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Is CBDC a potential threat to European commercial banks?

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Master in Political Economy

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CIÊNCIAS SOCIAIS
E HUMANAS

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Resumo

O euro digital encontra-se numa fase de desenvolvimento e, conseqüentemente, existem ainda muitas incógnitas em relação às suas características bem como à forma como a sua aplicação irá afetar o sistema financeiro europeu. Visto ser um projeto recente, a literatura atual ainda não contempla um estudo extenso e detalhado sobre as várias conseqüências que esta moeda poderá ter, assim, este trabalho pretende contribuir para a divulgação do euro digital e aprofundamento do conhecimento de modo a ajudar a prever possíveis constrangimentos aquando da sua aplicação. Este trabalho tem como objetivo investigar, especificamente, o impacto que o euro digital terá no normal funcionamento dos bancos comerciais europeus, procurando assim projetar o nível de impacto bem como das possíveis ações para o diminuir. Esta investigação parte inicialmente pelo estudo do design da moeda digital examinando as características que Banco Central Europeu pode escolher adotar. Seguidamente, foi analisado o impacto provável que euro digital terá nos bancos comerciais, mais concretamente no surgimento de desintermediação bancária e na probabilidade, velocidade e dimensão dos fenómenos de corrida aos depósitos. Também a política monetária foi objeto de análise de modo a perceber se esta beneficia com a introdução desta moeda. Durante o estudo foram analisados em todas as situações os três principais intervenientes deste processo sendo eles os bancos comerciais europeus, o Banco Central Europeu e os utilizadores do euro digital. Esta tese conclui que o euro digital poderá, em certas condições, ameaçar o bom funcionamento dos bancos comerciais e como tal a estabilidade financeira europeia.

Palavras-chave: Euro digital; Bancos comerciais; Desintermediação bancária; Corrida aos depósitos; Estabilidade financeira.

Códigos JEL: E40, E50.

Abstract

The digital euro is still in the development stage, so there are still many questions about its characteristics and how its implementation will impact the European financial system. Since it is a recent project, there is still no extensive and detailed study in the current literature on the different domains where this currency will intervene. Thus, this work aims to contribute to the dissemination of the digital euro and to foster a deeper understanding in order to help anticipate possible constraints when applying it. This work aims to specifically investigate the impact that the digital euro will have on the normal functioning of European commercial banks, thus seeking to predict the level of impact as well as possible actions to reduce it. This investigation initially began by studying the design of digital currency, examining the characteristics that the European Central Bank may choose to adopt. The likely effects of the digital euro on commercial banks were then examined, with a focus on the development of banking disintermediation and the likelihood, speed, and magnitude of bank run phenomena. Monetary policy was also the subject of analysis in order to understand whether it would benefit from the introduction of this currency. During the study, the three main players in this process were analyzed in all situations, namely European commercial banks, the European Central Bank, and users of the digital euro. This thesis concludes that the digital euro may, under certain circumstances, compromise the stability of the commercial banking system in Europe.

Keywords: Digital euro; Commercial banks; Banking disintermediation; Bank runs; Financial stability.

JEL Code: E40, E50.

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Glossary

AML - Anti-money Laundering

BIS - Bank for International Settlements

CBDC - Central Bank Digital Currency

DBM - Digital Base Money

DLT - Distributed Ledger Technology

ECB - European Central Bank

EDIS - European Deposit Insurance Scheme

FDIC - Federal Deposit Insurance Corporation

GDPR - General Data Protection Regulation

HLTF-CBDC - High-Level Task Force on Central Bank Digital Currency

IMF - International Monetary Fund

KYC - Know Your Customer

MiCA - Markets in Crypto-Assets Regulation

OJEU - Official Journal of the European Union

Introduction

Currently, cash is still the most widely used payment method in Europe, but it is gradually being replaced by electronic payments. Indeed, the usage of digital payment systems is expanding, particularly in e-commerce, and even more in the context of the COVID-19 pandemic (Mai, 2021). This situation presents itself as a business opportunity for BigTech (i.e., Facebook), given that these companies are attempting to develop private sector money through the creation of private digital currencies (Ahnert *et al.*, 2022). There are also crypto-assets, which, despite being unstable, represent a decentralized alternative to national currencies controlled by central banks.

As a result, numerous central banks worldwide have begun to study and develop the idea of a Central Bank Digital Currency (CBDC) (Mancini Griffoli *et al.*, 2018). The main goal is to develop a new payment method through central banks while thwarting the development of private digital currencies, whose use could jeopardize the exercise of monetary policy and even global financial stability. Specifically, the European Central Bank (ECB) seeks to create a digital version of the euro, whose design is still being finalized.

The format choice of the newly created CBDC matters when analyzing its potential impacts on the European financial system. Choosing a design requires defining critical characteristics of this digital money, such as whether deposits should be limited to certain amounts or if this money should exist in the form of a bank account with the ECB (Cukierman, 2020). It is important to notice that a bank account with the ECB for everybody is unprecedented since there have never been direct linkages between retail banking, business and enterprises and the ECB (Landau and Brunnermeier, 2022). Another design option is to choose between "wholesale" and "general purpose," where the former imposes the constraints just for business and the latter is open access.

This thesis aims to analyze the potential effects of the digital euro on European commercial banks. There is the possibility that the introduction of this new digital currency into the European market would change how citizens typically deposit their money in banks. As such, two main phenomena can occur simultaneously. On the one hand, there might be a financial disintermediation when commercial banks stop playing a role in the chain of relationships between the European Central Bank, commercial banks, and people. On the other hand, a change in our deposits can trigger bank runs (Bindseil, 2020). This phenomenon might occur in a variety of ways and for several reasons, but it is most likely to occur as a result of the central bank of Europe's currency's potential attractiveness, particularly in terms of security and stability. In unstable and crisis-prone times, the likelihood of such an occurrence increases. There is also a third problem, related to the financing of commercial banks, since a reduction in bank deposits compromises their funding sources, forcing banks to carry out different (riskier) financing actions and adopt new strategies to guarantee profits and growth (Ahnert *et al.*, 2022). This work aims to contribute to the CBDC discussion, specifically for the digital euro, by highlighting the effects (both positive and negative) that the use of this digital currency can have on society in general and particularly on the stability and functioning of commercial banks.

This thesis is composed of five chapters. The first chapter studies CBDC's concept, outlining its goal as well as the specifics and effects of its design, looking also at the primary drivers for its creation by several central banks worldwide. The second chapter focuses on the topic of banking disintermediation and how it affects economic stability while also posing questions about the ECB's potential new role and the effects of the digital euro on commercial banks' capital and funding. Next, the third chapter addresses the possible impacts of the digital euro on ECB's monetary policy. The fourth chapter examines the risk of financial stress brought by the possibility of bank runs, as a result of the adoption of CBDC. Finally, the last chapter summarizes the main arguments and conclusion, addressing the main question of this thesis, regarding the effects of CBDC on commercial banks.

Central Bank Digital Currency (CBDC)

1.1. What is a CBDC?

The digital euro is the future European CBDC and a type of digital currency. The CBDC can be defined as a central bank's digital currency that is at the same time a unit of account and a medium of exchange (*Central bank digital currencies*, 2018). For the ECB, the digital euro is synonymous with boosting innovation, fostering payment efficiency, and supporting the European Union's economic prosperity (European Central Bank, 2022c). CBDC is not a new concept. For example, Tobin (1987) proposed that the governments should develop a 'deposited currency' that does not require deposit insurance, having the convenience of deposits and the safety of currency.

According to Chapman et al. (2023), the most important decisions when creating a CBDC are linked to the type of access that users will have (i.e., quantity or privacy), the system architecture (centralized or through intermediaries) and finally, the level of remuneration. Additionally, Stevens (2017) recognizes that CBDC, and more specifically, the digital euro, can be inspired by characteristics of other currencies (or assets, i.e., Bitcoin) and promote positive changes in the European financial system through monetary policy. Also, regarding the impact of this digital currency, Keister and Sanches (2022) states that CBDC can be used much more easily than cash, which can potentially alter capital flows and interfere with the monetary policy - this will depend on the design adopted by the ECB.

It is now essential to understand the different types of currencies that fall into the category of digital currency in order to understand the uniqueness of creating a European CBDC. First of all, it is important to highlight that digital currency, digital money and electronic currency are synonymous. Although there are several types of digital currencies, most of them share certain characteristics. Digital currencies can be defined as assets whose storage, maintenance and exchange are only accessible through technological means. This definition is extremely broad, covering currencies with remarkably diverse characteristics. Besides CBDC, there are two other main sorts of digital currencies: crypto-assets and stablecoins.

