stagnate or at least slow down, especially in those countries where the use of cash is decreasing.¹¹

representing a value of \$213 trillion (in the same terminology as the previous metric). In addition, narrowing the focus even further, in 2023 the *Official Monetary and Financial Institutions Forum* (OMFIF) predicted that by the end of 2028, more than 40% of central banks would have issued their own CBDC. Having presented the factual data, the conclusion is clear: more and more central banks in different countries are developing their digital currencies with an expected medium-term issuance. As of today, we could say that, although it is difficult to generalise, the central banks of the 130 countries are led by the Central Bank of the Russian Federation and the Central Bank of the People's Republic of China, which have made substantial progress in their CBDC projects, with some of these digital currencies already in circulation (in the testing phase).

⁸Zetzsche et al. (2018) and Raskin and Yermacl (2016).

⁹Ward and Rochemont (2021).

¹⁰Klein (2020).

¹¹World Economic Forum (2019).

2.2 *CBDC Technological Infrastructure: With Special Reference to DLT/Blockchain*

While most CBDC projects do not determine the technology that will serve their technological infrastructure, it is worth mentioning DLT technology, which underpins several CBDC projects. DLT is a decentralised ledger system that allows data management to be distributed among several participants. In such a system, data is distributed among several nodes in a network. In terms of its origin, DLT technology comes from a combination of three technologies that already existed previously, namely¹²:

1. *Peer-to-peer* (P2P) networks: Models in which each participant acts simultaneously as a client and provider of resources.
2. Asymmetric key cryptography allows the secure exchange of information between two parties. It is used to authenticate the sender, ensure that the message is complete and, through encryption, prevent third parties from accessing the information in case they could intercept it.
3. Consensual algorithms: Thanks to these, several participants, who probably don't have to know each other, can reach an agreement to add transactions to the ledger.

DLT technology is thus characterised by being secure and tamper-resistant (data is stored in several places simultaneously and verified using cryptographic algorithms).¹³ In addition, to change a part of the network, validation by most participants is required before being accepted, thus minimising errors and fraud that may occur. In this sense, the technology provided by the blockchain allows greater efficiency in financial transactions and the possibility of preserving the user's privacy. The latter is one of the major concerns hovering over CBDC research projects.¹⁴

Finally, although CBDCs are frequently associated with DLT technology, this causal link does not necessarily exist since CBDC projects do not use this technology. Still, other more traditional technologies are deployed on telecommunications infrastructures. A good example of the latter can be found in the Jamaican CBDC (JAM-DEX), launched in July 2022.¹⁵

¹²BBVA Research (2019).

¹³It is also necessary to differentiate two concepts that are sometimes used interchangeably: Blockchain (known to be at the base of how Bitcoin works, mainly) and DLT. The second encompasses the former, a type of DLT that records transactions on blockchains. Each of these has a set of transactions and a reference to the previous block, which makes the traceability and security of transactions possible. The cryptography and consensus of the nodes that are part of the network, in some cases using algorithms such as *proof of work* or *proof of stake*, provides security to the network. DLT technology, with implementations such as IOTA or Corda, is a digital infrastructure suitable for recording transactions, and *Blockchain* is just one more manifestation of DLT.

¹⁴Catalini and Gans (2016).

¹⁵Spanish Data Protection Agency (2023).

2.3 *Typology of CBDCs*

2.3.1 Characteristics of CBDCs

Although it may seem premature to precisely delimit the different forms of CBDC that may exist or may do so, as it is an instrument in the process of design, it is possible to choose to follow the classification proposed by Fernández de Lis and Gouveia based on the characteristics of cash. This liquid and tangible asset is exchanged between peers, is universal, anonymous and does not accrue interest.

CBDCs only share the characteristic of being exchanged between peers (*peer-to-peer*), but they have variants in the rest of the characteristics, which can be:

1. Universal or restricted access to a group of users.
2. Open or closed (limited to certain financial institutions).
3. Anonymous (such as cash) or identified (such as current accounts). The former alludes to token-based CBDCs, while the latter refers to account-based CBDCs.
4. Interest-generating or not.

Along these lines, although we are aware that the possibilities of categorising the types of CBDCs could be very numerous, in this work, it has been decided to synthesise their modalities into four:

1. CBDCs that allow interbank settlements: these would be digital currencies restricted to use by banks (which in the future would improve their wholesale payments system, currently real-time gross settlement or RTGS), identified (not anonymous) and non-interest-generating.
2. CBDCs are similar to cash, aiming to replace it with one universal, anonymous, and interest-non-generating. Cash has historically been used in fraudulent activities (see the case of money laundering, for example), and changing this means of payment for a more efficient one could be a feasible alternative to end these criminal activities.
3. CBDC as a policy tool: with the same characteristics as the previous category, but with the possibility of generating interest, applying the interest rates (negative or positive) that best suit the specific economic situation.
4. CBDCs that serve as public deposits in central banks should have universal characteristics, be identified currencies (with the risk of loss of anonymity that cash allows) and be non-interest-generating. This would eliminate the risk of instability in banking crises.

2.3.2 Advantages and Disadvantages of Each Type of CBDC: In Particular, the Problem of Loss of Privacy

On the one hand, the first option of the four described *above* would increase the efficiency of wholesale payment systems since it would replace the current infrastructure of the RTGS, which gives central banks the role of guarantors of

transactions. In addition, the network would be expanded (via DLT) to new participants who could compete with banks, which would reduce costs.¹⁶ Even so, it seems unlikely that a CBDC (based on a national payment system and therefore subject to a specific jurisdiction) can compete in this aspect with decentralised cryptocurrencies (the greatest exponents of *DeFi*).

The second option, on the other hand, would allow cash to be replaced by a more efficient alternative, especially regarding payment between individuals. This is because cash production comes at a cost and can be easily lost or stolen. However, a drawback that should not be ignored is the loss of anonymity that characterises cash. Monetary authorities supporting a CBDC through a deliberate decision could only guarantee this intrinsic characteristic of cash.

The third alternative analyses the possibility of issuing a CBDC that would generate interest, which would be very positive for applying a specific monetary policy. However, the greatest doubts lie in the fact that a central bank has at its disposal a tool that can produce the impoverishment of the entire population (in nominal terms) and that is located on the border between monetary and fiscal policy. This is surely incompatible with the independence of central banks.¹⁷

The fourth of the alternatives is the most disruptive since it raises the possibility that the general public could open an account with a central bank. This would end the problem of banks' weakness in times of crisis (many bailouts are carried out to save many financial institutions when they have serious liquidity problems). However, like the second option, it also has the drawback of losing privacy and raises serious questions about where commercial banks would stand in the financial system. The latter is explained by the fact that customers would likely move their deposits into their central bank accounts, causing financial panic in commercial banks. In addition, as can be deduced, there is a common drawback in the last two alternatives: central banks would be given excessive power if allowed to offer deposits to the public, and this decision can be highly controversial.

Having briefly outlined the advantages and disadvantages of each of the four types of CBDCs that have been previously defined, the issue of loss of privacy is of most concern to future users of central bank digital currencies. Thus, the most controversial issue raised by the hypothetical issuance of the digital euro, and even more because of the recent entry into the preparation phase on 1 November 2023, is the possible loss of anonymity provided by cash payments. In fact, according to a public survey conducted by the European Central Bank (from now on ECB), the main feature that the digital euro should offer is to respect the privacy of its users.¹⁸

¹⁶This is in line with the aim of regulating payment services in the Proposal for a Regulation of the European Parliament and of the Council of 28 June 2023 on payment services in the internal market and amending Regulation (EU) No 1093/2010.

¹⁷Barrdear and Kumhof (2016).

¹⁸Most recent European discussion of this available at: EDPB-EDPS (2023) Joint Opinion 02/2023 on the Proposal for a Regulation of the European Parliament and of the Council on the establishment of the digital euro European Data Protection Board y ECB (2020) The role of cash.

Even before the emergence of blockchain technology, digital wallets were already an existing reality. However, they had the exclusive function of digitally representing physical goods, such as currency or other payment instruments, to facilitate online transactions. However, the ability to manage assets that do not have a physical counterpart (as an asset to back it up), including crypto assets, establishes the need to develop secure and accessible forms of custody. As Professor Barresi and Professor Zatti rightly predicted four years ago, this scenario exposed us to the new need that went beyond increasing the efficiency of payment systems linked to Web 2.0 and focused on connectivity and data.¹⁹ Thus, in Web 3.0, which is based on consensus and peer-to-peer algorithms, digital wallets would take on a different function, with a corresponding effect on the different technical, economic and legal aspects.²⁰ The first to use the concept of Web 3.0 in the context of cryptocurrencies was Ethereum co-founder Gavin Wood.

The first situation where a custody system with features such as digital wallets is necessary is CBDC management. As discussed *above*, the fundamental objective of a CBDC is to use technology to improve the efficiency of the payment system. However, this must be combined with maintaining price stability and user confidence in the payment system. Together with these issues, there are other critical aspects such as universality—as a measure of financial inclusion of all agents and social groups—and the protection of user data and privacy. Universality requires that digital wallets be managed, from a legal point of view, as necessary tools with the capacity to identify the person while simultaneously capable of guaranteeing full compliance with the rules on personal data protection. This is essential to ensure a high level of privacy and a low risk of illegal use of CBDCs, complying with anti-money laundering and countering the financing of terrorism (AML) rules. On a technical level, solutions such as creating *multi-party computations* and *zero-knowledge proof*, among others,²¹ have been proposed.

