



BANCA D'ITALIA  
EUROSISTEMA

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(Occasional Papers)

Technological progress and institutional adaptations:  
the case of the central bank digital currency (CBDC)

by Riccardo De Bonis and Giuseppe Ferrero

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# TECHNOLOGICAL PROGRESS AND INSTITUTIONAL ADAPTATIONS: THE CASE OF THE CENTRAL BANK DIGITAL CURRENCY (CBDC)

by Riccardo De Bonis\* and Giuseppe Ferrero°

## Abstract

The paper summarizes the debate about the proposed introduction of a Central Bank Digital Currency (CBDC). We place the CBDC in the wider context of the different types of money used in market economies. We explore the most important ideas on why economic agents use money, on the history of money and on the distinction between public and private money. We then discuss the digitalization of the payment system and the main characteristics of cryptoassets. We conclude the paper by explaining the reasons for introducing a CBDC as well as the associated risks.

**JEL Classification:** E42, E58.

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## 1. Introduction<sup>1</sup>

The intertwining of technology - the application of technical tools and knowledge to the solution of practical problems - and institutions has always characterized the history of finance. The transition from commodity money to minted metal money, from convertible to inconvertible banknotes, up to the appearance and diffusion of bank deposits, have been made possible by the combination of technological evolution and institutional changes. The shift from the use of gold and silver bars, which were weighed, to minted metal coins, which were counted, as we still do today, occurred around the seventeenth century BC. It was a technological leap, because men learned to obtain, through minting, metal coins, working with hammers and punches. But it was also an institutional leap, because the Greek city states managed the mints and impressed the king's head on one of the two sides of the coin. Also the passage from convertible banknotes to inconvertible ones is associated to technological developments that have improved their quality, incredibly increased over time, especially to make them difficult to counterfeit. But for the passage to inconvertible banknotes it was more important the idiosyncratic establishment of the central bank, whose task is to ensure trust in a piece of paper intrinsically worthless, through procedures, tools and decisions aimed at ensuring the stability of money value over time. In short, money is a social institution, not a mere technological support, and its evolution over time is a story of interconnectedness between technological progress and institutional adaptations. The central bank digital currency (CBDC) – a new type of public money based on digital technology – is a further step along this path.

According to a 2021 Bank for International Settlements survey of central banks, 86% of these institutions were researching the potential for CBDCs, 60% were experimenting with the technology and 14% were deploying pilot projects (Auer et al., 2021).<sup>2</sup> In 2021 the Governing Council of the European Central Bank (ECB) has decided to launch the investigation phase of a digital euro project which will last 24 months. In January 2022 the Federal Reserve presented a report to foster discussion on the hypothesis of a U.S. CBDC.<sup>3</sup>

Below we provide a review of the discussions which have favoured the experimentation on a CBDC. We place the CBDC in the wider context of the different types of money, public and private, used in market economies. The paper is divided into 7 Sections. After this Introduction, Section 2 summarises some ideas on why economic agents use money, on the history of money and on the distinction between public and private money. Section 3 deals with digitalization of the payment system while Section 4 debates the main characteristics of crypto-assets. Section 5 lists the motivations for the introduction of a CBDC, while Section 6 underlines some problems and risks associated with the CBDC. Section 7 concludes.

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<sup>2</sup> See also Boar, Holden and Wadsworth (2020).

<sup>3</sup> Board of the Governors of the Federal Reserve System (2022).

## 2. Why do we use money?

To answer this question, it is useful to ask another question first: what kind of society has no need for money?

Let us go back in time several centuries and consider a small village, located on an island. A family of fishermen and a family of farmers live together on the island. It is a beautiful day. Flat sea and a light breeze: the fishing family fishes in abundance. Back home, the fishing family consumes some of the fish and puts the rest in a barrel full of water to take them the next day to the farmer family. The farmers have not harvested any crop for several days now, but they expect to do so in the next few days, perhaps weeks. The two families agree that the farmer will give part of the crop, when it will be ready, in return to the fishermen. How much crop the farmers will provide to the fishermen depends on the agreement between the two families: it probably depends on how much crop they expect to harvest and how much fish they are provided with by the fishing family.

In this society, to violate an agreement would mean starvation in the future, because in times when there is no fishing, or no harvest, there would be no counterpart willing to give up a share of their income: agreements are always respected (i.e. full commitment holds). Both parties involved in the exchange give value to the goods produced by the other: there is a double coincidence of needs. Because the village is small, exchanges are few and easy to keep track of: there is an effective record keeping technology. In this society there is no need for money. Exchanges can be made simply on the basis of direct exchange agreements over time, through primitive forms of credit.<sup>4</sup>

When, on the other hand, these three conditions do not apply – counterparties sometimes violate agreements, the goods and services produced are not always considered useful by potential buyers, villages expand making it difficult to keep track of all agreements – some of the exchanges are not carried out and the society as a whole achieves a lower level of welfare. In this case, money, by simultaneously performing the functions of a unit of account, a store of value and a means for transferring value, becomes an instrument that improves social welfare.<sup>5</sup> Members of the society are willing to give up part of their goods or provide services in exchange for something that allows them to “seal the deal”. Both the subject who gives a good or service and the one who receives it in exchange for money are freed from any obligation linked to the exchange the moment the money is accepted. Money keeps track of the agreement: the fact that money becomes the property of the recipient is the “trace” that an exchange has taken place.