Crypto-assets are a form of digital currency that is mostly known for being decentralized and built on blockchain technology. Cryptocurrency platforms commonly employ Distributed Ledger Technology (DLT) systems to validate and secure modifications to ledgers. A certain number of users verifies transactions, and after the sender and receiver confirm the intention of the exchange, the user is left with a transaction record that serves as proof of transfer or purchase - usually referred to as *proof of work*. This mode of operation allows for the absence of a central authority that controls all currency movements. Each computer validates the consecutive currency transactions between users by updating the ledger - this method of operation is used by one of the most well-known crypto-assets, Bitcoin. This coin can be obtained in two ways: the first is through *mining* (i.e., *Bitcoin*), which allows the acquisition of a certain amount of the coin based on the volume of validations performed; the second is through purchase using centralized and official currencies (i.e., euro). This type of digital currency raises several issues, one related to high volatility, which causes its value to change abruptly at any time. Another issue concerns security since their high privacy level encourages using these currencies for criminal transactions. This is due to the low level of legislation and associated control. It is important to note that the ECB does not recognize the so-called cryptocurrencies as currencies, but rather as assets, and they should therefore be called crypto-assets according to the Markets in Crypto-Assets Regulation (MiCA).

Stablecoins are crypto-assets that strive to keep their value steady in relation to a certain item or a group or basket of assets (Delivorias, 2021). The specific functioning of many stablecoins is different, but almost all of them operate based on reserve assets, which can be legal assets or crypto-assets guaranteeing its conversion in relation to the price of the asset in question (Report on Stablecoins', 2021). Take Tether (USDT), one of the most well-known stablecoins connected to the US dollar, as an example. One USDT will equal one USD. This stablecoin provides the option of redemption upon request. It ensures the preservation of the unit's value, frequently through an algorithm whose goal is to limit the amount of the stablecoin in circulation by purchasing or disposing of it on the open market. However, there is a version of stablecoin whose operation differs from backed stablecoins, the algorithmic stablecoins. This is a non-collateralized stablecoin that works through an expansion and contraction of the supply of the stablecoin through a mechanism based on the specific algorithm of each currency ('Report on Stablecoins', 2021; Rosenberg and Pandl, 2022). Although it positions itself as a more stable alternative to crypto-assets, there are still concerns about how stablecoins actually works (Delivorias, 2021).

The CBDC is a digital version of central bank money that can be used by individuals, corporations, and governments and which aims to promote efficiency, liquidity, and scalability (Schilling, Fernández-Villaverde and Uhlig, 2020). This increased accessibility to central bank funds may open up new payment alternatives. Thus, this currency is issued and regulated by the ECB, in the European case. Furthermore, this currency is directly linked to the fiat currency of the country where it circulates. The design chosen by the central bank, responsible for the CBDC, substantially changes the behavior of the currency as well as the consequences that arise from it. As will be discussed later, CBDC can function in a distributed ledger system based on blockchain in token form, via direct account at the central bank. A token is merely a fresh term for a unit of value issued by a private company, and it has a value tied to it that is accepted by a community and is blockchain-based.

The concepts associated with the creation and development of digital currencies remain obscure to the general public. It is, therefore, crucial to draw a clear line between two different concepts: CBDC and virtual currency. Although they appear to be synonyms, virtual currency refers to a form of unregulated digital currency used and accepted by members of a particular online community and often produced and managed by its developers (Europe Central Bank, 2012). This category includes, for example, Farmville's in-game currency, whose functionality is embedded in the definition of the concept; as such, its distinction lies primarily in the distinction between decentralization and centralization.

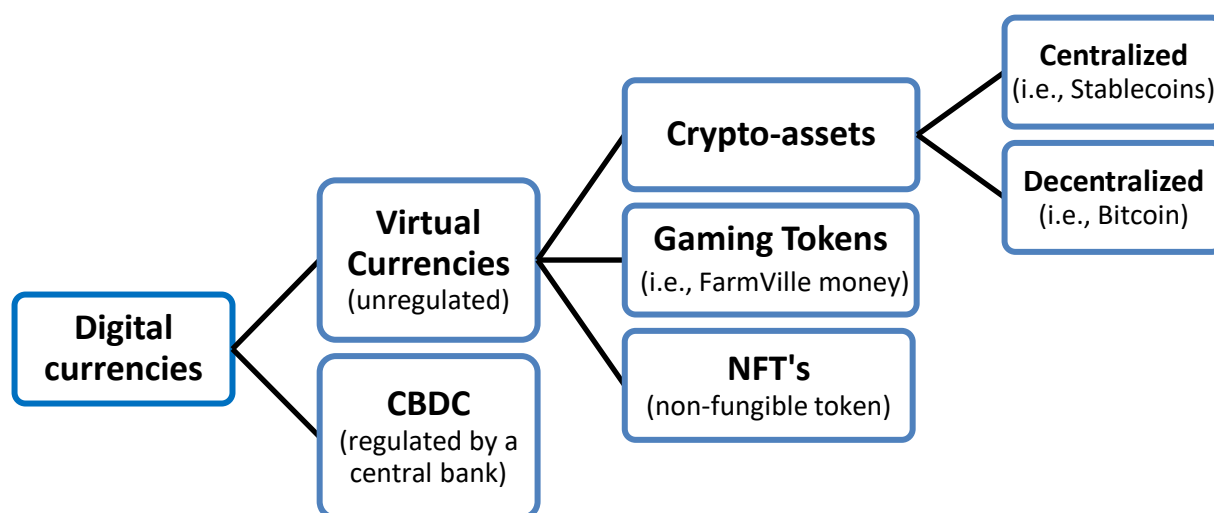


Figure 1.1 - Types of digital currencies scheme. Source: own elaboration.

Table 1.1 clarifies the complexity of the definition of "digital currency" and allows for examination of the different forms that this type of currency can take based on factors like regulation and centralization degrees.

Like the currencies mentioned above, the digital euro presents itself as a new currency with distinct characteristics, and common characteristics with the euro (such as centralization through the ECB) as its digital aspect is equated in some ways with crypto-assets. A High-Level Task Force on Central Bank Digital Currency (HLTF-CBDC) was established to comply with the requirements in a phased manner after the ECB launched an investigation project in 2021 intending to study potential designs and developments for the digital euro. Each phase corresponds to a quarter, each of which will have a distinct goal that needs to be accomplished. It is hoped that the launch phase of this digital currency will begin in the final trimester of 2023 (European Central Bank, 2022a).

1.1.1. Payment method

The primary goal of the digital euro, according to the ECB, is to serve as a brand-new payment method. The current market dominance for online retail payments is held by private companies whose investments in modernization allowed for a greater gap between the private and institutional technological innovations (Ahnert *et al.*, 2022). The factors driving the ECB and other central banks to invest in the development of the CBDC will be examined in greater detail later, but it is important to note that one of the main factors driving this development is competition for dominance the online payments market.

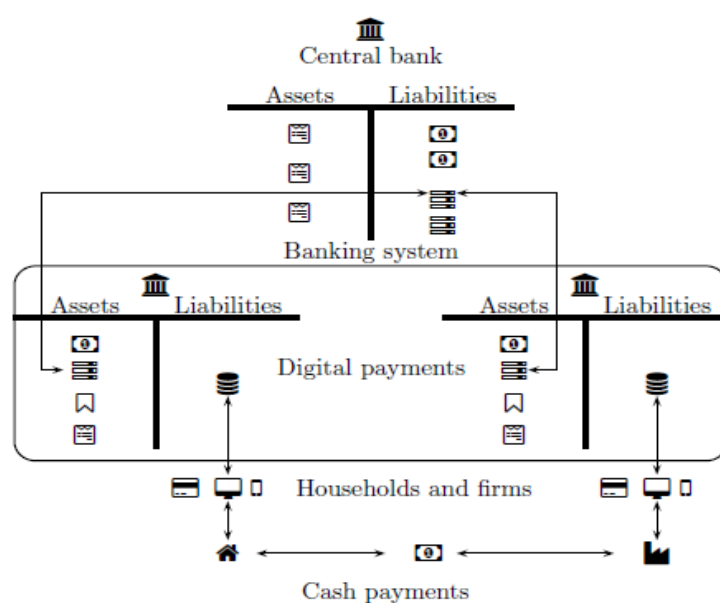


Figure 1.2 – Current two-tier monetary system. Retrieved from (Summer and Hermanky, 2022).