Although there are specific cases in which certain central bank digital currencies use traditional technologies based on telecommunications infrastructures (as is the case of JAM-DEX), most existing projects today are based on distributed ledger technologies (DLT), using blockchains of a private nature. However, one thing seems undeniable: in all these cases, the user needs a smartphone to access and use their coins. In this way, mobile applications that function as a digital wallet have access to millions of personal data that allow the identification of the customer and the application of other legal obligations (known as the *know your client* regulation, or, for its acronym in English, KYC). Certainly, mobile phones, as present and future support for digital currencies, present serious problems in safeguarding data privacy and security, which distances these currencies from one of the basic properties of cash, its anonymity.

¹⁹Zatti and Barresi (2020).

²⁰Turi (2023).

²¹Zatti and Barresi (2020).

Another factor to consider is that DLT/*Blockchain* networks are not anonymous and could be monitored. Likewise, another role that must be precisely defined is that of intermediaries between the central bank and the end user since they will also have a large amount of personal data that will be subjected to the appropriate processing to ensure the tracking of transactions.

Focusing on a more specific level, we examine the case of the digital euro. So far, the latest work on the digital euro published by the ECB in October 2023 argues that it will have characteristics similar to cash but incorporating the electronic aspect. Thus, in addition to allowing maximum security in payments (both in shops and in online purchases and transfers between individuals), the European Union's digital currency will allow, in the words of the highest monetary institution at the community level, “the highest possible level of privacy”. We can deduce from the words of the ECB that its purpose is to resemble as much as possible the current physical euro, adapted to the needs of the moment in which we live.

The ECB argues that electronic transactions linked to digital euro accounts opened with credit institutions will be processed only to control and combat money laundering (for this reason, the exclusion of full anonymity is avoided). This is already done today with transactions linked to physical euros. On the other hand, the ECB is strongly committed to ensuring privacy in offline digital euro payments. However, for reasons of control over money laundering, full anonymity is excluded. However, the digitisation of a currency certainly carries a traceability risk regarding where and when transactions are made. In addition, there is a possibility of access to private personal data that should be duly regulated in the future.

In short, the ECB's purpose is clear: to strike a balance between the protection of privacy and the ability to trace financial transactions to avoid the problems that can occur (in the form of criminal activities, for example). The question arises is how far this power can go in the hands of central banks and, specifically, the ECB, to exert even greater control over economic transactions. That is the most disturbing aspect of developing this and other digital currencies. Without a doubt, the user's privacy and the existence of minimal interference in personal data must be rigorously guaranteed, and all this by doing so from the original design of these digital currencies.²² Even so, as is logical, a proportionate and justified balance must be guaranteed between protecting data privacy and other objectives, such as fighting money laundering and tax evasion. If a thorough and joint analysis of the risks to users' rights and freedoms is conducted, CBDC projects will come to fruition more quickly than expected.

²²In this regard, it will be of great relevance to refer to the latest advances in the BIS *Innovation Hub* projects that I comment on in Sect. 4.1 of this work.

2.4 *Differences Between CBDCs and Other Monetary Concepts*

To achieve a precise conceptual delimitation, in the following sections, the concept of CBDC will be distinguished from both the idea of cash and electronic bank money, as well as terms such as *stablecoins* or crypto assets, to which CBDCs are opposed, and what is known as *tokenised bank money*.

2.4.1 Cash and Electronic Bank Money

As we mentioned at the beginning of Sect. 2.2, cash is a liquid and tangible asset that can be exchanged between peers, is universal, anonymous and does not accrue interest. For their part, CBDCs, even though they share (or aspire to share) characteristics of physical money, are digital currencies and, as such, can incorporate functions that are impossible for physical money. Through them, access to the central bank's liabilities is increased, giving way to the third form of central bank money, cash and reserves, called "primary issuance".

The main distinction between *tokenised* and account-based money lies in the form of verification required for its exchange. Payment systems based on the former depend essentially on the ability of the beneficiary to verify the validity of the object used for payment. In the digital ecosystem, the concern is the authenticity of the *token* (or currency) and the possibility that it has already been spent; in the case of cash, there is concern that it has not been counterfeited; by contrast, systems based on account money rely fundamentally on the ability to verify the identity of the account holder. Consequently, one of the main concerns is identity theft, which allows criminals to withdraw money from accounts without authorisation from the owner. In fact, without the corresponding identification, it is not possible to correctly relate payers and beneficiaries.

Cash does not generate interest but is available at any time and place, is anonymous and can be transferred "peer to peer (P2P)". On the other hand, electronic bank money (called "balances in reserve and settlement accounts") can generate interest. Still, it is not available at any time and place, nor is it anonymous to the Central Bank, nor can it be transferred between individuals without a monetary authority being aware of it. Finally, digital currencies issued by retail central banks would be available anytime, anywhere. They could be anonymous (hence the importance of establishing proper regulation that safeguards users' privacy), transferred between individuals, and even generate interest. However, the characteristic that establishes the greatest difference of this category concerning the others is that CBDCs are digital currencies with programming capacity, which allows the monetary authority to set limits on the availability of funds and even for these funds to "expire" over time.

2.4.2 Cryptocurrencies and Stablecoins

In addition to the above distinction, CBDCs—as digital representations of a country’s fiat money or economic area, which is issued and backed by the corresponding central bank—must be demarcated from so-called *stablecoins*.²³ CBDCs are digital currencies pegged to an official currency already in progress and with the above characteristics (see Sect. 2.2). The former constitutes a form of public money, while the latter represents private money.²⁴ As a mixed monetary asset, stablecoins are virtual currencies with parity or peg to a *fiat* currency, such as the euro or dollar, or pegged to the value of an asset, such as gold. Thus, *stablecoins*, unlike non-intermediated cryptocurrencies, are characterised by their ability to stabilise their price since they are backed by an underlying asset (reserve). In addition, they can correct the instability of non-intermediated cryptocurrencies, thanks to the limitation of issuers where they will operate and the setting of a reference value concerning legal tender fiat money.²⁵

As introduced *above*, *stablecoins* can be backed by *fiat currencies* (*fully reserved*), cryptocurrencies (such as DAI, backed by *Ethereum*), other assets (such as gold or real estate), or controlled by algorithms (referenced to an index and without any backing). In short, *stablecoins* were born to put an end to some of the main drawbacks of the original cryptocurrencies, such as the high volatility of their value and the absence of backing, while taking advantage of their benefits, including the use of technology, programmability and financial decentralisation. The main exponent of this category was *Diem* (formerly called *Libra*), the failed *stablecoin* of *Facebook* (now *Meta*).²⁶

Algorithmic *stablecoins* encounter serious problems, including, on the one hand, their volatility, understood as a lack of stability as they do not have the backing of an economic regulator, and, on the other hand, the negative consequences of anonymity in transactions, such as the possibility of being used in criminal activities.

In Prof. Zatti’s opinion, before allowing the creation and issuance of coins privately (without intermediaries), it is elementary to understand the potential consequences on a particular jurisdiction’s values, principles and financial objectives.²⁷ These are the three critical elements that condition the adoption of a currency as a *legal tender*.²⁸ El Salvador was the first country in the world to adopt the Bitcoin cryptocurrency as an official tender in June 2021, and it has continued to be the reference country.²⁹ However, adoption has not been exempted from the problems

²³Iberpay (2023).

²⁴Dyson et al. (2016).

²⁵ECB (2020) and Arner et al. (2020b).

²⁶Zetzsche et al. (2019).

²⁷Zatti (2023), pp. 3–13.

²⁸Sono (2023), pp. 700–720.

²⁹El Salvador’s Royal Decree number 57 (also referred to as the “Bitcoin Law”) was passed on June 9, 2021, and came into force on September 7 of the same year, ninety days after its publication.

described above and Prime Minister Nayib Bukele's criticism because, according to polls, less than 5% of Salvadorans know what Bitcoin is.³⁰ In this sense, Prof. Filippo Zatti understands that two critical aspects deserve to be considered in this decision: On the one hand, El Salvador's link with the IMF, since the country is looking for a way to be financially independent; on the other, Salvadorans' relationship with the "new fiat money," which connects with the still scarce use of Bitcoin by the population of El Salvador.³¹

2.4.3 Tokenized Bank Money (e-Money Token)

Tokenised traditional assets are cryptographic representations of traditional assets that use DLT (or analogous) technology in their registry, which banks can issue. Thus, the *electronic money token (e-money token)* is a *stablecoin*, a type of crypto asset that was born to be used as a medium of exchange of stable value thanks to the fact that it is referenced to the value of a fiat currency, legal tender. As opposed to tokenised bank money, CBDCs are digital currencies issued by and backed by a central bank, not *stablecoins*. Consequently, the digital euro, for example, would not be a *stablecoin* replicating the euro's value but the digital form of the same currency whose control would fall to its issuer, the ECB.³²

In addition, tokenised bank money is regulated in Title IV of the European Union's Markets in Crypto Assets Regulation (hereinafter, "MiCA"), while the digital euro (EU CBDC project), which will be developed in the next section of this chapter, is outside the MiCA regulatory framework.³³ This subsection of the former to the Regulation means that e-money *token* providers are subject to obligations, including the supervision and regulation of a banking authority (in this case, the European one) and that issuers of tokenised bank money will be required to have a MiCA license and an e-money license (subject to the European Directive on electronic money).³⁴

In this regard, it is worth paying attention to tokenised bank deposits as an expression of bank money tokens deployed in DLT networks. In mid-2023, up to 9 banks joined the Federal Reserve Bank of New York's innovation hub to develop a proof of concept of the Regulated Liability Network (with a wholesale CBDC). BNY Mellon, Citi, HSBC, PNC Bank, Mastercard, TD Bank, Truist, U.S. Bank and Wells Fargo participated in the development of the project, with a common aim: to introduce a series of improvements in the dollar, but always maintaining the currency's hegemonic position in the international macroeconomic environment. Thus, they outlined their well-known desire to create an analogue to a US CBDC. As

³⁰ On this point, we refer to a previous work: Sanz Bayón (2021b), pp. 5–9.