In increasingly complex economies, money has made it possible to produce and allocate goods and services more efficiently across space and time. However, history is littered with episodes in which previously widely used currencies ceased to be exchanged and were replaced by new or other existing currencies. Technological innovations are one of the reasons why these changes occurred. But they are certainly not the only reason. We are only willing to accept a piece of paper (banknote), metal discs (coins) or electronic bits (bank account deposits) in exchange for the goods and services we produce or own, or in exchange for our work, if we are sufficiently confident that tomorrow, the day after tomorrow, in a month or whenever, someone

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<sup>4</sup> On the fact that credit/debit relations have historically preceded the use of money, see Martin (2013) and Knopf and Graeber (2011).

<sup>5</sup> For a description of these concepts see, for example, Kiyotaki and Wright (1989), Kocherlakota and Wallace (1998) and Wallace (1980). These papers regard the introduction of money is the result of a *mechanism design* through which societies solve a shared social welfare problem.

else will accept them in turn, at a value that is (essentially) unchanged. In other words, we have to trust that the issuer of money is able to preserve its value over time. When the value of money becomes unstable, citizens stop using it. The public's trust in monetary stability is essential if money is to be regarded as a store of value and widely used as a mean of payment in the economy.

## 2.1. Money in a historical perspective

As in other fields of economics, scholars have long debated whether money should be produced, transferred and preserved under a state monopoly or whether it should be issued through a competitive market system, supervised and regulated by the state.

A good case for adopting the first solution is the argument that a currency is economically-efficient, in that it is at once uniform (because it is issued by a single entity), stable (because an independent state institution has the mandate to preserve its value over time) and that it minimises transaction costs (because there is no need to have information on the creditworthiness and the ability to preserve its value by each individual issuer, there being only one).<sup>6</sup>

Those who favour the second option believe that a currency monopoly creates distorted incentives for the issuer to exploit its position in order to devalue it, thus increasing seigniorage profits. Furthermore, they believe that in a competitive market with many issuers, information spreads more efficiently and issuers are better able to know and assess household and business demand for money. Public regulation and supervision can eliminate or correct the distortions and negative externalities that can occur in such a market.

In the Middle Ages, kings and lords produced their own gold (or other precious material) coins. The Italian economic historian Carlo Maria Cipolla analysed the “dollars of the Middle Ages”, i.e. coins that were accepted in many countries, as has been the case with the US dollar from the 20th century onwards.<sup>7</sup> The relative value (i.e., exchange rate) depended on the amount of gold in the individual coins. Often kings or lords would reduce the amount of gold (sometimes temporarily, sometimes permanently) in the coins they issued, in order to extract more seigniorage revenue to finance wars or other expenses.<sup>8</sup> A widespread mechanism was as follows: the lord or king would borrow (for example) a hundred gold coins, which he had previously issued. When he had to pay back the loan, he would produce and return one hundred gold coins that he had issued but with less gold than he had previously borrowed. New coins with less gold and therefore less value entered the economy. The currency was thus devalued. Since the amount of gold or silver in a coin could not be easily and immediately measured, its value was often “certified” by the reputation of the issuer. Reputation and competition meant that kings and lords did not “exaggerate” or systematically use devaluations. Keeping the value of their coins stable over time was the way to preserve (or strengthen) the reputation of the issuer and ensure the use of the coin.

Some qualification is in order. Firstly, we are talking about the “big” currency, with a high unit value. The “dollars of the Middle Ages”, such as the florin of Florence and the ducat of Venice, circulated only among the elite, the wealthiest merchants and bankers, and were the means of payment used in international transactions. But only the wealthy classes had the big coins. The majority of the population used “small” currency - where silver was mixed with copper

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<sup>6</sup> See Eichengreen (2019).

<sup>7</sup> See Cipolla (1956).

<sup>8</sup> Seigniorage is commonly understood to mean all income derived from the issue of money.

- which prevailed in everyday trade, small-scale commerce and wage payments. The big coin kept its original precious metal content. The small coin, on the other hand, experienced a progressive decrease in the amount of precious metal it contained (a debasement).

Secondly, faced with a recurring shortage of gold and silver in Europe, the debasement of money enabled countries to avoid currency shortages that would have reduced demand for goods and led to falls in prices (deflation) and productive activity. Even before the invention of central banks, governments aimed to avoid dangerous deflation. The debasement of the small currency gave many countries the opportunity to experience phases of economic development.<sup>9</sup>

Trade with gold and silver coins was also extremely inefficient, given the high costs of extracting and storing precious metals. The advent of entities (such as goldsmiths and banks) that accepted gold coins for deposit and gave deposit receipts in exchange, which in time became banknotes, marked the transition from commodity money (gold coins) to representative money: banknotes, issued by banks, constituted a right to obtain gold coins, issued by the King or the Lord. The value of one was closely linked to the value of the other. As time passed, economies got rid of metallism. This was possible thanks to the emergence of central banks independent of the Sovereign and able to anchor the value of banknotes no longer to that of gold and silver, but to the trust and credibility that citizens place in the central banks themselves and in their ability to keep prices stable over time.