The current two-tier monetary system (Figure 1.2) is based on two types of money: the most popular and traditional form is cash, which is a type of public money issued by central banks and whose characteristics are still valued today in the absence of a perfect replacement (i.e., offline payments).

However, over the past few years, the use of cash has been gradually declining, in part because of the accelerated growth of e-commerce (Mai, 2021). As a result, more and more users and manufacturers are drawn to digital currency. This is the second type of money created through banks, frequently via bank deposits and investments, therefore considered private money. Online payments are possible with digital currency, but it also has some drawbacks, such as being subject to legal restrictions and bank transfers that slightly slow down the payment process. On the other hand, credit cards require fees for use that are considered high by consumers, this is due to the low number of companies operating in this market (such as Visa or Mastercard), which allows for the practice of these prices with little competition.

The development of the European CBDC as a new method of payment will cover multiple payment practices, each of which serves a different purpose. As such, the digital euro seeks to be an innovative solution for several payment types, including e-commerce, person-to-person (P2P) and physical points of interaction (POI). However, for this to happen, certain requirements must be met, such as an efficient digital euro distribution model and widespread acceptance among retailers and consumers.

The ECB has previously warned that the development of the digital euro does not represent the beginning of cash's replacement. The European CBDC will supplement the existing payment methods, so interaction with cash is intended. As soon as it is put into practice, it will give the European Union's society (and not just it) a second way to receive publicly issued money from the ECB. The distinctive feature of this currency can be observed in the next table (Table 1.1) since it enhances the union of three structural elements: an electronic feature, universal accessibility, and centralized currency issuance (Bjerg, 2017). The development of the digital euro will make it possible to maintain the value of public money in circulation, thereby ensuring financial stability while also boosting citizens' security and privacy. Public money refers to universally accessible money issued by the ECB, in the European case.

Table 1.1 - The features of CBDC. Source: own elaboration.

	Cash	Reserve Money	Bank Account Money	CBDC
Central Bank Issued	Yes	Yes	No	Yes
Electronic	No	Yes	Yes	Yes
Universally Accessible	Yes	No	Yes	Yes

1.1.2. CBDC design choices

The ECB's money is regularly used throughout the eurozone through the movement of cash within and outside of the countries. However, the central bank's digital currency is only accessible to commercial banks wholesale money. It circulates between banks and the ECB through its reserves intending to ensure bank financing and liquidity while serving as a tool for the implementation of monetary policy. By allowing direct public access to the digital currency issued by the ECB, the digital euro represents an innovation in the existing system. The use of the new retail CBDC means that, users will now have access to a new currency that is issued by the ECB. This serves as a starting point for choosing the design of the digital euro, so decisions made in this regard must take into account both the potential uses of this currency as well as the effects it will have on the current monetary and financial system.

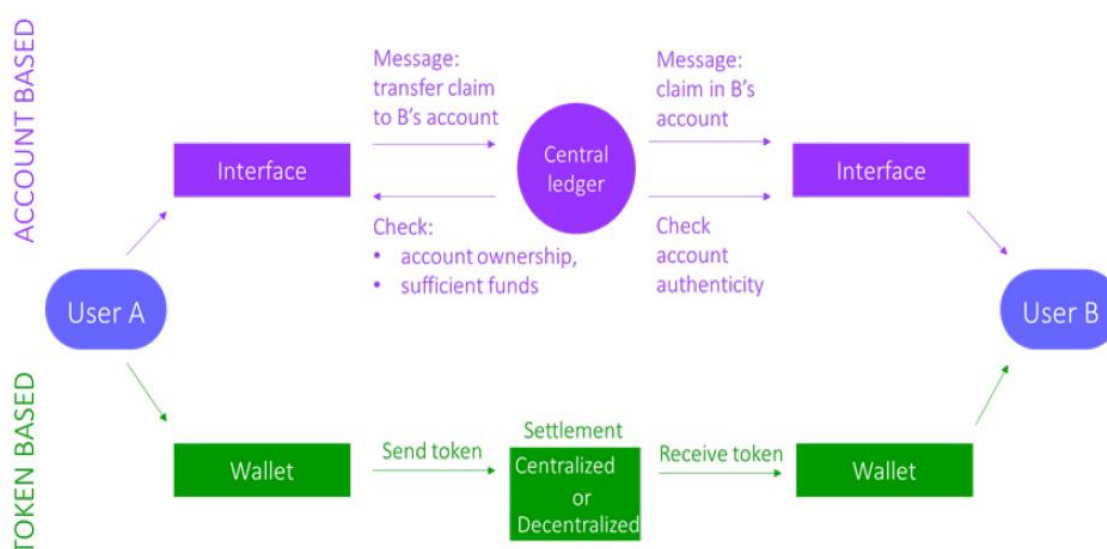


Figure 1.3 - Account based vs. Token based procedures scheme. Retrieved from (Mancini Griffoli et al., 2018).

When analyzing the properties of this currency, the first question is whether this new form of money will be stored and used directly in the central bank (account based) or whether it will be used as a token (token based). The figure below (Figure 1.2) represents, through a diagram, the main differences between the two options.

Under the account based CBDC option, each person will be able to have an open account with the ECB, which will change the way that this bank acts by making it a more direct and active participant in money circulation and payments but also increase its footprint in the overall financial system.

However, this scenario does not present itself as a viable solution, for several reasons. First, because the ECB would have to deal with a massive data entry in its system, since the number of accounts at the bank would increase exponentially. As such, it would be a challenging task to process all this information while carrying out procedures like KYC ("Know Your Customer") and AML (Anti-money Laundering) at the same time. Second, this type of account-based requires a significant technological investment from the ECB. Finally, this option raises financial stability concerns. The phenomenon of "bank runs" would be greatly amplified if this method of accounting were to be adopted in these circumstances, incentivizing the transfer of deposits from commercial banks to ECB accounts by sensing greater stability and robustness to the general public.

It is still possible to create a moderate account-based digital euro. In this scenario, the public still has access to the digital euro, but it does not have an open account with the ECB. As a result, intermediaries, in this case, commercial banks, would be responsible for maintaining the accounts and acquiring the digital currency. The tasks associated with managing accounts and interacting with the public would then be transferred to commercial banks throughout Europe. In this hypothetical scenario, these banks' accounts allow customers to perform payments, deposits, and withdrawals in addition to exchanging deposits for CBDC, presumably with a fee (Bindseil, 2020). The major differences between both account-based situations are more meaningful to commercial banks than to the average user since, in both cases, users can access the digital euro and all of its features while keeping their bank accounts accessible. At the banking level, the moderate account-based method preserves the weight of banks in the system through financial intermediation, minimizing the possibility of bank runs and bank disintermediation, thereby preventing financial stress (Cukierman, 2020).

In the token-based scenario, the digital euro is based on a token format, with the key differentiator being the potential for decentralized currency circulation. As a result, token transfers may take on a more private and open character, enabling peer-to-peer transactions, for instance. In contrast to account-based option, where transactions must go through a central ledger that examines and approves them, token-based option allows for semi-anonymous transactions to be made in a version of the Decentralized Ledger Technology that is tailored to this new currency. Another option is through an ECB verification, whose purpose would be to authenticate and modify the tokens' serial numbers to prevent cases of double spending (Figure 1.3). This option has a higher level of anonymity because the amount of data needed and stored by the chosen system would determine the exact level of privacy. High levels of anonymity, on the other hand, can open up new channels for money laundering, make it easier to finance illegal activities and encourage excessive currency accumulation. All of these factors, particularly the last one, could have detrimental effects, particularly on the management of European monetary policy (European Central Bank, 2020; Summer and Hermanky, 2022) .

1.1.3. CBDC limitations and safeguards

The adverse effects of the European CBDC's implementation have already been mentioned, specifically concerning how it may affect European commercial banks. Therefore, it is the responsibility of the ECB to advance a set of regulations that ensure specific restrictions on the use of this currency both inside and outside the European Union. The establishment of limitations aims to prevent the application of the digital euro from weakening the financial and payment systems as well as monetary policies (European Central Bank, 2022c).

Numerous ways to restrict the ECB's new currency are being discussed to predict and prevent potential negative effects, with the ECB admitting to use more than one to achieve its ultimate goals in several different circumstances.