³¹ Zatti (2023), pp. 3–13.

³² ECB (2021), p. 247.

³³ Annunziata (2023a), p. 202 and Annunziata (2023b).

³⁴ Madrid Parra (2021), pp. 219–244.

a result of the advances in this project, it was possible to generate a theoretical infrastructure to exchange and settle commercial bank deposit tokens and central bank liabilities using DLT technology and a simulated US central bank digital currency, a CBDC.³⁵ Likewise, the technical and legal reports clarified that the project did not present any legal problem since the current regulations of the United States would allow the creation of a Regulated Liability Network.³⁶

3 Analysis of Major CBDC Projects

3.1 Context of the Digital Euro³⁷

Although the European Central Bank (ECB) published its first reports on the digital euro project in October 2020, the research phase of the digital euro officially began within the framework of the European Union in October 2021. Almost two years later, in June 2023, the European Commission published the package of legislative proposals on the digital euro and the legal tender of cash.³⁸ In the words of Fabio Panetta, current Governor of the Bank of Italy and former member of the ECB's Executive Board, before the European Parliament's Committee on Economic and Monetary Affairs, these proposals shared the objective of "designing an inclusive and truly European digital means of payment that can meet the needs and preferences of citizens". In addition, the aim was to achieve a conjunction between the ECB's desire to preserve its monetary sovereignty and the demand of citizens that their freedoms be guaranteed in the digital age.³⁹

Even though 60% of people recently surveyed by the ECB⁴⁰ state that they would like to continue to have the option of using cash, more and more people pay digitally in their day-to-day lives. In fact, 55% of consumers in the Eurozone prefer to do so.⁴¹ That is why the European Commission had to define the digital euro in its June 2023 proposals as a currency issued by the ECB that guarantees the continuity of cash.

The objectives of the digital euro project include the promotion of the digitalisation of the economy, the improvement of the security and efficiency of

³⁵The simulated network of regulated liabilities could be a disruptive change, mainly for international dollar users, as it would allow all *anti-money laundering* (AML) and *know-your-client* (KYC) measures to be applied in international settlements.

³⁶Federal Reserve Bank of New York (2023).

³⁷For more detail on this epigraph, we refer to the book's next chapter, by Professors Zatti and Barresi.

³⁸ECB (2024) Update on the work of the digital euro scheme's Rulebook Development Group. Bindseil et al. (2024).

³⁹Borgovono et al. (2017).

⁴⁰Parrondo (2023), pp. 4–10.

⁴¹ECB (2023) Study on the payment attitudes of consumers in the euro area (SPACE).

transactions, the strengthening of the international role of the euro and the stimulation of innovation in payment services. The ECB identifies two fundamental reasons why the digital euro should be implemented. On the one hand, it carries out its functions through an innovative digital solution accessible to everyone and compatible with private solutions. On the other hand, it may contribute to developing the EU's economic policies, including continuing to have the capacity to act on interest rates, offering support in the event of cyber or any other incidents, and making the financial system more efficient and greener.

Months after these legislative proposals, on 1 November 2023, the digital euro began the preparation phase once the research phase had been completed. In this new scenario, the ECB and the national monetary authorities of each of the euro area countries will continue to analyse the functionalities of the digital currency, as well as make progress in the development and experimentation of the appropriate technical solutions and operational mechanisms to, where appropriate, start issuing the digital euro in the future. In his numerous speeches on the digital euro project, Fabio Panetta assured that this digital currency issued and backed by the funds of the European Central Bank will complement cash, as it will be enshrined in legislation in the future and against the many critical voices that have been raised in recent years around the idea of the hypothetical suppression of physical money (which the digital euro would have come to replace, as already mentioned). Thus, the current role of the European regulator would be to refine the proposals set out and ensure that the future digital euro reproduces the main essential notes of cash in the digital realm, providing an electronic means of payment available to all citizens, available free of charge, anywhere and even without an internet connection while ensuring the highest possible level of privacy in digital transactions.⁴²

For Fabio Panneta, there are four decisive aspects to consider to ensure access to the digital euro for all citizens:⁴³ Firstly, it must have legal tender status; that is, citizens must be able to access and pay with the digital euro, even from their current commercial bank. Second, privacy must be guaranteed. Along these lines, the latest draft legislation states that the digital euro would be a novel payment solution with greater privacy and data protection, minimising the risks related to money laundering and terrorist financing. In addition, EU authorities would not be able to access the personal data of users of the digital euro, and the possibility of paying without an internet connection would be very similar to how cash works today. Thirdly, the European Commission includes in its proposals the idea of seeking a balance between the pricing objectives of both the public and private sectors. Thus, end-users would be able to use basic services of the digital euro free of charge, while intermediaries would be compensated like that of private digital means of payment. Fourth, one of the biggest conundrums in developing the digital euro was where commercial banks would stand, as many customers might think about

⁴²This is another of the great concerns of the citizens of the European Union, which has been addressed in point 2.3 of this paper.

⁴³ECB (2023).

withdrawing their funds by looking for deposits or other more profitable financial instruments in the ECB's digital euro. In this sense, it seems necessary to maintain the balance between private money, such as the deposits of commercial banks, and central bank money. To this end, the ECB has developed numerous instruments that will avoid undesirable effects on monetary policy, the stability of the financial system and the provision of credit to the real economy.⁴⁴ Users can also link their digital euro wallet to their bank account.⁴⁵

The ECB is actively working with the main payment service providers at the EU level and other stakeholders to ensure that the digital euro is fully compatible with existing payment tools and that it responds to the demands of the digital revolution (notably by improving the payment system) but without compromising the stability of the financial sector or user privacy.

For his part, the governor of the Bank of Spain, Pablo Hernández de Cos, oversaw reviewing and commenting on the current digital euro project in this phase of preparation it has recently entered. In this regard, at the end of 2023 at the Financial Markets Association Annual Convention he reiterated his support for the project, considering that it has the potential to offer significant advantages, even though he is aware that risks may appear. The risks need to be mitigated with a solid regulatory framework; that is, the potential issuance is always subject to an adequate regulatory framework. His speech was based on several solid arguments:⁴⁶

- (i) On the one hand, the use of digital means of payment is increasing, and the relative weight of cash use is decreasing. The use of cash in commerce experienced a drop of 13 percentage points, going from 72% of total operations in 2019 to only 59% in 2022.
- (ii) On the other hand, the digital euro would have the potential to foster innovation in the European payment system as a whole in the face of an excessively fragmented retail payments scenario across euro-area countries.
- (iii) Third, the EU's digital currency would allow for "strategic autonomy of the region". Although the integration of the euro system with SEPA instruments has progressed in a very good way, there is still a great dependence on foreign brands in payments at points of sale, which weakens the strategic autonomy of the euro area. In this sense, some initiatives, including the *European Payments Initiative* (EPI), are encouraging, as they aim to design a pan-European

⁴⁴ Among the instruments designed for this purpose are "holding limits".

⁴⁵ In this regard, the second version of the Electronic Identification, Authentication and Trust Services Regulation (eIDAS 2) is worth mentioning. Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) No 910/2014 regarding establishing a Framework for a European Digital Identity. This aims that by 2030, 80% of citizens will have a new, more robust European digital identity that allows them to carry out procedures and processes between companies and with the public administration with the greatest possible security and simplicity. Thus, in 2024, EU Member States will almost certainly have to provide the *European Digital Identity Wallet* (EDIW), with which they will be able to open bank accounts in any Member State.

⁴⁶ Hernández de Cos (2023).

interbank network with its payment system, which aspires to compete with foreign companies such as Visa or Mastercard.⁴⁷

For his part, about the possible remuneration of the digital euro referred to *above*, Hernández de Cos advocates a balance between commercial banks and the ECB, so he understands that it has been concluded that there are no elements that sufficiently justify the introduction of such remuneration. In line with this point, the digital euro is set to culminate the effectiveness of existing instant payment systems and, more specifically, the *TARGET Instant Payment Settlement* (better known as TIPS), launched in 2018.⁴⁸ The ECB introduced TIPS to provide a settlement layer for commercial banks. If it were to enjoy mass adoption, this would allow businesses and individuals to transact with each other instantly. According to the ECB, this network is designed to settle a regular load of more than 43 million instant payment transactions per day and about 2000 transactions per second. It is still a pending matter to know if the digital euro and the TIPS will be able to coexist in the SEPA area and if their future adoption will compromise the position of the predominant players in the retail payments market in Europe, controlled by North American companies such as Visa, MasterCard and PayPal.