## **2.2. Public and private money: the division of labour between central bank and banks**

For centuries, banks have issued banknotes in competition. A slow evolution has led to the current situation:<sup>10</sup> there is only one central bank for each country, an institution that has a monopoly on issuing banknotes.<sup>11</sup>

It has often been the case that a central bank would arise from the transformation of a commercial bank, sometimes through a process of merger between several banks. A “leading” bank, usually specialising in dealing with the kingdom’s finances, would take on the role of a central bank, becoming the “bank of banks”, on the basis of an investiture by the state. The central bank, given its history as a commercial bank, would continue to collect deposits and offer loans to private individuals for years.

Today, households and companies cannot hold deposits with the central bank. By collecting deposits from the public, central banks would compete with commercial banks. In his most important work Marcello De Cecco recounted the struggle fought in the 19th century by English banks to prevent the Bank of England from collecting deposits.<sup>12</sup> This battle, which also took place in many other countries, was ended by introducing a principle of division of labour between the central bank and the commercial banks.

In modern economies, the central bank issues two forms of public money that constitute the so-called base money (or outside money): *central bank reserves* (bank reserves) and *currency in circulation* (mostly banknotes, and to a lesser extent coins, often minted by the state). While the latter is used by all economic agents (in this case we speak of “*retail*” money), bank reserves

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<sup>9</sup> See Cipolla (1958).

<sup>10</sup> See Giannini (2011) and De Bonis and Vangelisti (2019).

<sup>11</sup> Obviously with the exception of monetary unions.

<sup>12</sup> See De Cecco (1975).

are used only by banks to carry out transactions among themselves or with the central bank (in this case we speak of “*wholesale*” money). Banks issue a third type of money, *bank deposits*, and grant loans to households and businesses, giving rise to the so-called maturity transformation: they issue a liquid, short-term liability (i.e. immediately convertible into goods and services), bank deposits, and hold less liquid, longer-term assets (loans and other financial assets).<sup>13</sup> The three forms of money are characterised by being expressed in the same unit of account and thus by having a conversion rate (exchange rate) at par at all times: €10 on a bank deposit or €10 of central bank reserves are both convertible into €10 of currency in circulation.

The close link between bank money and public money rests on three pillars: (i) the legal, regulatory and supervisory framework; (ii) the conduct and transmission of monetary policy; (iii) the payments system.

The first area involves the set of constraints, rules and controls that the central bank and the legislator impose on banks. Rules state that the holder of a bank deposit may at any time dispose of the sums resulting to his deposit by requesting their transfer or their conversion into banknotes at face value (subject to observance of the notice period and any agreed limits).<sup>14</sup> There are constraints imposed by prudential regulation and controls exercised by banking supervision to contain the risks of illiquidity and insolvency of banks, and to preserve the value of the money they issue. The central bank’s role as lender of last resort reduces the likelihood that a bank’s temporary difficulty in raising liquidity will turn into a default. Finally, the insurance of deposits ensures their availability, up to a certain amount, even if the bank becomes insolvent.

The second area concerns the conduct of monetary policy, which in many jurisdictions sees banks as the first link in the monetary policy transmission chain. When the central bank wants to incentivize households and firms to consume and invest, it usually does so by reducing the official interest rates: these are the rates at which banks can borrow reserves from the central bank or the rates they receive for holding the reserves at the central bank. Changes in official rates affect the rates that banks are charged when they borrow central bank reserves, in the so-called interbank market. Interbank rates, in turn, affect the rates that banks pay on bank deposits and the rates they charge for lending these deposits to households and firms.<sup>15</sup> In this way, monetary policy not only affects the incentives of economic agents to save, consume and get into debt, but also influences the quantity of bank deposits within the economy.

The third area is the payment system. When we use our bank deposits to make a payment, not only do our funds move within the banking system from our account to that of the beneficiary, but central bank reserves also move from the reserve account (at the central bank) of our bank to that of the beneficiary’s bank.<sup>16</sup> The transfer of reserves plays an important role for the stability

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<sup>13</sup> Banks also hold, among their assets, instruments issued by the public sector (reserves and government bonds), but what distinguishes banks from other financial intermediaries is that they issue deposits and provide credit to the economy.

<sup>14</sup> In Italy, for example, the convertibility and transfer of bank accounts are governed by Articles 1834, 1842 and 1852 of the Civil Code.

<sup>15</sup> This is only one of the transmission channels. Many others operate, which for the sake of brevity we will not analyse in this article.