One of the options would be to temporarily halt the digital currency's ability to be converted. In unstable times when there is a high risk that commercial money (bank runs) will flee to the digital euro, this measure would act as a stopgap, and the limit would be lifted once it was determined that there was no longer a threat of currency flight. In this scenario, it would no longer be required for commercial banks to guarantee convertibility between these two currencies, which ensures that the bank run would be avoided (Kumhof and Noone, 2018a). This choice faces two major obstacles: first, the continuous convertibility of the digital euro is one of its distinguishing features, and it also contributes to the currency's increased attractiveness – it is important to keep in mind that this currency's attractiveness is a crucial factor in its application's success, which can only occur if the CBDC is appealing to new users; the second barrier is based on the development of an atmosphere of unease, where currency users may occasionally attempt to predict when this measure will be temporarily applied and convert currencies before its application, creating an environment of constant alertness with unfavorable effects that may make the application of this limit less effective (Bindseil, Panetta and Terol, 2021).

There are also flow-based and stock-based limits to the use of CBDC. First, the amount of CBDC that may be transferred within a specific period—previously determined by the ECB—is limited. For example, this can be a daily limitation, and aims to slow down and limit the speed and flow of private money to the CBDC, thus reducing the risk of bank run (Bank for International Settlements, 2021). The stock-based limits or holding limits are another option that is presented in a more efficient and consensual manner. In this case, the goal is to cap the maximum amount of digital euros that any person can hold in order to significantly reduce the likelihood of bank runs, particularly during unstable economic periods. In contrast to the previous limit, convertibility is always available. As a result, it is possible to effectively control financial stability and the implementation of monetary policy while exerting greater control over the amount of digital euros in circulation. The ECB establishes a maximum number of digital euros that each individual may have in their wallet under the tightest interpretation of this restriction. Once the limit is reached, additional currency cannot be added to the user's account (Bindseil, Panetta and Terol, 2021).

This application makes it possible to prevent very effectively, bank runs in the first place and the use of this digital currency as a means of capital accumulation – a situation that the ECB wants to avoid as much as possible since the CBDC should only be used as a method of payment. This restriction forces each user to regularly monitor the amount of digital currency they possess in order to manage transfers and payments, which is a major disadvantage because, once the limit on digital currency holding is reached, it would be impossible to receive payments whose value exceeded the maximum allowed in an account or wallet (depending on the design chosen for the European CBDC). To avoid payment constraints due to an excess of CBDC in the destined account, the recipients would have to guarantee in advance that they would have enough margin to receive the transaction (Soderberg et al., 2022).

Other problems emerge when this limits issue is explored, one of which is the problem of the maximum value to be determined by the ECB. This is because choosing a common limit among the various types of currency holders, such as individuals and businesses, will require it to be extremely balanced to ensure that it is useful and attractive to both sectors (Ahnert *et al.*, 2022). In the worst-case scenario, these measures could have an adverse effect on the public's perception of the currency's advantages, thus diminishing the currency's attractiveness in the eyes of users, thereby reducing the level of adoption of the currency.

A *waterfall* technique may solve this problem, in which case every incoming digital euro that exceeds the holding limit would be automatically transferred to the payee's commercial bank account in private money (European Central Bank, 2020). This measure requires any CBDC holder who wants to receive payments above the maximum allowable amounts to have a bank account, reducing the level of independence of the European CBDC in the process. However, if a user does not have a bank account, a feasible scenario is the application of the previously mentioned simple holding limits, where a transfer is not conducted since it would result in surpassing the maximum permitted amount (Bindseil, Panetta and Terol, 2021).

Yet, a proposal clearly stands out from the rest by adopting new mechanisms in addition to some already mentioned features. This proposal is known as "*two-tier remuneration*." In this scenario, the ECB has more control over monetary policy and the amount of digital euros in circulation through the implementation and adjustment of tiered remuneration, more specifically, through the adjustment of interest rates. In this situation, the ECB sets two CBDC remuneration tiers, applying one of them depending on the amount of CBDC the user has - in short, each user would have one of these tiers depending on the volume of CBDC they own. The remuneration can be positive in order to encourage the acquisition of the currency or negative if the user holds too much of it. The ECB may increase the rate to encourage savings or decrease it to promote spending (European Central Bank, 2022a).

The aim of this measure is to make CBDC unattractive and uncompetitive as a form of investment, discouraging the use of the currency for these purposes. At the same time, it makes it less profitable to hold significant amounts of capital in this currency, particularly during times of crisis when the risk of bank runs is higher. This mechanism will be further analyzed in order to better understand its operation as well as the consequences of its application.

The ECB confirms that the hypothesis of tiered compensation combined with a *waterfall approach* is being studied to be incorporated into the design of the digital euro, as stated in its report on the investigation phase of the project, which was produced in September 2022. This reveals the ECB's preference in this area relative to the others previously mentioned. The report also raises the possibility that there may be different holding restrictions for currency usage both online and offline, allowing for temporary deviations from the holding limits (European Central Bank, 2022a).

1.2. Main reasons to develop a CBDC

1.2.1 Monetary sovereignty

The first reason to develop a CBDC has to do with the long-standing question of monetary sovereignty. The growth of new virtual currencies is the first threat to monetary sovereignty, because their use transforms the payment service into a new and complex issue of decentralized digital money, opening doors for digital currencies to also be used as a unit of account (Ahnert et al., 2022). The main result of this expansion could lead to significant detrimental situations for the European monetary and financial system. There is a negative impact on the ability to fully utilize internal instruments for regulation, which results in a reduction in the effectiveness ECB's monetary policy, given the larger use of more foreign currencies, specifically private digital currencies.

For the reasons mentioned above, the loss of monetary sovereignty is associated with an increase in financial and monetary instability. However, this can be prevented by the European CBDC because the use of the digital euro will guarantee some equal benefits offered by foreign digital currencies. Additionally, because the digital euro is issued by the ECB, it may be a new extension to the application of monetary policies issued by the central bank (i.e., by using negative interest rates, as discussed in the previous section, to prevent bank runs) (Bjerg, 2017). Since there is still no official design for the digital euro, the impact on monetary policy is up for debate. The potential impacts and advantages will be examined later in this thesis.

1.2.2. Declining of cash use

One of the primary payment methods utilized today is still cash, which can also serve as a tool for implementing monetary policies. Some of its features stand out for being distinctive, meaning that it has special qualities that are not shared by other types of payment. Thus, it is a payment method that guarantees complete privacy in the payment process and allows for instant transactions without additional fees or the requirement for a specific technology (such as payment terminals or an internet connection). These characteristics ensure that everyone has access to currency, regardless of location or age.

However, the use of cash has become less and less popular as a result of a variety of factors, including the ongoing expansion of e-commerce. In the European Union, the number of cash transactions fell by 20% between 2016 and 2022, in line with the 12% decrease in the value of cash transactions over the same period (Central Bank, 2022). According to ECB Data Portal, regarding to the number of banknotes and coins in circulation in the Eurozone, it is also possible to see that in December 2015 this was equivalent to 306,779,771 euros, while in August 2023 this number dropped substantially to 138,923,443 euros. Additionally, as this method of payment is more frequently accepted by retailers, contactless technologies and digital wallets are replacing cash daily.

The ECB has already emphasized multiple times that the launch of the European CBDC seeks to fill in sectors where cash has been losing expression rather than replace it, to maintain the presence of money issued by the ECB in the economy. The development of the digital euro aims to avoid the negative effects of not using cash, such as the growth of virtual currencies and private payment systems. Due to the lack of public competition, payment services gain greater relevance and weight, and at the same time the demand for private money increases. This situation calls into question the ECB's monetary policy, which primarily regulates interest rates and the amount of money in circulation.

At the same time, data protection becomes more challenging, allowing private services to collect more data and be less regulated. On the other hand, European integrity may feel the effects of the loss of expression of its common currency. This is due to a possible dispersion in the growing use of different currencies in the European space as virtual currencies - where the ECB has no control, thus affecting monetary policies, as mentioned above.

Thus, the European CBDC sees the declining use of cash as a further justification for its implementation to maintain the success of monetary policies. The maintenance of public currency in circulation turns into a vehicle for the modernization of the euro in order to address needs brought by the rapid development of technology in the financial sector, thus attempting to cover areas where cash does not reach, namely in the online sector. In essence, the digital euro positions itself as a digital extension of cash, ensuring the maintenance of some of the currency's key attributes including universality, security, and a monetary policy instrument by managing the associated interest rates – the latter of which will be examined in more detail later.