On the other hand, it had been considered for some time whether the digital euro project would be the precursor to a wholesale digital currency, restricted to a limited group of financial counterparties (interbank market), or whether, on the contrary, it was considering creating a retail CBDC, accessible to all types of users. As discussed *below*, the Chinese digital yuan is an example of retail and wholesale CBDCs. However, the digital euro seems intended to be issued as a retail currency.

On a legal level, the regulation that will govern the issuance of this digital currency will depend on both its design and its purpose.⁴⁹ However, despite the many unknowns that are still present, we have some certainties. To begin with, all CBDCs are outside the scope of application of MiCA but one or another precept will apply to the digital euro depending on the design it finally adopts. For example, if it were issued as a monetary policy instrument only for central bank counterparties—although it is a highly unlikely alternative—we would be within the framework of Article 127.2 TFEU. On the other hand, if its issuance were extended to retail and private company accounts through the ECB, Article 17 of the Statute of the European System of Central Banks (ESCB) would be added to the previous provision. If it is considered equivalent to physical bank money, Article 128 TFEU and Article 16 of the Statute of the ESCB would apply to it. If it were issued as a means of settlement for types of payment processed by a dedicated payment infrastructure, Article 22 of the Statute of the ESCB would apply.

⁴⁷ In the US, for example, the payment management service is publicly managed by the *Automated Clearing House Association* (NACHA) through the *Automated Clearing House* (ACH) system; however, the truth is that most of the operations in terms of payment processing worldwide are carried out by private companies with great experience.

⁴⁸ Sanz Bayón (2020b), pp. 58–65.

⁴⁹ Parrondo (2023), pp. 4–10.

However, the most specific regulation in this regard comes from the *Proposal for a Regulation of the European Parliament and of the Council, of 28 June 2023, on implementing the digital euro*. This proposal for a Regulation establishes the legal framework and the essential elements of the digital currency. It shifts the focus on the decision-making of the issuance of the currency solely to the ECB, which is responsible for carrying out the technical studies in this regard, relying on the reports and projects of the BIS *Innovation Hub*, as well as other monetary authorities.

In addition, on the same day that the previous proposal was approved, *the Proposal for a Regulation of the European Parliament and of the Council of 28 June 2023 on the provision of digital euro services by payment service providers incorporated in Member States whose currency is not the euro and amending Regulation (EU) 2021/1230 of the European Parliament was also presented and approved European and Council Rules*. Its mission is to safeguard the role of cash, ensure that it remains accepted as a means of payment and easily accessible to individuals and legal entities in the euro area. In this sense, this proposal was a great step forward because it stipulates that the autonomy of the will of all citizens of the euro area must be respected so that they can choose their preferred payment method, freely. It also sets out the legal obligation to safeguard the right to access cash supply services, especially guaranteeing the financial inclusion of the most vulnerable groups, such as the elderly, who depend on cash payments.⁵⁰

In short, the digital euro is not yet a reality. Still, it may be in the coming years, so it is the duty of the highest legislative authorities at the European level to ensure that solid foundations are laid that allow, where appropriate, the development of the future digital euro, safeguarding the fundamental rights of citizens, especially their privacy. Undoubtedly, the key to development will be that all progress in this area is made from the perspective of dialogue and dialogue with all the actors involved (especially with citizens, governments, companies, and financial institutions, etc.).⁵¹

3.2 Comparative Analysis of Some CBDC Projects: Special Mention of the Chinese Digital Yuan, the Russian Digital Ruble and the So-Called Digital Dollar

This section briefly reflects on the CBDC projects of the major international economic powers, mainly the Chinese digital yuan, the Russian digital ruble, and the US digital dollar.

⁵⁰Zatti and Barresi (2024), pp. 360–375.

⁵¹See European Parliament (2024) y European Parliament, Committee on Economic and Monetary Affairs (2024) Draft Report on the proposal for a regulation of the European Parliament and of the Council on the establishment of the digital euro (COM (2023)0369 – C9-0219/2023 – 2023/0212 (COD)).

Although the first of the central banks to be interested in creating their digital currencies was the Swedish (known as the *Riksbank*), its digital currency project (*e-krona*), started in 2017 and not yet implemented, does not enjoy the same international knowledge as the projects that will be presented below. Sweden is waiting to know how the rest of the counterpart projects evolve at a technological level and, mainly, to study how they are regulated.

3.2.1 The Digital Yuan (e-CNY): The People's Bank of China's Digital Monetary Project

The digital yuan or e-CNY is the Chinese CBDC, i.e., the centralised digital currency expected to be used primarily for retail payments in China. The Chinese central bank, the People's Bank of China (PBOC) will be the issuer of the digital yuan, which is already experimenting with this project through large-scale pilot programs in several cities over the past few years.⁵² The high digitalisation of the Chinese economy experienced in the last decade has favoured the fact that the pilot tests have been carried out very quickly and with considerable efficiency in the results obtained.⁵³

The PBOC began researching the launch of its digital currency in 2014 when it established a specific research team for this task. Although more than a decade has passed, and even testing with retail payments has already begun, many of the important elements of what the digital yuan or DC/EP aims to achieve and how it will work remain open and could see substantial variations. The introduction of e-CNY by the PBOC has two different but related objectives. The first, longer-term goal is to issue and consolidate a digital currency that can compete with other digital currencies, such as bitcoins, stablecoins, and other central bank digital currencies (CBDCs), while ensuring that the yuan (fiat)—Renminbi—remains legal tender in China. The second, more immediate objective is to reshape China's current payments market by providing a digital payment method like cash, i.e. one that is accessible, low-cost, with controllable anonymity and facilitates competition between payment service providers.⁵⁴

On a broader horizon, the digital yuan represents an aspect of China's economic digitalisation objective, which figured very prominently in China's Five-Year Plan for National Informatization in 2016, from which the broad outlines of the design of the DLT/Blockchain networks that the Chinese state intends to build in the short and medium term (called *Blockchain-based Network Service* were extracted). In this

⁵²In the PBOC's white paper, published a few days after the ECB made its move on the Digital Euro in July 2021, it outlines the progress of its plan for the digital yuan (e-CNY, DC/EP). For example, [JD.com](https://www.jd.com), one of the largest e-commerce platforms in China, engaged in experimentation, allowing its customers to buy products with the subscribed units of digital yuan.

⁵³Yao (2018).

⁵⁴People's Bank of China (2021).

sense, in addition to the progress of the PBOC (specifically its Departments of Technology, Payments and particularly the Department of Research in digital money, which processes industrial and intellectual property rights related to financial innovation), it is also advisable to pay attention to the work of the National Development and Reform Commission, which guides the priority lines in the field of industry and technology as well as the development of the activities of the Cyberspace Administration of China, with its “Blockchain Information Service Management Regulation” (BISRM) Program, without forgetting the participation in this matter of the China International Economic Exchange Center (CCIEE). This organisation began research on introducing a CBDC in China almost seven years ago. At the same time, the work of the main Chinese banks, manufacturers such as Huawei and Xiaomi, technology companies such as Baidu, Tencent or Alibaba, or financial companies such as Union Pay and Ant Financial, as well as telecommunications operators (China Mobile, China Telecom and China Unicom), are relevant, since they provide timely information on the development of Chinese technological financial services.

Meanwhile, the regulatory development of distributed ledger technology in China, which will be an important infrastructure option to host the digital yuan, is based on the National Cryptography Law, approved on October 26, 2019, by the Standing Committee of the 13th National People’s Congress and entering into force on January 1, 2020.⁵⁵

3.2.2 Characteristic Elements and Functionality of the Digital Yuan

The PBOC will fully support the e-CNY but will be put into operation by payment service providers. The PBOC defined the e-CNY as cash in circulation or M0 in monetary policy language. Defining the digital yuan as M0 rather than M1 or M2 has several implications.⁵⁶ Firstly, the PBOC will be responsible for the digital yuan. This implies that M0 is a direct liability of the central bank, while M1 and M2 include certain liabilities of commercial banks. This definition means that the e-CNY will be completely risk-free. Additionally, digital wallets containing the e-CNY will not be considered bank accounts. PBOC pilots so far only require a mobile phone number to open an e-wallet that can accommodate the digital yuan. Thirdly, as we discussed earlier concerning the Digital Euro, the e-CNY does not accrue interest,

⁵⁵The most relevant would be in Chapter 3, Article 24. The purpose of this law was to facilitate the development of business with commercial cryptography and to guarantee the security of cyberspace and information. Under this law, cryptographic codes will be classified into two groups: “basic and common codes”—which will be administered by the State—and “commercial codes”—which can be developed and applied at the business level. It will be up to the Chinese government to establish encryption standards covering state and enterprise cryptography.