<sup>16</sup> The movement of reserves does not occur if the issuer and the recipient of the payment both have an account with the same bank.

and proper functioning of the centralised payment system, where the central bank and the banking system are at the centre.

### 3. The digitalization of the payments system

One aspect that bank money and central bank reserves have in common today is that both are currencies in electronic (or digital) format.<sup>17</sup> More precisely, they are accounting records (ledger) in electronic format. This means that they are created, stored and transferred electronically. They are also part of a wider payment system mainly consisting of electronic instruments. We use credit and debit cards, which contain an electronic chip. We make online transfers from home, exploiting the potential of *home banking*. We no longer need to physically go to the bank counter and we use cheques much less than in the past.

One type of digital currency that has emerged over the years is the so-called *e-money*. Its main feature, apart from the fact that it can be stored on physical devices (such as in a card chip) or through a software that requires an Internet connection, is that the issuer is obliged to convert it into bank money at the holder's request. To ensure that this actually occurs, the issuer must have in its balance sheet a quantity of very liquid assets (i.e. rapidly convertible into bank money, without loss of value) at least equal to the e-money it has issued. An example, widely used in Europe, are prepaid cards, which can be purchased at banks or post offices, on which we transfer funds by handing cash to the intermediary or by moving them from one of our bank accounts.

E-money can be issued by banks, post offices and electronic money institutions (EMIs). In Europe, EMIs are subject to regulation and supervision. However, the money they issue is not covered by an insurance similar to that which exists for bank deposits; moreover, EMIs do not have access to the reserves of a central bank, therefore, the latter does not perform the function of lender of last resort in respect of them.

An important feature of all these records is that they are centralised, i.e. they are physically stored within the computer memory (or servers) of banks, post offices, central banks (for central bank reserves) and EMIs. Not only do these institutions issue these forms of money, but they also store and transfer them.<sup>18</sup>

### 4. Crypto-assets

If it is true, as we have observed, that the payments system has become increasingly electronic over the years, a further technological-institutional shift has taken place, more recently, with the advent of the so-called crypto-currencies.<sup>19</sup> The technology (in this case, cryptography) becomes a mean of decentralising the system by which money is created, transferred and stored.<sup>20</sup>

Today, there are thousands of crypto-assets in the world, including Ethereum, Litecoin and Ripple. But Bitcoin, whose market share exceeds 50 per cent, is the most famous. Its birth date back to late 2008, two months after the bankruptcy of Lehman Brothers. Bitcoin uses a system

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<sup>17</sup> We use the adjectives electronic, digital and virtual as synonyms.

<sup>18</sup> In all countries, the activities of banks, as well as the issuance of payment instruments, are a prerogative of supervised financial intermediaries. This has not changed with the electronic transformation of the payment system.

<sup>19</sup> More correctly, they should be called crypto-assets, since they are not able to perform the three functions of currency described in the first part of the article at the same time.

<sup>20</sup> See De Bonis and Ferrero (2020).

for digital transactions in which the issuing of new units and the validation of transfers of ownership of existing units is “completely decentralised, with no server or central authority”.<sup>21</sup>

Bitcoin is not a central bank liability, like banknotes; it is not a bank liability, like deposits. Bitcoin is not legal tender, which the state obliges citizens to accept in transactions and for the settlement of debts. There are no controls or guarantees by a central institution for Bitcoin: it is accepted on a voluntary basis, using procedures over which there is no public control.

Trust in bodies such as the central bank and commercial banks, at the heart of the payment system, is replaced by a cryptographic system managed by individuals ideally placed on an equal footing: the nodes of the database are connected to one another, without the presence of central servers. A blockchain, a *decentralised ledger technology* (DLT), is used to transfer and validate the ownership of Bitcoin units. All Bitcoin holders have access to a copy of the ledger in which the previous transactions of all Bitcoin units are recorded, and can validate and write new transfers of ownership of the crypto-asset (*permissionless blockchain*) directly to their own and all other users’ copies of the ledger. To do this, they have to solve complicated mathematical problems. Since this activity is expensive in terms of computation and therefore energy, it is usually delegated to a small group of users, the so-called *miners*. The prize for finding the solution is a share of the new Bitcoins generated by the system.<sup>22</sup>

Apart from its potential use for illicit activities and as an instrument for speculation, the appeal of Bitcoin is ideological: anarcho-libertarians all over the world dream of the spread of a currency and a technology that allows transactions between private individuals without any role for banks, central banks nor any supervision of the payment system Brunton (2019).

Bitcoin, not being the liability of any issuer, is to some extent comparable to a commodity like gold (in fact the term *miners*, mentioned above, is reminiscent of gold miners). The supply is regulated by an algorithm that establishes the quantity of new units to be injected as a function of the flow of time, not of fluctuations in the demand. Consequently, as with other financial or real assets whose supply is independent of the demand, sudden changes in the latter are reflected entirely in its price, making it very unstable. Price fluctuations make it unattractive as a unit of account or as a medium of exchange (Heller, 2017). The high volatility and risks involved also imply that Bitcoin is a very risky store of value, unlike central bank-issued money and bank deposits, whose value is stable. Therefore, it is correct to call Bitcoin a risky crypto-asset rather than a crypto-currency<sup>23</sup>.