1.2.3. Compete with and control the rise of the private sector payment systems and crypto-assets

Numerous central banks are worried about maintaining the availability and accessibility of their official currencies, in this case, the euro. However, the world today is much more technologically advanced than it was when the euro was launched and, as a result, new challenges are emerging. One such challenge is the increasing use of digital payment methods by both individuals and businesses, particularly in the commercial sector (Bindseil, Panetta and Terol, 2021).

The responsibility for ensuring that the euro remains the dominant currency falls to the ECB, although cash is the only kind of central bank money that the general population can access. To ensure monetary and financial stability at a time when the use of cash is gradually declining, the ECB simultaneously aims to innovate and digitize the euro. The autonomy strategy that the central bank seeks is, in this particular case, based on the digital payments market where new competitors are continually developing. For instance, companies like Visa and Mastercard dominate the global payments market, making it harder to enact legislation that is intended to protect European citizens, particularly when it comes to payment data (Mai, 2021).

The current scenario can partly be attributed to institutions' lack of active participation in this area, which left room for expansion and investment in the payments private sector (such as Paypal, Alipay, ApplePay or GooglePay). It is important to explain the difference between the payment methods mentioned: AliPay and Paypal are online payment systems that process transactions between customers and merchants in exchange for a commission, acting as intermediaries. GooglePay and ApplePay are digital wallets and the payment service that offers enhanced security through tokenization. The most striking example of the investment made by private sector regarding the payment methods and crypto-assets is Libra, later called Diem, a currency developed by Facebook that ended up failing due to legislative issues in the US. The announcement raised concerns among many central banks, including the European one, due to its potential and possible impact on monetary policy. As mentioned in the previous point, the more active private currencies are, the less central banks can control monetary policies, which increases financial instability.

The European Union formulated the Markets in Crypto Assets Regulation (MiCA), published in the Official Journal of the European Union (OJEU) in June 2023, however, its application is not expected until June 2024. MiCA was made in order to regulate the market for these currencies, promoting greater security for users and investors. However, these still raise some concerns for the European financial system, particularly with regard to excessive privacy and aid to criminal activities - although its operation has limited scalability (as a result of the DLT system's requirement for continuous "proof of work"). Additionally, the volatility of its value is another important and undesirable factor when used as a form of payment, hence it is typically employed as an investment. It then becomes fundamental, on the one hand, to protect monetary sovereignty and, on the other hand, to create a version of digital currency (digital euro) that equals the advantages of private payment methods and outweighs the benefits – guaranteed by being issued by the central bank.

1.2.4. Benefits of CBDC

As has already been shown, the new digital euro currency has the power to interact and possibly impact numerous financial and economic aspects of the euro area. In this section, the various benefits that the European CBDC could offer are individually identified and analyzed. These benefits could strengthen and develop the European economy and finances as well as the level of security of its citizen's data. The five primary areas where the application of this currency will result in beneficial effects are: retail payment and economic efficiency, monetary sovereignty, strengthen monetary policy, strategic autonomy in payment services and data protection, and privacy.

Table 1.2 - List of CBDC benefits. Source: own elaboration.

Benefits of CBDC	
A.	Retail payment and economic efficiency
B.	Monetary Sovereignty
C.	Strengthen monetary policy
D.	Strategic autonomy in payment services
E.	Data protection and privacy

A. Retail payment and economic efficiency

Currently, a small number of private companies (such as Visa and Mastercard) control the retail payment market. The implementation of a CBDC in Europe provides an alternative to these methods, leading to greater market diversification and higher levels of competition that, ultimately, benefit the user by lowering transfer costs (Bindseil, 2020). Additionally, there are even more optimistic projections regarding the beneficial impact that the implementation of the euro digital may have in this matter specifically on collaboration with other CBDCs.

This scenario explores the possibility of cooperation between multiple digital currencies issued by central banks to ease transactions and lower the costs involved in those operations (Auer, Haene and Holden, 2021). As a result of this, increased international cooperation, as well as the development of the global marketplace, will be ensured while the digital euro will benefit from lower costs that offer a more attractive alternative to more conventional international payment methods, reducing their influence on the global payments market. The shift from cash to digital payments allows for a strengthening of measures relating to data and privacy protection, albeit this point will be covered in more detail in this section.

The introduction of the euro digital also strengthens economic efficiency, most notably in two specific areas: the use of this currency offers an alternative to bank deposits allowing a greater diversification of deposit forms and reducing the monopoly of commercial banks in this sector. The implementation of the CBDCB would force banks to make greater efforts to remain competitive and attractive, for example, by increasing deposit rates (Ahnert *et al.*, 2022). It is still unclear what effect the European CBDC will have on commercial banks, so this thesis will attempt to recognize and describe any potential effects that the application of this new currency may have in the following chapters.

The second point of improving economic efficiency is related to public money – money issued by the central bank, for example banknotes, reserves and soon digital euro (Financial Stability Institute, 2023). While the introduction of the digital euro will allow for the continuation of another form of public money (other than cash) in circulation, a key distinction is that this new currency will be used to combat the use of public money for illegal purposes. The unique characteristics of cash, such as its physical nature, make it easier to finance illegal activities because its transactions are completely anonymous, and it is impossible to trace their sources. As a result, the digital euro presents itself as a continuation of the use of public money, but in a setting where the token does not allow for complete anonymity, making it less attractive to be used in illegal operations like financing terrorism or money laundering (Bindseil, 2020).

B. Monetary sovereignty

The introduction of the digital euro would also strengthen monetary sovereignty since, it will be possible to centralize information that is currently dispersed by large private companies and compete with other tokens that threaten the euro.

The introduction of the digital euro would redirect private sector payments data to ECB in a scenario where the use of CBDC is widely accepted. This occurs because large private companies such as PayPal and Visa now have massive data storage containing information on millions of users. With the introduction of CBDC, the ECB ensures that the data generated by the use of its digital currency is stored by itself and not by third parties. It is worth noting that in this digital age, having data is a guarantee of power because it provides valuable information about capital movements as well as enables one to learn about users' habits (Landau and Brunnermeier, 2022). The transfer of private data to the central bank allows for greater security for two main reasons: first, it allows for the use of collected data to analyze the current financial situation, allowing it to be used as a financial indicator; second, widespread use of the euro digital ensures a greater degree of control by central bank authorities to monitor the use of currency, in this case, the euro, for illicit purposes (European Central Bank, 2022a).

The usage of private virtual currencies is a growing issue for the ECB, since they constitute a challenge to European monetary sovereignty by, for example, diminishing the weight of centralized public money and increasing all the risks that come with it, such as reducing the impact of the application of monetary policies, as already mentioned. In a worst-case situation, virtual currencies could even outperform public money as a medium of exchange (Brunnermeier and Niepelt, 2019). True monetary sovereignty requires the protection and expansion of the euro, in this case, the digital version of the euro.

C. Strengthen monetary policy

The introduction of the digital euro can also strengthen monetary policy, as it will be used as a new tool for the implementation of such policies (Bindseil, 2020). Nevertheless, this topic is still controversial because there are some concerns regarding its applicability. Through the digital euro, the ECB could be able to employ its interest rates as a monetary instrument to increase or decrease the attractiveness of this currency to counteract adverse trends in the European financial system as previously explained (Bindseil, Panetta and Terol, 2021).

Furthermore, the potential use of this CBDC for the use of helicopter money is a possibility - “In more prosaic and realistic terms, a ‘helicopter drop’ of money is an expansionary fiscal policy—an increase in public spending or a tax cut—financed by a permanent increase in the money stock” (Bernanke, 2016). According to Friedman, the concept of helicopter money is applicable in extreme cases of recession (Friedman, 1969). Even though it is not a new concept, CBDCs may change it by allowing the ECB to stimulate economic activity in times of crisis by sending money directly into retail accounts on their balance sheets (Wieladek and Kumar, 2021). However, it is important to notice that this monetary policy instrument is highly controversial. Due to various factors, the negative and positive impact of this new CBDC may have on monetary policy will be carefully evaluated in Chapter 3.