⁵⁶The M0 definition of the digital yuan will likely prevent the disintermediation of Chinese banks because by prohibiting interest payments, the PBOC will issue a limited amount of e-CNY for circulation to replace cash but not to capture bank deposits.

unlike assets on M1 or M2 (bank deposits). This is crucial because most digital currencies, including some CBDCs that other central banks are currently considering, have not ruled out interest payments. Finally, only Chinese commercial banks could convert the e-CNY to bank deposits and vice versa. In other words, the exchange operations of this CBDC correspond to those of Chinese commercial banks.

Consequently, instead of a “fractional reserve” system used in the traditional banking system, the Chinese CBDC would require financial institutions to maintain a 100% reserve ratio. As a result, the CBDC would not have any derivative deposits or money multipliers. In this way, the digital yuan would act only as an intermediary between commercial banks and the PBOC and between commercial banks, companies, and retail users. As one of its objectives is to replace physical cash, although not imminently or close to its launch, the Chinese CBDC will not be overissued and will follow the exact and necessary issuance process, which already exists with the physical cash issued by central banks and distributed by commercial banks. Therefore, the current monetary policy tools would not be questioned in any case, so the digital yuan should not generate a priori any negative impact on the policy carried out by the PBOC, which would nevertheless clearly gain a greater presence in the Chinese economy and finance.

3.2.3 Structure and Distribution of the Digital Yuan

The e-CNY adopts a two-tier structure, according to the PBOC.⁵⁷ However, from an e-CNY user’s perspective, the system has more than two layers. On the one hand, the PBOC is located at the top level and plays the role of issuer and supervisor. To open an account in an e-CNY e-wallet, the user will need to go to one of the second-tier institutions. These institutions now only include the largest state-owned banks (Industrial and Commercial Bank of China, Bank of China, Agricultural Bank of China, Construction Bank of China, China Merchants Bank) and two online banks (WeBank and MYBank). Once the e-CNY wallet is set up, the user can enjoy a wide range of services provided by the issuing bank and many other banks and payment service providers. These institutions are called “2.5 tier” institutions, which cannot conduct e-CNY exchanges but can provide payments and other services to e-CNY holders. In other words, the programmability of transactions and the scalability of services in the digital yuan system will depend on this level. Finally, on the lower level are commercial establishments, companies and consumers. Commercial companies can agree with level 2 or 2.5 institutions on their infrastructure configurations to receive e-CNY payments online and offline.

Under the planned structure, the PBOC will delegate most of the responsibilities to the second-tier institutions, which will provide direct service to the customer, assume KYC obligations, and protect their privacy. In this sense, it is conceivable

⁵⁷ Yao (2018).

that the issuance of this CBDC in China will come at a cost to second-tier institutions. Still, at the same time, it will offer a new business opportunity for commercial banks in the payments sector, putting them in a more competitive position with Internet companies.

Regarding its technological infrastructure, it remains uncertain whether the second layer of the digital yuan would also be based on a DLT/Blockchain network. As the administration of the second layer would be delegated to financial institutions, the Chinese CBDC could run on multiple different networks at the same time, which could lead to transaction performance issues. Pilot tests will determine and verify the technical feasibility of these aspects since, currently, DLT/Blockchain technology does not achieve yields as high as those necessary to sustain the entire Chinese payment market. Likewise, the PBOC suggested that its CBDC could work with smart contracts but not applications that provide functionality beyond “basic monetary requirements.”⁵⁸ This is due to concerns that a programmable development layer on top of the currency could add additional value to the CBDC but undermine its security or stability in exchange for usability, negatively affecting the Renminbi's internationalisation.

3.2.4 Privacy in the Digital Yuan: The Concept of “Controllable Anonymity”

Privacy is one of the most contentious issues regarding CBDCs, mainly because the system's design can allow for much more oversight than physical cash or existing digital payment methods. The digital yuan is no exception in this regard. Privacy issues can be considered on two levels: what access state authorities have to individual transaction data and what access the parties to the transaction have (e.g., merchants, banks and payment processors, digital wallets).

While the contrast between a CBDC and physical cash is often raised—under the presumption that the latter is always anonymous public money—the truth is that cash transactions in China are no longer completely anonymous because ATMs and other scanners record the serial numbers of banknotes entering and leaving the banking system. Of course, small individual transactions do remain anonymous. However, the degree of government monitoring of transactions on systems run by banks or through e-wallets that dominate online payments in China (Ant Group's Alipay and Tencent's WeChat Pay) is largely unknown. There are also no independent courts that establish protection measures for the personal data that the government can obtain.

The PBOC promotes the digital yuan to the Chinese public as a more privacy- and anonymity-preserving form of payment than the currently dominant payment tools run by private companies in China. The PBOC's motto for digital yuan privacy is

⁵⁸The definition of “basic monetary requirements” has not yet been specified in the digital yuan regulation.

“controllable anonymity,” which seems like a juxtaposition of two mutually exclusive concepts. This concept suggests that the PBOC will have access to the ledger that shows each balance and transaction in real-time, but in which the monetary authority itself or any other competent state entity is prevented from accessing the identity of each user or the entity that owns the addresses or private keys of the digital wallet through which transactions with the digital yuan are carried out.

The information available shows that the e-CNY is built with an approach based on “three centres”: authentication, registration and analysis centres. The authentication centre assumes that the PBOC would implement centralised management of financial institutions and end-user identity information, which is the basic component of the system’s security. The registration centre would note the identity of each CBDC unit and the corresponding users and complete the CBDC registration for the following functions: issuance, transfer, and redemption. Finally, the analytics centre would fulfil several functions, such as preventing money laundering, analysing payment behaviour analysis, monitoring real-time indicators, etc. The “three hubs” are claimed to be designed to ensure that Chinese CBDC transactions are anonymous from the user’s perspective while preventing money laundering and tax evasion. The scheme proposed by the Chinese central bank would theoretically be suitable for maintaining identification and traceability records of all transactions and users. However, the only proposal is to deactivate anonymity for illegal activities such as money laundering and tax fraud. For this reason, the PBOC has described the privacy protection capabilities of e-CNY as “controllable anonymity.” This means that its users will have the option to hide their identity from their counterparts while the Government reserves the ability to monitor illegal transactions.⁵⁹

3.2.5 Implications of the Digital Yuan for Commercial Banking and the Chinese State

In light of its nascent regulation and experimentation, e-CNY will likely bring substantial changes to China’s digital payments sector, improving the positioning of commercial banks in a commercial segment such as this, which large digital technology companies currently dominate. The e-CNY became massively deployed in 2022 as a catalyst for other central banks to bring forward or accelerate their CBDC projects. On the other hand, the fact that a state can follow the flow of money in its economy and monitor general monetary activity more effectively, thanks to a new tool, contributes to its decisions being more planned. As a result, it is most likely that thanks to the digital yuan, the Chinese state will considerably increase its ability to control money movements and flows more effectively. In addition, the digital yuan will undoubtedly bring an operational advantage for the Chinese economy in terms of cross-border payments and investments, which will help to improve the

⁵⁹ Sanz Bayón (2021a).

positioning of the Renminbi as an international reserve currency, possibly enhancing its competitiveness against the US dollar and the Euro.⁶⁰

However, another reason, this time geopolitical, underlies the issuance of the Chinese CBDC. If the Beijing government formalises interoperability between the e-CNY and other CBDCs, China could do without the Society for Worldwide Interbank Financial Telecommunication (SWIFT) infrastructure.⁶¹ This would effectively allow the Chinese economy, along with other countries, to bypass the SWIFT intermediary node, but to do so, China would need to get other countries to accept international payments with the digital yuan.⁶² A situation like this would have a direct consequence in the global geopolitical context since it would mean, in practice, the deactivation of the scope and effectiveness of hypothetical US sanctions against China.

The digital yuan (e-CNY) project is putting pressure on other major economies to accelerate their national CBDC projects. For this reason, in geopolitical terms, China is trying to accompany its digital yuan project by strengthening its international cooperation plans to promote the interoperability of its CBDC with others. The monetary policy objective behind the e-CNY is not ostensibly to supplant the US dollar as the dominant global currency but to reduce the Chinese economy's dependence on the dollar by establishing a new and alternative payment system. To push this agenda forward, China can successfully leverage its global economic power to shape and foster the international, or at least multilateral, CBDC space.⁶³

⁶⁰PBOC's issuance of a CBDC could alter the distribution of international payments market shares if China introduces it into its bilateral investment agreements or exports it to its international payment schemes, ceasing to rely on the U.S. dollar. If examined in comparative terms, the yuan significantly underperforms the Chinese economy globally. This makes Beijing heavily dependent on the US dollar in foreign trade. On this subject, see Huang et al. (2014), p. 482.

⁶¹SWIFT, faced with the potential loss of access to the Chinese economy, has set up a joint venture, called *Finance Gateway Information Services*, with the PBOC, to improve cross-border transaction services in China. 3% of the joint venture is owned by the PBOC's Digital Money Research Institute, suggesting there would be more scope to promote the use of the digital yuan globally.