In order to react to the excessive volatility of so-called crypto-currencies, the market is developing *stablecoins*.<sup>24</sup> Like Bitcoin, these private digital tokens use DLT technology to transfer and validate the transfer of ownership of individual units but, unlike Bitcoin, are generally issued by identified entities, financial or other. *Stablecoins* are created with the explicit objective of maintaining the value of the instrument stable over time, by linking it to that of

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<sup>21</sup> Nakamoto (2008) is available at <https://bitcoin.org/bitcoin.pdf>.

<sup>22</sup> *Miners* also receive commissions, the amount of which is chosen by the parties making the transaction according to the time they are willing to wait for validation.

<sup>23</sup> On September 2021 Bitcoin has been recognised as legal tender in El Salvador, siding the USD as the country's currency. Every citizen will be able to download an app where they will find the equivalent of 30 USD in Bitcoins, courtesy of the government.

<sup>24</sup> See Berentsen and Schär (2019) and De Bonis and Ferrero (2020).

financial or real assets with a relatively stable value (*asset-linked stablecoins*)<sup>25</sup> or by means of algorithms that regulate the supply according to the fluctuations in the demand (*algorithmic stablecoins*). In the case of *asset-linked stablecoins*, the quality and liquidity of the assets held by the issuer against the crypto-assets issued, generate a trade-off for the issuer: the higher the degree of quality and liquidity, the lower the return on those assets, and hence the seigniorage profit. At the same time, the easier it is to convert *stablecoins* into official currency, the greater the confidence in them.

Among *stablecoins*, the proposal that has attracted the most attention is that of Diem, formerly known as Libra, put forward by Mark Zuckerberg, co-founder, chairman and CEO of *Facebook*. The first Libra white paper, published in June 2019, was followed in October 2019 by a very stern stance by the G7, which stressed the risks of the instrument.<sup>26</sup> Libra would be issued by a company that, by operating on a global scale in the field of technology and information, enjoys a strong comparative advantage over other companies in the collection and analysis of customer data. As such, its potential global deployment raised many questions about its possible effects on monetary sovereignty, the stability of the financial and payments system and the effectiveness of monetary policy as well as on consumer protection and on the fight against money laundering and financial crime. Libra responded to the comments with a second white paper, published in April 2020. Recently, the European Commission and the G7 countries have reiterated the view that private cryptocurrencies, if authorised, can only be issued under strict regulation, clearly setting out the obligations for issuers in terms of protection of users and of society as a whole, in order to preserve the security and stability of the economic and financial system. No asset-backed *cryptocurrency* scheme (*stable coins*) can start operating until the legal framework is in place and the above-mentioned risks have been addressed. At the beginning of 2022 Facebook's Diem seems to be in a stalemate.

## 5. Central bank digital currency: why?

In the mid-1980s, James Tobin, Nobel laureate in economics in 1981, proposed transforming central bank reserves from *wholesale* money, accessible only to banks, into *retail* money, accessible to everyone. According to Tobin, central banks should make it possible for households and businesses to build up deposits, which can be mobilised through cheques or other instruments. “*I think the government should make available to the public a medium with the convenience of deposits and the safety of currency, essentially currency on deposit, transferable in any amount by check or other order... The Federal Reserve banks themselves could offer such deposits, a species of Federal Funds*” (Tobin, 1987).

Tobin was writing in years marked by a return of banking crises. The United States had been hit by the failure of *savings and loan associations*, small local banks. The crises led to losses of USD 200 billion, which in turn necessitated deposit insurance and government bailouts. Tobin's aim was to limit excessive exposure of the deposit insurance system: a deposit with the central bank is by definition safer than a deposit with a commercial bank. The central bank cannot fail. Tobin's idea was not followed up, but the American economist has the merit of having been the first to propose that the central bank issue an instrument somewhere between a bank note,

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<sup>25</sup> For this purpose, the issuer holds in its balance sheet assets an amount of assets equal to the amount of crypto-assets that have been issued. For example, an issuer of euro-linked stablecoins would hold liquid euro securities in an amount equal to the amount of crypto-assets it has issued.

<sup>26</sup> See Adrian and Mancini-Griffoli (2019) Sitglitz (2019).

central bank reserves and a bank deposit. In some respects, it is the precursor of the *central bank digital currency*.

The CBDC would, in fact, be a currency with certain characteristics similar to those of the currencies we have described in the previous sections. First of all, as the name implies, it would be a digital currency. This does not mean that, like crypto-assets, it would necessarily use a decentralised ledger system with DLT technology. This is one of the possibilities. Alternatively, the new digital currency could be more akin to central bank reserves and be based on a centralised ledger system, held at the central bank. In the latter case, we speak of *account-based* CBDC, i.e. a kind of current account at the central bank. In the first case, instead, CBDC would be *value-based* and would look more like a form of electronic cash<sup>27</sup>. Similarly to other forms of digital money, it could be stored and transferred through an application installed on one's *smartphone* or through a software that uses the Internet to access the system for transferring and storing it, or it could be stored on the chip of electronic *smart cards*.