D. Strategic autonomy in payment services

As previously stated, the launch of CBDC may provide significant extra advantages by directly competing with huge private corporations in the payment services industry, as well as competing with other tokens that are becoming increasingly popular. This new digital currency will provide consumers with a new option to the most frequent means of payment, thereby introducing public money into digital payment systems. The issuance of this currency by the ECB, provides a secure alternative to private money while also providing a new payment system that supports both financial stability and confidence in the currency by acting as a monetary anchor (European Central Bank, 2022a).

The different currency design assumptions discussed above will impact the degree of value-added this currency can provide. In addition to bearer instruments, independence and service availability are three other factors that strengthen strategic autonomy in payment (Wong and Maniff, 2020). There is an additional scenario in which European independence in payment services is reinforced. The promotion of payment infrastructure control by, for example, encouraging governments to use this new digital form of public money to transfer money to citizens, ensuring greater security, efficiency, and independence when compared to other forms of payment such as bank transfers or checks (Ahnert *et al.*, 2022). Thus, fiscal policy is reinforced by the digital euro, whose adoption by eurozone governments for transfers and payments will strengthen the currency while also ensuring an evolution in European independence in terms of strategic autonomy in payment services.

Another advantage of the digital euro in terms of payment autonomy is the decrease of transaction costs and bundling benefits, which may increase the demand for foreign transactions - both as a means of payment and as a unit for settling current transactions. In other terms, this may boost the amount of commercial transactions in goods and services that can occur digitally across borders, ensuring the international e-commerce growth (Ferrari and Mehl, 2021). In short, strategic autonomy in payment services means not only greater self-determination but also greater data protection and universal access to central bank money, increasing diversity and competition in this specific market (Summer and Hermanky, 2022).

E. Data protection and privacy

The subjects of data protection and privacy have already been mentioned in this work and are given as advantages of the digital euro that may serve as an attractive factor for users. Although privacy and data protection are highly valued, it appears that user's data flow is substantially facilitated (Ahnert *et al.*, 2022). The digital euro will be created to offer strong security measures comparable to those used now in popular payment methods. One advantage of the digital euro is the minimal data disclosure it will require, which may be less than what the market currently offers. It is important to note, however, that this does not imply complete anonymity, so the degree and type of privacy are still uncertain given the various scenarios that are possible: privacy for low-value payments, privacy under offline functionality, and data transfer to intermediaries, the latter being the most likely to be applied (European Central Bank, 2022a).

The adoption of the digital euro will result in enhanced data and privacy protection through the implementation of the General Data Protection Regulation (GDPR), as this currency will circulate based on the rules of this legislation. This effectively means that everyone who chooses to use the digital euro is assured of respect for the handling, storing, and control of their data, as well as the assurance of various rigorous rights and privacy-related rules. The GDPR considered the strictest privacy and security law in the world because of rigorous requirements and safeguards, has heavy fines for violations that are not limited to the digital sector.

1.3. Experimentations on CBDC around the world

CBDC is not an exclusively European project, numerous countries are currently developing their digital currencies, which differ in terms of design and level of development. As showed in Figure 1.4, nations like Australia, the United States of America, and even the United Kingdom are at the same point of development of the digital euro - the research. Only three nations have officially introduced their

digital currencies as of today: Jamaica (JAM-DEX), the Bahamas (Sand Dollar), and Nigeria (e-Naira). When comparing the G20 nations, it is observed that just five of them—Canada, France, Saudi Arabia, India, and China—are currently developing pilot projects, further demonstrating the low degree of CBDC development around the world. It is crucial to clarify that France, although a member of the Eurozone, has taken part in CBDC implementation experiments, highlighted by a different color on the map meaning a different phase of digital euro development.

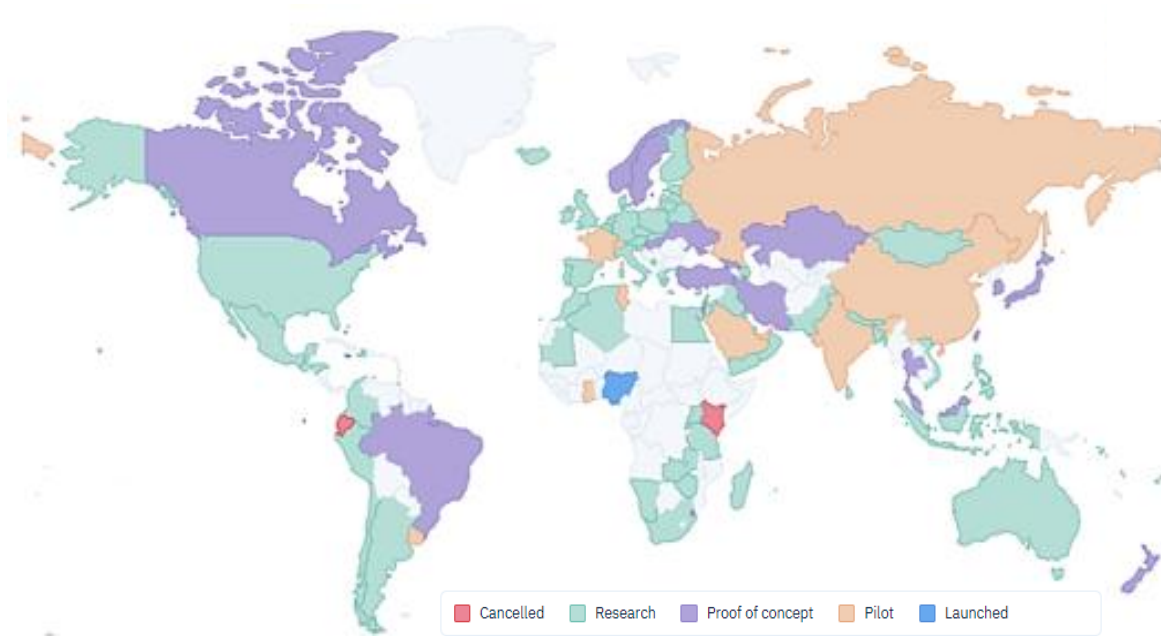


Figure 1.4 - World map representation of CBDC development in each country. Retrieved from <https://cbdctracker.org/>. Accessed 1 September 2023.

The development of these currencies is frequently accompanied by international partnerships for a variety of reasons such as to understand how different CBDCs can work together on international level, the following table (Table 1.4) highlights some of the existing initiatives:

Table 1.3 - International CBDC developing projects. Based on <https://www.atlanticcouncil.org/cbdctracker/>. Accessed on 6 September 2023.

Project	Countries / Institutions	Use case	Aim
<i>Project Dunbar</i>	Australia, Singapore, Malaysia, South Africa	Wholesale	Allow international settlements across multiple CBDCs
<i>Project Icebreaker</i>	Israel, Sweden, Norway	Retail	Permit retail CBDC payments across borders
<i>Project Rosalind</i>	United Kingdom, Bank for International Settlements (BIS)	Retail	Understand how central bank ledgers can effectively communicate with private sector vendors

CHAPTER 2

Bank Disintermediation – financial stability

The potential risk associated with the impact that the usage of the currency may have on banks—bank disintermediation—is one of the most challenging topics in the discussion of the development and use of new CBDCs. In general, this could occur if commercial bank deposits are replaced with digital euro accounts or wallets. In this situation, bank funding and, consequently, financial stability, are put in jeopardy (Bindseil, 2020).

The early stage of development of the digital euro allows for a great deal of speculation on its potential effects, both positive and negative. For example, to Chiu et al. (2022), the introduction of a CBDC is not sufficient to establish an event of banking disintermediation. For the authors, this probability is related to the interest rate, in case it is too high. Concerning the costs of potential banking disintermediation induced by the implementation of CBDC, Piazzesi and Schneider (2022) argue that banks supply liquidity through deposits as well as credit lines, and that both of these operations are complimentary. A digital currency that takes away deposits will also reduce credit line availability, resulting in significant losses. However, Chiu and Davoodalhosseini (2021) model deviates from the majority of the literature on bank disintermediation. According to this model, the implementation of CBDC could benefit bank deposits through facilitating goods transactions. As a result, CBDC increases demand for goods, which leads to more loans. As loans used to back the creation of deposits, CBDC could boost the amount of deposits. There is also the argument advanced by Monnet, Petursdottir and Rojas-Breu (2021) that argue that a CBDC with an interest rate drives commercial banks to enhance deposit remuneration, hence fostering banking intermediation. This scenario is plausible, and it will be examined in greater depth in Section 4.4.