⁶²However, in our view, the attractiveness of a CBDC will depend on economic and institutional factors, such as general macroeconomic conditions, the openness and transparency of the issuing state's financial markets, or the credibility of its socio-political institutions. These factors are currently limiting the yuan's potential international status, and if the Chinese CBDC is issued, this limitation will most likely be extended. As some analyses suggest, political and institutional factors are weighing on the yuan's potential share of global foreign exchange reserves to around 2%. However, it does seem clear that the digital yuan could strengthen the adoption of the Renminbi in cross-border payments, linking the e-CNY to various forms of economic activities through bilateral, regional, and multilateral trade agreements, especially for those countries that already participate in China-backed programs (such as the *Belt and Road Initiative*). On this point: Liang (2020), pp. 317–328.

⁶³Knoerich (2021), p. 160.

3.3 *The Digital Ruble*

On July 11, 2023, the Russian parliament presented the project for introducing its digital currency, the digital ruble, and creating the appropriate platform for developing its currency. This project aimed to integrate the digital ruble into its financial system, regulate it properly, and establish due control for tax purposes. In mid-August 2023, the country announced that its Central Bank (BCR) would start a “large-scale” pilot program to test the operation of the digital ruble. In this way, it consolidated itself as one of the countries leading the tests with digital currencies issued and backed by central banks, a role it continues to play today.

As announced, up to 13 Russian banks (including Sberbank, VTB and Gazprombank) and several customers of these financial institutions would be involved in this pilot project, who would carry out their operations thanks to a digital wallet. Thus, in the words of the BCR’s First Deputy Governor, Olga Skorobogatova, the country is in the most important stage of its CBDC project, a testing phase that anticipates the hypothetical introduction of the digital ruble into the Russian economy in 2025. The evolution of the project is subject to the outcome of the stages of this testing phase.

Presently, through the tests being carried out in this phase, Russia intends to obtain information on the “real” operation of the payment platform of its digital currency, thanks to the participation of bank customers. The number of customers participating in the pilot project has expanded throughout the last quarter of 2023. Among the basic operations that customers can currently carry out include opening and topping up digital accounts in the national CBDC, the possibility of making digital transfers between citizens (P2P), making automatic payments and paying for purchases and services using a QR code in up to thirty businesses located in eleven Russian cities. In addition, the BCR has the power to set and limit the users who have access to the platform on which the digital ruble is based, the volume of transactions undertaken and the threshold of amounts in question. Likewise, by law, the country has prohibited crediting accounts in its CBDC and the accumulation of interest.

3.4 *The So-Called “Digital Dollar”*

For its part, a private project for issuing a digital dollar of the United States was promoted by the former chairman of the *Commodity Futures Trading Commission* (CFTC), Christopher Giancarlo, outside the Federal Reserve. This project is embryonic, and numerous obstacles have prevented its acceptance. Two fundamental reasons can be adduced to explain the slowdown in the progress of the U.S. CBDC:

1. In the first place, it can be said that the world economy is currently dollarised since the currency of the North American country occupies the first place in commercial transactions. Globally, more than three-quarters of these are made in dollars. In addition, 60% of central banks' foreign exchange reserves are denominated in dollars, and more than two-thirds of the debt issued by these entities are denominated in dollars. Furthermore, one only has to take a brief approach to the functioning of the digital economy to appreciate the significant presence of *stablecoins* and other digital assets in the payment of goods and services. Of these *stablecoins*, up to 95% are denominated in dollars. The conclusion is unequivocal: the United States, through its economic policy, makes decisions with a macroeconomic impact at the international level, and the hegemony of the U.S. currency seems unrivalled, as much as this is the goal of the *e-yuan*.
2. Second, the role of the private sector in issuing *stablecoins* denominated in the U.S. currency also appeases interest in accelerating the process toward the creation of the digital dollar. In this sense, more than 85% of the *stablecoins* in circulation are concentrated in the hands of Bitfinex and Tether's USDT, Circle and Coinbase's USDC and Paxos and Binance's BUSD. All these companies operate in U.S. territory or with U.S. citizens through their currency. In this way, the institutions of the United States maintain the competence and jurisdiction to supervise the aforementioned actors.

In sum, the main players in the digital financial ecosystem (and, specifically, *stablecoin* issuers) are closely linked to the US administration, either voluntarily or coercively, thus participating in positioning the dollar as the main currency used in transactions in the digital economy. In general terms, it could be said that the most representative difference between the Fed and the rest of the central banks is that, while the latter considers that *stablecoins* can violate their monetary sovereignty, the former, based on a positive and complementary vision of *stablecoins* as a tool for technological innovation, has as its main objective to be transparent with its reserves and with the investments made with them.⁶⁴

The European Union, China, India, and the UK, among others, have expressed concern for monetary sovereignty in statements by the G7 and G20 and in the work of the *Financial Stability Board* (FSB), a body whose mission is to propose international recommendations on financial matters.⁶⁵ On the one hand, many countries assume the risk of facing the dollarisation of their economy and seeing their local currency replaced by another issued by a private company. On the other hand, the North American giant, representing the other side of the coin, considers the possibility of reinforcing its monetary hegemony.⁶⁶

⁶⁴Wong and Maniff (2020).

⁶⁵Financial Stability Board (2022).

⁶⁶Meanwhile, a sector of the Republican Party has shown its deepest rejection because it considers that a CBDC issued by the Federal Reserve may constitute a threat to individual privacy and freedom. In fact, former President Donald Trump has expressed this at the beginning of 2024 in

Finally, concerning the United States moving in the direction of a CBDC, it is worth mentioning the Hamilton Project, which developed research by the Federal Reserve Bank of Boston and the Massachusetts Institute of Technology (MIT) and whose purpose focused on studying the technical aspects of a potential digital dollar. This project brought with it the publication of a white paper and open-source research software (OpenCBDC) in two versions, although only one was based on DLT technology. At the time, the researchers promised to work on “privacy, auditability, programmability, interoperability, and much more.”⁶⁷

In short, the general impression is that today, the debate about a potential digital dollar project has a large political component, and any decision can only be made if it has broad support in Congress.⁶⁸ In any case, the decision to launch a digital dollar will require a thorough prior analysis that will take at least another two or three years in an environment that seems to lead to the coexistence of this CBDC if it is finally issued with *stablecoins*.⁶⁹ The latest statements by Fed Chairman Jerome Powell made public in March 2024 make it clear that the US power does not have the issuance of the “digital dollar” on the near horizon.⁷⁰

3.5 *Alternative CBDC Models*

As previously introduced, CBDCs are typically divided into two general categories: wholesale (used for interbank transactions) and retail (used by merchants and the general public). The digital euro is a paradigmatic example of a CBDC presented as a retail digital currency project. In contrast, the digital yuan, on the other hand, is a digital currency being tested in wholesale and retail contexts. On the one hand, a wholesale CBDC aims to improve the efficiency and reliability of the existing financial system, ensuring that high-value cross-border transactions between banks, such as interbank lending or securities settlement, are carried out quickly

numerous public statements, assuring that he will block the development of the US CBDC if he comes to power again. On the other hand, more recently, Congressman Tom Emmer introduced a bill that sought to ban the U.S. digital currency, and on September 20, 2023, the House Financial Services Committee and the House itself took another step in the line of preventing the issuance of this CBDC. Another congressman, A. Mooney, introduced a bill prohibiting the Federal Reserve from initiating pilot programs to test CBDC initiatives without congressional approval. This project was soon joined by an amendment to the Federal Reserve Act, which established an additional ban on Fed banks so that they could not offer certain products or services directly to an individual, along with a ban on using a CBDC for monetary policy-related purposes.

⁶⁷ Brownworth et al. (2017).

⁶⁸ The *Digital Dollar Pilot Prevention Act* prohibits the Federal Reserve from initiating pilot programs to test CBDC initiatives without congressional approval.

⁶⁹ This approach was already defended by the economist F. Hayek, who in 1976 published his work “The Denationalization of Money”, in which he argued that stability of value between two currencies was only possible through competition between them.

⁷⁰ Powell (2024).

and securely. In addition, eliminating the currently required intermediaries reduces the cost and complexity of operations and enables international transactions between banks and other financial institutions. In this way, individuals and businesses continue to use existing forms of digital money through fiat currencies (such as the euro or the dollar) stored in their bank accounts. Thus, payments between individuals are still in the traditional banking system, in which accounts are debited and credited with each transaction. On the other hand, retail CBDCs are designed to offer the general public direct access to money guaranteed by a state and, therefore, risk-free (central bank money). These digital currencies are characterised by the fact that they can be used for everyday transactions (such as purchasing goods and services or transferring money between individuals). A central bank can easily inject liquidity into the market using a retail CBDC.⁷¹

The results of the BIS Innovation Hub study (to be presented *below* in Sect. 4.1 of this paper), which analyse a survey that collected data from more than 86 central banks in 2022, predict that by the end of the current decade, there will be at least 15 retail CBDCs and nine wholesale CBDCs in circulation.⁷²

Finally, another important foreign policy issue, which should not go unnoticed, is the strong influence of the BRICS when exploring an alternative currency to the dollar as the world's reference currency. The BRICS countries share a common commitment to discuss US hegemony globally, accounting for 40% of the world's population and 25% of the planet's GDP. With de-dollarization as one of their most prominent objectives, these countries have devised a reserve system called *the Contingent Reserve Arrangement* (CRA). Thus, extrapolating this emerging situation from the geopolitical context, the key to the CBDCs of these countries will be whether they can present themselves and be used as an element that contributes to the de-dollarization of their markets.⁷³

4 CBDC Projects Under the Bank for International Settlements (BIS) Innovation Hub

Founded in 1930, the Bank for International Settlements (BIS), based in Basel, Switzerland, is an international organisation whose vision is to promote monetary and financial cooperation at the global level. This body is a forum for debate on the different economic policies to be adopted around monetary and financial research projects. Its main objective is to gain an in-depth understanding of the technological innovations that affect (or potentially will affect) central banking and to harness these innovations to improve the functioning of the global financial system.