On account of being issued by the central bank, the CBDC would have similar characteristics to the other forms of central bank-issued money: it would be convertible 1 to 1 into currency in circulation, and the stability of its value over time would be the same as that of currency in circulation. The central bank could also decide to remunerate the holders of CBDC. In this case, it would be similar to a bank account, i.e. a very liquid store of value that remunerates the holder and partly covers them against the risk of inflation. If, on the other hand, the central bank decided not to remunerate the holders, the CBDC would be more similar to cash, which is characterised by being a store of value that cannot protect the holder against changes in the prices of goods and services.

If CBDC has features “taken” from other forms of currency, why should the central bank issue a new one?

The reasons to issue a CBDC are manifold. Here we focus on those commonly found in the official documents of the major central banks.<sup>28</sup>

*Concentration and fragmentation of the payment system.* Payment systems benefit from economies of scale and *network effects*: the more people use the same currency within the system, the more willing people are to accept it as a means of payment, because it will be easier to find someone else to accept it in the future. The mechanism can lead to over-concentration. One way to counter this risk is to regulate the entry into the payment system of companies operating on a global scale in the fields of technology and information, such as the so-called BigTech or GAFA (Google, Amazon, Facebook, Apple). These companies, already operating through widespread platforms, have an incentive to develop systems with barriers to entry for other payment service providers. CBDC could be an alternative to the risk of private oligopolies; we will come back to this point shortly below, when we discuss monetary sovereignty. At the opposite end of the spectrum, *local stablecoins* could be created in one country, based on standards and technologies specific to each issuer. In this case, the economic and technical costs of preserving interoperability of payments could be significant, and the risks of fragmentation high: consumers

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<sup>27</sup> This type of CBDC is often referred to as a “*digital token*” to indicate that, as with circulating currency or tokens, the transfer, once issued, would not take place through centralised registers but through registers in the token itself. On the different options see Urbinati et al (2021).

<sup>28</sup> See, for example, ECB (2020), Bank of England (2020), Bank of Canada (2020).

and firms would be exposed to considerable difficulties and transaction costs when trading through institutions using other *stablecoins* as means of payment.<sup>29</sup> The CBDC could, in this case, become a tool to ensure interoperability, in the same way that central bank reserves allow the banking system to exchange liquidity today.

*Evolution in the use of cash.* In some countries, there has been a gradual reduction in the use of cash in payments. Although it is not yet possible to draw any clear conclusions on the impact of the Covid-19 crisis on the use of cash, the pandemic may have accelerated a structural change in payment habits by increasing the use of electronic instruments.<sup>30</sup> The network effects, as described in the previous section, could quickly lead to a situation where the sustainability of the infrastructure necessary for issuing and using cash, and related services, is put at risk. Citizens would find it difficult to access the only mean of payment provided by the public sector, the only one that takes into account their needs, regardless of any commercial perspective.<sup>31</sup> As the major central banks are expected to provide a currency that is accessible to all, citizens would lose confidence in the central bank and, presumably, in its ability to preserve monetary stability.<sup>32</sup> Moreover, the stability of the payment system itself would be called into question. Indeed, the trust in bank money, discussed in the previous sections, also rests on the obligation to convert bank deposits into money issued by the central bank. If cash were to disappear, the link between bank deposits and banknotes would be at risk in absence of a CBDC.

*The digitalization of the economy.* To the extent that the CBDC is able to provide services that are not available in the private payments sector, it could facilitate the digital transformation of the economy by supporting the development of innovative solutions and new business models, not only in the financial sector but also in other sectors. For example, it could incentivise payment service providers to reduce environmental costs and increase energy efficiency.

*Security and stability of the payment system in the presence of extreme events.* The stability of a payment system centred on digital currencies and payment instruments is subject to risks related to the occurrence of events such as *cyber attacks* or other extreme situations, such as natural disasters. These events could lead to disruptions in payment card services, *online banking* and cash withdrawals from ATMs, limiting retail payments significantly and eroding confidence in the financial and payments system in general. In these scenarios, the CBDC could provide a contingency mechanism for electronic retail payments, capable of functioning even when private payment solutions are not available.

*The defence of privacy.* A key feature of cash is that there is no centralised recording of transactions and ownership of individual units: this ensures the privacy of users. Cryptocurrencies, in addition to allowing complete anonymity, make it easier to carry out transactions that are contrary to the *Anti-Money Laundering/Combating the Financing of Terrorism* (AML/CFT) regulations. The CBDC can be designed to increase privacy in digital payments through the involvement of the central bank, which – unlike private payment service providers – has no commercial interest in consumer data; at the same time, the CBDC would be designed to comply with existing AML/CFT requirements.<sup>33</sup> As with interoperability, described

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<sup>29</sup> See BIS (2018). On market failures in the retail payment system see Passacantando (2022).