In June of 2023 at the Global Official Institutions Conference, the Governor of the Bank of France, François Villeroy de Galhau, made the following statement specifically related to the potential impact on European banks: “To make it crystal-clear, a digital euro will not lead to disintermediation. It will be distributed through banks: we central banks have absolutely no intention to open private accounts. In response to some other worries, there will be no financial stability risks, due to possible significant outflows from commercial bank money to central bank money”.

2.1. Back-end infrastructure of CBDC: centralized and decentralized options

The ECB's choice of back-end infrastructure will be key to determining how to assess the degree of bank disintermediation as well as its financial effect. Presently, there are two kinds of back-end

infrastructure: centralized and decentralized (European Central Bank, 2020). As a result, the role of banks may vary between gatekeepers and settlement agents.

2.1.1. Centralized

A centralized back-end infrastructure puts more pressure on the ECB generally because it necessitates system robustness as well as a greater commitment to security and performance since every transaction will go through a single, centralized system. However, the ECB offers two distinct versions of a centralized back-end infrastructure distinguished by the type of access: direct or intermediary (European Central Bank, 2020).

Since the ECB is in charge of every process in the direct access scenario (left side of Figure 2.1), this model presents a significant technological challenge for the ECB. The users have direct access to their ECB accounts, enabling them to carry out transactions directly between individuals without the need for intermediaries to buy and sell digital euro. It is important to note that this is the model where bank disintermediation is strongest since they just serve as the process' gatekeepers, assisting in its smooth operation without any actual intervention.

However, another type of centralized back-end infrastructure may be used using intermediated access (see the right side of Figure 2.1). The level of disintermediation is lower in this scenario as a result of the European commercial banks' role change from gatekeepers to settlement agents. The user keeps an account with the ECB., but direct access to the account is no longer possible since all transactions must go through intermediaries, who subsequently communicate with the ECB on behalf of users. This model stands out due to the potential for commercial banks to use their position as intermediaries to integrate the euro into their business operations while utilizing innovative infrastructure to foster competition in the payments market. As already mentioned in this work, the possibility of a centralized banking infrastructure is unlikely to be adopted by the European Central Bank due to the enormous challenges that would provide.

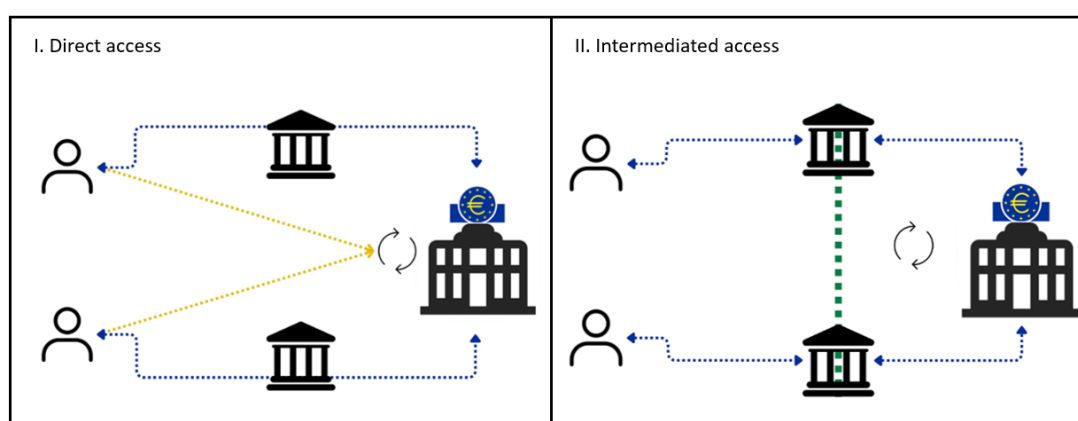


Figure 2.1 - Digital euro centralized back-end infrastructure models. Source: own elaboration.

2.1.2. Decentralized

The alternative to the version previously shown is a decentralized back-end infrastructure that stands out in several ways, with the integration of bearer euro digital being the most significant. In a paper from 2020 regarding the development of the digital euro, the ECB distinguishes two decentralized forms of decentralized back-end infrastructure that have the potential to operate simultaneously: direct end-user access to a bearer digital euro and hybrid bearer digital euro account-based infrastructure. In this version, the ECB reduces its direct involvement in digital euro operations. As a result, a decentralized system is created, which requires regulation and the development of a private infrastructure to ensure security and optimal operation at the user, intermediary, and ECB levels.

Direct access to a bearer digital euro (left side of Figure 2.2) is one possible form of decentralized back-end infrastructure. In this case, users can transfer bearer digital euro among themselves without the need for intermediaries or the ECB to intervene. Security and smooth operation can be ensured using a DLT system or even functionalities like offline payments using mobile devices. In this version, commercial banks return to taking on the role of gatekeepers, reducing the degree of their intervention by transferring most of the operating process to the user. This system continues to operate within the European system even if decentralized, thus ensuring the application of all ECB requirements.

European commercial banks have a more active role in the account-based and bearer infrastructure (right side of Figure 2.2). In this case, users are still able to interact with the Eurosystème, but opposite the previous model, commercial banks now have a more active role. As a result, the ECB will not need to directly intervene in digital euro transactions; instead, intermediaries will carry it out on behalf of users. As a result, it will continue to be necessary for the user to have a commercial bank account in order for the intermediary to carry out the actions that the user requests.

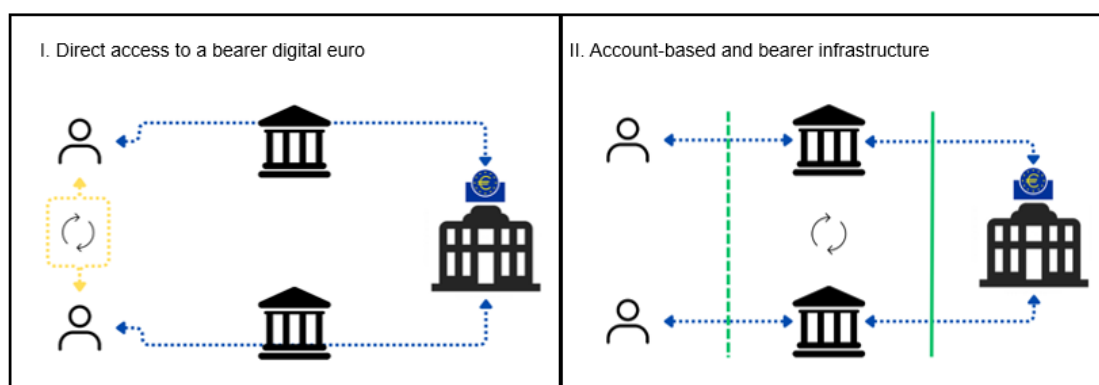


Figure 2.2 - Digital euro decentralized back-end infrastructure models. Source: own elaboration.

This model may be mistakenly compared to the intermediated access model of the centralized back-end infrastructure, but it is important to emphasize that in the former case, users have accounts with the ECB, whereas in the latter, accounts are held by commercial banks. In addition, in this model, banks have greater independence from the central bank and greater responsibility to ensure the proper functioning of this system, highlighting the decentralized aspect.

As such, the ECB has more recently proposed clarifying the roles of the central bank and the intermediaries. A greater volume of tasks is delegated to intermediaries, rewarding their presence in this system and encouraging active participation of commercial banks in the operation of this new digital currency in Europe. In this proposal, the ECB is responsible for both liquidity management and transaction management, in addition to ensuring the supervision of the intermediaries. The intermediaries in this proposal ensure a greater collection of functions across the three management levels through operations, including managing digital euro wallets, authentication, validation, funding, and defunding (European Central Bank, 2022b).

2.2. Structural shift in banks intermediation

With the introduction of the digital euro in the European financial system, the regular operation of European commercial banks may be altered. As a result, it is crucial to understand both the potential consequences and the necessary changes for banks' sustainable operation. The projections of the potential consequences are influenced by the design of the digital euro, which, as has already been mentioned, remains uncertain in several areas. One of the scenarios is a structural shift of private money to the digital euro. In this scenario, European commercial banks lose funds, causing the adoption of new funding strategies that might increase or decrease competition among banks, like equity, bonds and commercial paper (Mancini Griffoli *et al.*, 2018; Landau and Brunnermeier, 2022). As such, this potential phenomenon is based on two structural points: first, the effect on bank funding and capital, and second, the response of commercial banks.