⁷¹Today, we find examples of this type of CBDC in Nigeria, The Bahamas, the Western Caribbean, and Jamaica.

⁷²Kosse and Mattei (2023), p. 136.

⁷³Wang and Gao (2021), pp. 288–306.

The BIS is the nerve centre for international financial decision-making and a supervisor and centre for economic and monetary studies. It is the main counterparty for central bank financial operations and the agent responsible for depositing collateral in international financial transactions. The BIS published a report in July 2021 that foreshadowed the risk of forming cryptocurrency monetary areas, enabling the emergence of global private stablecoins (GSC) whose scope of operations did not coincide with traditional state jurisdictions.⁷⁴ As a result, a fracture in international payments could be triggered, putting the global money market in check.⁷⁵

The BIS has an *Innovation Hub* that carries out very important research work to help central banks evolve their digital currency projects. A strong institutional public component and a large technological component nourish this research centre. The BIS defines a CBDC as “a digital form of central bank money distinct from balances in traditional reserve or settlement accounts” but warns that any measure aimed at achieving a potential launch of a CBDC needs to be given thorough and careful consideration, especially about its possible effects on interest rates, the financial intermediation structure, stability and supervision.⁷⁶ Many open fronts today still deserve a much more detailed analysis. Among his latest and most recognised projects in CBDC research are Mariana, Polaris, mBridge, Mandala, Tourbillon, Hertha, Promissa, and Aurum 2.0.

4.1 Some Notable CBDC Projects Under the BIS Innovation Hub

4.1.1 Mariana Project

The Mariana Project aims to show how CBDCs can be the future of cross-border transactions. The project takes ideas and concepts from decentralised finance (DeFi) through interbank exchanges, where crypto assets are immediately traded and settled through automated market makers linked to smart contracts.⁷⁷ The Mariana Project builds on previous work examining the feasibility of cross-border transactions. It is a joint proof-of-concept project between the BIS Innovation Hub, the Bank of France, the Monetary Authority of Singapore, and the Swiss National Bank. The project's

⁷⁴IOSCO (2020).

⁷⁵Sanz Bayón (2021a).

⁷⁶Reserve and settlement accounts are available in most jurisdictions to “money market counterparties”, i.e. financial institutions directly relevant to implementing monetary policy, such as depository institutions, which already have access to deposits and lending facilities from central banks. In certain jurisdictions, account holders may fall into more categories, such as non-monetary counterparties (e.g. the Treasury, foreign central banks or other institutions such as the IMF). Thus, introducing CBDCs would further expand access to central bank digital money but not to their lending facilities. Retrieved from: BIS Innovation Hub (2018).

⁷⁷Sanz Bayón (2019).

findings could be valuable to central banks and financial institutions considering the future of cross-border payments and FX markets.⁷⁸

In its development, it is intended to test the functionality of the *Automated Market-Maker* (AMM), a systematised and decentralised market based on using a liquidity pool to set prices and exchange tokenised assets. The project is based on the future existence of wholesale digital currencies (wCBDCs). For the project, an architecture of domestic platforms controlled by central banks and a decentralised transnational blockchain network were established, where the AMM would be located. In both of them, wCBDCs could circulate, thanks to the interoperability of systems and protocols. However, passage between the two spaces would be restricted, with instructions under central banks' control.

The main objective was limited to creating a functional experiment of an interbank exchange market based on an AMM, in which wCBDCs coexisted and traded uninterruptedly. Second, we sought to understand the role of liquidity providers for an AMM in this type of market, in which commercial banks would participate directly and take exit or provision orders to and from the fund. In short, the Mariana Project allows wholesale CBDCs used by commercial banks and financial institutions, using AMMs to simplify interbank FX processes through high technological developments. As reflected in the Final Report of the project, the conclusions of this proof of concept could be summarised in three:

1. It is possible to balance the need for central banks to control the issuance of and access to wCBDCs with the ability for exchange intermediaries to hold, trade, and settle trades with these currencies. Thus, the transnational network would support an interbank market according to the permits and regulations of central banks and supervisors.
2. Combining wCBDCs with an automated exchange mechanism through platforms and networks simplifies the currency exchange process, making the market more efficient and reducing counterparty risks when trading against the liquidity pool.
3. Integrating an interoperable interbank foreign exchange market with cross-border infrastructure is possible, allowing actors to trade under an AMM with a foreign exchange liquidity pool.

One possibility arising from the Mariana project is the implementation of an architecture for the cross-border Forex market that complies with the principles of the Foreign Exchange Global Code.⁷⁹ Regarding risk management, the Mariana project makes it possible to mitigate the counterparty risk (by operating against the liquidity fund) and the clearing and settlement risk by contracting the steps of the operations and making them immediate in a P2P system. While the blockchain security system can bring benefits for identifying data useful for risk management, it also poses privacy challenges, which could be exposed as a multi-jurisdictional

⁷⁸ BIS (2023) Project Mariana. Cross-border exchange of wholesale CBDCs using automated market-makers. Final report.

⁷⁹ Global Foreign Exchange Committee-GFXC (2021).

changing market. This point, as observed in the analysis made by the BIS, may become a problem of greater risk due to the impact on fundamental rights and the public's trust in the financial system and its relationship with the CBDC.

4.1.2 Project Polaris

The first one we mention here has been led by the Nordic Center of the BIS *Innovation Hub*, following a survey showing that 49% of central banks consider offline payments with their retail digital currencies essential. In comparison, another 49% think it “advantageous”. However, they all agree that the reasons that lead them to give their opinion are resilience, inclusion, privacy and similarity to cash. In this way, the project published on October 26, 2023, defines itself as “a manual for offline payments with CBDCs”, which aims to guide central banks. The study, entrusted to expert advisors, orbits around the design of secure and resilient CBDC systems, both *online* and *offline* and aims to help central banks to:

1. understand the available technologies and security measures, as well as the main threats, risks and risk management measures;
2. be aware of privacy issues, inclusion needs, and resilience options;
3. know the design and architecture principles involved;
4. Have a perspective on hypothetical operational and change management issues.⁸⁰

One of the most relevant conclusions is that there is no single solution. Each country has different reasons for providing offline payments with CBDCs, so the currency's design must be adjusted to local requirements. Its implementation will certainly not be without its difficulties. It will involve many technological, operational, and security considerations that must be planned for in the early phases of a CBDC project.

4.1.3 mBridge Project

The second of these latter projects is called “mBridge”.⁸¹ This project uses DLT technology to experiment with a common multi-central bank (wholesale) digital currency platform (multi-CBDC) for cross-border bank payments. Published on October 31, 2023, the study is being developed by the BIS Innovation Center of Hong Kong and the central banks of Thailand, Hong Kong, the United Arab Emirates, and the Digital Currency Institute of the People's Bank of China. Its vocation is to solve some of the inefficiencies of cross-border payments, including its high costs, speed and transparency, and the countless operational complexities.

⁸⁰ BIS Innovation Hub (2023) Project Polaris: handbook for offline payments with CBDC.

⁸¹ BIS Innovation Hub (2023) Project mBridge: Experimenting with a multi-CBDC platform for cross-border payments.

Thus, the objective was (and still is) to design a common technical infrastructure with the potential to improve the current system and allow cross-border payments to be affordable, immediate, and universally accessible with the final settlement.

Criticism of the current international payments system for its inefficiency is increasing due to its inefficiency. The payment system that supports cross-border financial flows has not kept pace with the rapid growth of global economic integration. Meanwhile, banks are also cutting back on their networks and correspondent services, leaving many participants without access to the global financial system. Among them, emerging markets and developing economies present the most alarming situation. It was, in fact, already tested in 2022, the year in which a pilot project was carried out involving real corporate transactions on the platform between the participating central banks, several selected commercial banks and their clients in four jurisdictions. The challenge is implementing the improvements provided by technology, legal, and governance frameworks to examine possible synergies with other BIS projects and solutions the private sector proposes.

4.1.4 Mandala Project

On 15 November 2023, the BIS *Innovation Hub* published one of its most recent works, the “Mandala Project”, in line with the actions carried out by the *Financial Stability Board* in 2023 to achieve the G20 objectives.⁸² The project aims to improve cross-border payments by ensuring an efficient and automated legal, regulatory, and supervisory framework for this type of transaction while maintaining its security and integrity. To this end, the project has managed to monitor transactions in real-time, increasing transparency and visibility around country-specific policies.