<sup>30</sup> On the Italian case see Ardizzi et al. (2021).

<sup>31</sup> This point is extensively described in ECB (2020).

<sup>32</sup> See on this issue Cipollone (2020).

<sup>33</sup> See for example Panetta (2020).

above, CBDC would be an option for a payments system that respects privacy and AML/CFT rules. However this is not the only option. Regulations aimed at issuers of *stablecoins* and supervision are other tools.<sup>34</sup>

*The defence of monetary sovereignty and the international role of CBDCs.* Widespread use of *stablecoins* or CBDCs denominated in currencies other than the domestic one could limit the ability of a national central bank to pursue price and macroeconomic stabilisation objectives, thus reducing the welfare of its citizens. In extreme situations, the use of the national currency could be reduced to the point where it is replaced by a unit of account (currency) controlled by non-resident issuers. The national central bank could gradually lose control over monetary matters. By issuing a CBDC, the central bank can reduce the risk of this happening and further, it can expand the international role of its currency by stimulating demand for it among foreign investors. To this end, a cooperative approach aimed at interoperability between CBDC systems would help strengthen the global role of each central bank, making the international payments system cheaper and more efficient. The publication in October 2020 of a joint report by the central banks of the Eurosystem, the United States, Canada, Japan, Sweden, Switzerland and the United Kingdom indicates that they would adopt the principle of interoperability between CBDCs if they were to issue CBDCs.<sup>35</sup>

*The conduct and transmission of monetary policy.* In theory, a remunerated CBDC could allow the central bank to influence the economic decisions of households and firms more directly. Changes in official interest rates could be applied directly to the returns paid on CBDC. The innovation would give banks an incentive to pass on such changes to the rates applied to deposits and loans more quickly. In principle, the issuance of CBDCs, if accompanied by the elimination of currency in circulation, would also overcome the problem of the effective lower bound (ELB) of official interest rates: the possibility of holding cash, the nominal return on which is zero, prevents the nominal return on any financial asset from falling to significantly negative levels. When the ELB is reached, real interest rates (which measure the effective return on a financial asset by stripping nominal interest rates of the expected change in the prices of goods and services) are determined solely by inflation expectations. In this situation, the central bank is no longer able to counteract below-target inflation reductions by lowering official interest rates. The introduction of a CBDC would – in theory – allow negative nominal interest rates to be applied to this type of digital money as well, thus eliminating the ELB. The possibility, however, appears to be an academic hypothesis, since in practice no central bank that has undertaken analyses on CBDC considers the discontinuation of the supply of banknotes to citizens a viable option.<sup>36</sup>

*The management of certain fiscal measures.* During the pandemic crisis, several governments made direct financial transfers to households and small firms, outside the traditional social protection mechanisms. Countries with a developed banking system were able to quickly transfer funds to the public and to companies in crisis. But one of the problems of these systems is that not all citizens have a bank account. For example, in the United States and Italy about 7% of the population does not have a bank account. Proposals have therefore emerged to develop

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<sup>34</sup> Indeed, the European Commission's recently published regulatory proposal provides that issuers of *stablecoins* may only issue such assets if they comply with stringent privacy and AML/CFT rules.

<sup>35</sup> See BIS (2020) and Passacantando (2021).

<sup>36</sup> The ECB, for example, in its Press Release of 2 October 2020 announcing the publication of a Report on the possible issuance of a digital euro, prepared by the Eurosystem High-Level Task Force on Central Bank Digital Currency (HLTF-CBDC) and endorsed by the Governing Council, stated that "*the digital euro would complement, but not replace, cash. The Eurosystem will continue to issue cash in any case*".

and use CBDC to make *government-to-person* (G2P) payments. In this case, CBDC should have similar technical features to crypto-assets: in order to reach even those who do not have a bank account, CBDC could be based on a decentralised transfer system. But unlike crypto-assets, where the identity of the user is not known, in this case the system should allow for the identification of users, e.g. by providing a system linked to a national digital identity scheme. Such CBDC-centred G2P systems could be used in the future, not only to implement social protection measures in emergency conditions, but more generally to settle payments between government and citizens, in both directions.

## 6. Risks associated with the issuance of CBDCs

In addition to the advantages described above, CBDCs raises issues such as: technical difficulties; possible negative implications for the stability of the financial system; problems for the effectiveness of monetary policy; implications for the relationship between monetary and fiscal policy. These aspects are being analysed by all central banks that are considering issuing CBDCs, in order to identify the technical and economic features that can minimise any negative implications.

*Technology-related risks.* Depending on its technical characteristics, the CBDC may be exposed to cyber and counterfeit risks. As far as cash is concerned, central banks have developed sophisticated anti-counterfeiting systems that limit the possibility of a large number of users being confronted with counterfeit banknotes. In the case of a CBDC exploiting DLT, the risks of counterfeiting or *cyber attacks* would be higher than for cash in circulation. A cyber attack aimed at counterfeiting CBDC could, in fact, directly affect a large number of users. This aspect requires in-depth analysis by central banks. On the other hand, centralised electronic payment systems are also subject to similar risks. With one difference. A centralised system offers a “*single point of failure*”: whoever manages to get into the system can take over everything. By contrast, a DLT can only be altered by changing the entire history of previous transactions, an enormously expensive operation.

*Risks to financial stability.* From the perspective of financial stability and the banking system’s ability to provide credit to the economy, the implications would differ depending on whether CBDC is remunerated or not. In the first case, CBDC could become a perfect substitute for bank deposits. The role of banks could be limited not only in the context of the payment system, but also in the context of maturity transformation and, hence, household and firm financing. The overall effects for the economic system would depend on the banks’ ability to attract funds by issuing longer-term liabilities than current account deposits, or by increasing the remuneration of the latter. If, on the other hand, the CBDC does not pay an interest rate, in phases of high financial instability it could still increase the risk of a “*digital run*” from bank deposits, which would be easily and quickly converted into central bank liabilities, making the economy more unstable. However, just as today deposit insurance and bank resolution rules limit depositors’ incentive to “run” to convert deposits into banknotes, and thus reduce the frequency of “*bank runs*”, these two instruments could also limit (at least partially) any flight of deposits to CBDC. Whether CBDC is remunerated or not, the instruments considered by central banks to limit disintermediation in the banking system are, firstly, the imposition of limits on the amount of CBDC that each citizen could hold and, secondly, the introduction of a system of price

disincentives (e.g. by imposing, for levels of CBDC held by individual users above a certain threshold, significantly lower rates than those paid by banks on current account deposits).<sup>37</sup>

*Implications for the effectiveness of monetary policy.* In the previous section we have seen that a remunerated CBDC could, in principle, allow a more direct transmission of monetary policy decisions to households and firms. On the other hand, the greater instability in the banking system and the possible impact of CBDC on the ability of banks to provide financing to the economy could, in principle, limit the effectiveness of some channels of monetary policy transmission.

*Demarcation line between monetary and fiscal policy.* G2P systems centred on CBDC could be used to implement some fiscal measures and regulate payments between government and citizens. Among these measures are proposals for direct transfers from government to citizens through the use of CBDC. While such use of CBDC, as mentioned above, could allow a broader range of citizens to be reached more quickly, it could at the same time blur the distinction between monetary and fiscal policy, affecting the degree of (perceived) independence of the central bank and, ultimately, its credibility in pursuing the objective of price stability.

## 7. Conclusions

The Italian economist Paolo Sylos Labini has stated in an ironic way that if a phenomenon has many causes, this implies that scholars are unable to explain it. The same opinion is held by editors and referees of academic journals who refuse to publish scientific articles when their authors do not distinguish between the fundamental causes of a phenomenon and factors that can be missed in a first approximation (so-called control variables).

In order to avoid running the same risk, let us state what, in our opinion, is the main motivation behind the possible introduction of a CBDC: the risk of loss of monetary sovereignty. Here “sovereignty” means the ability of the state “*to control outcomes and respond to the fundamental needs of the citizens, ‘the peace, safety, and public good of the people’*”, according to John Locke’s definition”.<sup>38</sup> Such a loss could occur in several cases: if other central banks were to issue CBDCs that were attractive on an international scale; if private digital currencies were to develop on a global scale (*global stablecoins*); if currency in circulation were no longer used. If such events were to occur and the central bank were not prepared to introduce CBDC, the ability to preserve the stability of prices as well as the financial and payment systems, which are the main contribution of the monetary authority to the welfare of citizens, could be endangered.<sup>39</sup>

The reader who has had the patience to follow us up to this point will naturally wonder about the other motivations that we have tried to summarise in the paragraphs above.<sup>40</sup> These include financial inclusion, the reduction of costs in cross-border payments, the risks of fragmentation of the payments system, the protection of privacy, the transmission of monetary policy, the management of certain fiscal measures, and the digitalisation of the economy. These are all important reasons, but the reader will probably conclude that they concern objectives that can (to a large extent) also be achieved through instruments other than CBDCs.

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<sup>37</sup> See Panetta and Bindseil (2020).

<sup>38</sup> Draghi (2019).

<sup>39</sup> See Panetta (2021), Cipollone (2021) and Panetta F. (2022).

<sup>40</sup> And which are more extensively discussed in the international reports cited above.

The debate on the nature of money, public or private, is an old one and has received different answers over time. Today, although most payments are made through instruments issued within the private sector, central bank reserves play a key role in the stability of the payments system. In the future, this role could also be played by the CBDC, which, unlike reserves, would be directly available to citizens. In this sense, the issuance of CBDC would still imply a central role of the state within the payment system. This possible innovation would be followed by regulation of privately issued digital currencies, for example along the lines outlined by the European Commission.<sup>41</sup>

These issues – which reflect the eternal confrontation between state and market – will be at the heart of the debate on CBDC in the coming years.

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<sup>41</sup> See the Proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, released in September 2020.

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