The project has been led by the BIS Innovation Centre Singapore, the Reserve Bank of Australia (RBA), the Bank of Korea (BOK), the Central Bank of Malaysia (BNM) and the Monetary Authority of Singapore (MAS), and has benefited from several financial institutions. It has addressed the feasibility of codifying a jurisdiction’s specific policy, with its regulatory requirements, into a common protocol for cross-border use cases such as payments, foreign direct investment or lending. The particular example tested has been a cross-border loan from an entity located in Singapore to a counterpart in Malaysia. A common system authorises the transaction by implementing various technological tools that allow the simultaneous detection of sanctions and checking that the capital flow management measures (during the pre-validation phase) are complied with. It then generates proof certifying compliance with the regulation, which can be attached to the settlement asset to simplify existing compliance procedures and speed up the payment process.

⁸²BIS Innovation Hub (2023) Project Mandala: shaping the future of cross-border payments compliance.

4.1.5 Tourbillon Project

Meanwhile, the interesting “Project Turbillon” studies the anonymity of retail CBDC projects (such as the digital euro).⁸³ This Project was launched on November 29, 2023, and has been a great advance for the entire doctrine that focused its greatest concern on its ability to respect users’ privacy, just as cash currently does. This is because the project allows for a new paradigm that guarantees the privacy of the payer’s anonymity, protecting buyers’ identities. Furthermore, according to the latest surveys conducted by the Bank of England and the European Central Bank, privacy is essential for a retail CBDC.

This project has conducted its experiments based on payer anonymity (similar to cash to payers, but not to payees). If a consumer were to pay a seller using CBDC, they would not disclose their personal information to anyone (not the merchant, commercial banks, or the central bank). However, the seller’s identity would be revealed to its bank as part of the payment and kept confidential at the checkout. The purpose of this inspection is to contribute to the reduction of tax evasion or illicit payments. Finally, the central bank could see the final amount of the transaction but not details about the consumer or seller.

Regarding technical design, the project developed two prototypes based on the eCash design: an eCash 1.0 design, which resembles a digital payment instrument similar to cash, and a second design, called eCash 2.0, which provides enhanced security features against counterfeiting.

4.1.6 Hertha Project

The so-called “Hertha Project” owes its name to the British scientist and inventor Hertha Ayrton, who made important contributions to the physical sciences during her long career.⁸⁴ Hertha, a project in which the London Centre of the *BIS Innovation Hub* and the Bank of England collaborate, is one of the projects on which the greatest public attention is focused because it aims to protect payment systems against financial crimes, preserving users’ privacy. This interesting mission is a complex challenge and will be decisive for the future of payments in general and CBDCs in particular. The project maps the different typologies of current and potential financial crimes in payment systems in real-time, thanks to the exploitation of lessons from instant payment systems and the analysis of digital asset networks. The project also aims to design a series of synthetic data to test how typologies could be accurately identified while reducing false positives.

⁸³BIS Innovation Hub (2023) Project Tourbillon: exploring privacy, security and scalability for CBDCs.

⁸⁴BIS Innovation Hub (2024) Project Hertha: identifying financial crime patterns while preserving user privacy within a real-time payment system.

4.1.7 Promissa Project

Another project developed by the BIS that we want to reflect in this research is the one carried out between the Swiss National Bank and the World Bank, called “Project Promissa,”⁸⁵ which was born within the tests to tokenise financial instruments. In addition, the International Monetary Fund also participates in the work, albeit as an observer. For several years now, much of the work of the G20 has focused on making multilateral development banks increase their financing capacity to be more effective.

Most international financial institutions are financed by debt instruments such as (paper-based) promissory notes. However, these promissory notes could be digitised and, using DLT technology, be more efficient. This is because it would simplify management by providing a single verification for all parties throughout the life cycle of debt and payment instruments. Today, two of the World Bank’s largest entities, the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA), hold many IOUs from member countries. In other words, the number of promissory notes held by all international financial institutions is very high, and this reality requires a solution that simplifies their management between international financial institutions. In summary, the project’s goal is to build a proof-of-concept (PoC) of a platform for tokenised digital promissory notes, and it is scheduled to culminate in early 2025.

4.1.8 Aurum 2.0 Project

More recently, in March 2024, the Hong Kong BIS Innovation Centre launched the second phase of its Project Aurum with the support of the Hong Kong Monetary Authority (HKMA). Known as “Project Aurum 2.0,” the goal of this research project is to improve the privacy of retail CBDCs, following experimentation with a tech stack that integrated a wholesale interbank system and a retail e-wallet in its initial phase.⁸⁶

The importance of this project lies in understanding that privacy is a key consideration and concern for users when they are presented with the idea of adopting a CBDC. They have made this known to the respective central banks through the public consultations proposed in different countries. Central banks, aware of citizens’ concerns, seek to implement measures that balance the purported privacy with a necessary level of transparency. As discussed *above*, other research projects focus on studying the privacy of retail CBDCs, such as the Tourbillon Project.

⁸⁵BIS Innovation Hub (2024) BIS Innovation Hub, Swiss National Bank and World Bank launch Project Promissa to test tokenisation of financial instruments.

⁸⁶BIS Innovation Hub (2024) Project Aurum 2.0: Improving privacy for retail CBDC payment.

The Aurum 2.0 project will draw on the expertise of collaborating universities and many privacy experts to advance the design of privacy-respecting CBDC systems. In this sense, the project aims to explain how technology can safeguard users' data in the public sector and evaluate how strengthening privacy impacts a given system's performance and compliance. Among the technologies that will be explored to improve privacy, project leaders cite pseudonymisation and zero-knowledge proof.

5 Conclusions

Once the regulatory perspectives of the different global CBDC projects and initiatives have been exposed from an exhaustive conceptual delimitation and their characteristics, a legal analysis of the main CBDC projects, as well as the role of the main monetary authorities at the international level, it is possible to draw some conclusions. Based on the premise that this matter is continuously evolving and most CBDC projects are in the experimental phase, some provisional criteria can be shed to inspire reflection on this new monetary reality and contribute to the debate on its legislative policy.

1. At a conceptual level, to understand the characteristics and typology of CBDCs, it is necessary to start by making a correct functional and regulatory differentiation between these and other concepts such as cash and electronic bank money, cryptocurrencies and stablecoins, and tokenised bank money (*e-money token*). Likewise, the differences between alternative CBDC models (retail and wholesale) should be understood, as each CBDC project can be ascribed to one of these typologies (or both), and its design and characteristics will depend on this categorisation. In this sense, this document has tried to contribute to the appropriate conceptual demarcation.
2. CBDCs, as digital currency projects issued by a central bank responsible for their distribution and the backing of their securities, with the nature of *fiat* currencies and programming capacity, were born as a reactive response by central banks to the challenges posed by decentralised cryptocurrencies and *stablecoins*, to preserve the monetary sovereignty of States. In addition, they can be considered one of the main manifestations of the monetary digitalisation to which the financial and banking system has been subjected in recent years.
3. Among all the projects under development, 4 stand out whose current situation and development, even heterogeneous among themselves, are the object of in-depth analysis in this work; these are, according to the degree of development: the Chinese digital yuan, with hundreds of millions of digital wallets issued in China in the last year; the Russian digital ruble, in the testing phase, although on a smaller scale, since 2023 and with a view to a hypothetical future issue in 2025; the digital euro, whose recent advance from the research phase to the preparation phase has energised doctrinal study and has led to the idea of a possible issuance

at the end of 2025; and the controversial attempt at a so-called US “digital dollar”, which is nothing more than a proposal in a very embryonic phase, after the numerous political obstacles that are preventing it from advancing in its design and implementation.

4. Specifically, the digital euro will take as a source of inspiration and as a legal framework for its regulation both the *Proposal for a Regulation of the European Parliament and of the Council on the implementation of the digital euro* and the *Proposal for a Regulation of the European Parliament and of the Council, on the provision of services in digital euros by payment service providers incorporated in Member States whose currency is not the euro*, both of June 28, 2023. With all this, it aims, as defended by the governor of the Bank of Italy, Fabio Panetta, to achieve its mission of safeguarding the role of cash as a complement to the digital euro and that the former remains easily accessible to natural and legal persons in the euro area.
5. Faced with this scenario, multiple questions and challenges arise at the legal and economic level that can only be tackled, on the one hand, by an adequate regulatory framework that limits the control of central banks to guarantee the privacy of users adequately and, on the other hand, by a careful technical design that takes into account the aforementioned legal framework and achieves the fit of the digital currency, whether it is retail or wholesaler, in the financial system.
6. CBDCs respond to certain interests in their market, where they will operate as legal tender and even as instruments of cross-border payments. However, the development of each CBDC project by their respective central banks is influenced by a political factor of unquestionable relevance. From a geopolitical perspective, it seems there is still a long way to go, and the next few years will be decisive.
7. The set of ongoing or already developed BIS *Innovation Hub* CBDC projects represent very significant advances in the future of CBDC standardisation and interoperability globally. Each addresses an area related to the development of any evolving CBDC project, including privacy, cross-border payment network technical support, or the viability of offline payments and transactions. Considering that most central bank digital currency projects are in the research and experimentation phase, I believe that the future regulation and development of CBDCs cannot be alien to the approaches of monetary authorities, commercial banks or the concerns of users.
8. Finally, the great challenge of any CBDC project that aspires to global adoption is that it can examine the situation of commercial banks, respecting the financial stability and integrity of the banking system, and, at the same time, be aware of the need to combine improving efficiency in the payment network by incorporating DLT (or other similar technology) while respecting users’ privacy.

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