2.2.1. Impact on bank's funding and capital

The introduction of CBDC into the European financial system gives users a new option for deposits, payments, and transfers. As a result, it is now possible that households will prefer to transfer some of their money into a digital euro online wallet for a variety of reasons related to the currency's design. This change directly affects the balance sheets of commercial banks as deposits are the main source of funding for banks in the Eurozone. Banks divide their balance sheet into two separate categories: assets and liabilities. Bank funding is part of the liabilities, which are also made up of other sources,

however, deposits are the biggest source of funding for Eurozone banks, constituting more than 40% of total funding sources (Bindseil, 2020).

Table 2.1- Euro area bank funding costs instruments. Adapted from (Bindseil, 2020).

	2003 - 2008		2009 - 2018	
	Share in bank funding	Average interest rate	Share in bank funding	Average interest rate
Deposits	44%	1.83%	47%	0.78%
Other deposits	13%	3.25%	14%	2.39%
Bonds issued	30%	4.10%	23%	2.15%
Equity issued	10%	8.47%	12%	10.54%
Central bank credit	3%	2.79%	4%	0.50%

Table 2.1 makes possible the examination of deposits' increasing weight in bank's funding structure. Bank deposits from 2003 to 2008, with an average interest rate of 1.83%, guaranteed 44% of the total amount of funding. Banks became more reliant on deposits between 2009 and 2018, which accounts for an additional 3% of total funding. It is also important to compare the evolution of the average interest rate, which shows a downward trend, in this second period from 1.83% to 0.78%. These two data sets compared at two different times, allow the analysis and observation of two significant factors: the first is that banks increased their reliance on deposits during the period from 2003 to 2018; the second is that they did it at smaller costs due to a decline in the average interest rate. Table 2.1 is intended to show the size of the deposits in the balance sheets of the banks in the Eurozone as well as to assess their significance for good banking operations and, ultimately, for the stability of the European financial system. It is important to note that these deposits are made up of different types and amounts.

In a situation involving bank disintermediation, three actors need to be examined: the commercial banks, the digital euro users, and the ECB. Potential shifts in user preferences could be explained by the characteristics of the digital currency, the amount of digital euros in circulation, or even the financial climate that prevails at the time. This last point will be elaborated on in more detail later. In this way, the introduction of this new form of money may lead to changes in the balance sheets of these three actors. First, the users, or households, start the transition by switching from bank deposits to CBDC. This change results in a decrease, not only in the bank's balance sheet's assets, due to a smaller amount of reserves, but also in liabilities, due to a smaller amount of deposits. In turn, ECB liabilities see a decrease in reserves, however, due to the increase in CBDC, there is consequently an increase in loans to banks (Ahnert *et al.*, 2022).

To compare two alternative scenarios, different sector's accounts are presented in a simplified manner in the following table. Users in the first scenario replace cash with the new digital euro (CBDC1), while in the second scenario users replace their bank deposits with CBDC (CBDC2).

Households, pension and investment funds, insurance companies				
Real Assets	20		Household Equity	40
Sight deposits	5	-CBDC2		
Savings + time deposits	4		Bank loans	5
CBDC		+CBDC1 +CBDC2		
Banknotes	1	-CBDC1		
Bank bonds	4			
Corporate/Government bonds	7	--		
Equity	8			
Corporates				
Real assets	13		Bonds issued	3
Sight deposits	2		Loans	8
Savings deposits	1		Shares / equity	5
Government				
Real assets	11		Bonds issued	9
			Loans	2
Commercial Banks				
Loans to corporates	8		Sight deposits	7 -CBDC2
Loans to government	2		Savings + time deposits	5
Loans to HH	5		Bonds issued	4
Corp/state bonds	5		Equity	3
Central bank deposits	0		Central bank credit	1 +CBDC2
Central Bank				
Credit to banks	1 +CBDC2		Banknotes issued	1 -CBDC1
Corp/Government bonds	0		Deposits of banks	0
			CBDC	+CBDC1 +CBDC2

Figure 2.3 - Impact of two different CBDC scenarios on different sector's accounts representation (numbers in trillion euros). Retrieved from Bindseil (2020).

Using Figure 2.3 it is possible to analyze the effects of both possibilities at four distinct financial system sectors. The CBDC1 scenario has less of an impact on accounts. In this projection, the replacement of cash with digital currency reduces the use of cash by households, pension funds and insurance companies, as well as reducing the issuance of banknotes by the ECB, which increases the amount of CBDC. This scenario does not present risks in terms of bank disintermediation, more specifically in aspects of bank funding and capital, and so, disintermediation it is less likely to happen. It is essential to stress that the ECB reiterates that the digital euro should be used alongside the physical currency, not as a replacement (European Central Bank, 2022c).

The second scenario (CBDC2) shows a decline in deposits at European banks and an increase in the ECB's allocation of credit to commercial banks. The importance of the design choice for the digital euro is highlighted in Figure 2.3, making it clear that the decisions on the characteristics of the currency may change the purpose and scope of this CBDC's use, altering its effects. Ultimately, the modification of the current dominant bank deposit usage in favor of CBDC may have an impact on the capital and funding of European banks.

2.2.2. Reaction of commercial banks

In the event of bank disintermediation, banks must pursue new policies that might lessen any potential negative effects that the European CBDC may have; hence, the relationship between customers, commercial banks, and the ECB has to be adapted. Banks may use interest rates in an attempt to mitigate the impact of the currency due to the funding issue with the digital euro. Banks continue to have the usual business tools at their disposal, such as deposits and loans, so a solution could involve changing interest rates so that they are more competitive in a market where the digital euro presents itself as attractive and at the same time competition between banks increases due to the growing shortage of customers who change their financial habits.

As such, banks could choose to make their deposits more attractive by increasing their remuneration. This measure would increase the added value of depositing money in European commercial banks instead of depositing in digital euro accounts whose interest rate would be zero or even negative. In turn, this would mean that the bank's profit margin would decrease due to the higher interest rate on deposits unless the quantity of loans increases. The solution could be to lower interest rates on loans, making bank loans more appealing and accessible to avoid this from happening (Juks, 2018; Mancini Griffoli *et al.*, 2018; Andolfatto, 2021). It is also important to note that banks are not all the same and as such the consequences of the digital euro may have different results depending on bank's market power. The greater the bank's market power, the greater the level of resilience and greater ability to adapt to the entry of CBDC into the European financial system (Sanches and Keister, 2021).

Furthermore, new forms of funding, such as equity, bonds and commercial paper, could be studied by banks in order to diversify their funding sources. As such banking discipline can also be affected due to the need for banks to seek to take more risks in order to preserve sources of funding - which may also become, consequently, less stable (Mancini Griffoli *et al.*, 2018).

2.3. Expansion of ECB's balance sheet and its consequences

The adoption of the digital euro has an influence on the ECB's role since, in order to protect the stability of the European financial system, the central bank must effectively monitor and support how the new currency impacts commercial banks. Despite making up a relatively small part of overall financing, central bank credit (Table 2.1) is one of the sources of funding for European commercial banks. However, with the launch of the European CBDC, that percentage is likely to increase while deposits in commercial banks decline as the ECB may be forced to implement measures that compensate for the lost deposits. This source of funding might end up being more expensive for commercial banks. As a result, lowering the monetary policy rate is one of the ECB's options in the event of disintermediation. However, this possibility does not eliminate the likelihood of a material change in the nature of funding, shifting from bank-based funding to market based funding (Juks, 2018; Bindseil, 2020).

The ECB's actions and responses must be proportional to the level of adoption of the digital euro, as a result, the impact of its actions will be greater if adoption levels are high. With the introduction of the digital euro, the ECB will have more liabilities, as there will be more money issued by this bank circulating in the economy. At the same time, there will be an increase in assets because of the greater demand for funding from commercial banks.

The expansion of the central bank's balance sheet may have unintended consequences brought on by the European banking system. A change in deposits would result in an adjustment to the ECB's reserves for CBDC in the initial phase since the value of deposits would be transformed into digital euro and as such there is an increase in the volume of digital euro in the ECB balance sheet - this situation is depicted by the CBDC2 scenario in Figure 2.3. However, as a result, it becomes necessary for the ECB to adjust its reserve offering to try to regulate the monetary market interest rates. This action might be carried out either through loan operations or asset purchases. The frequency of these types of transactions in the monetary markets may be impacted by the potential volatility and large size of the digital euro in the central bank's liabilities (Bank for International Settlements, 2021). It is particularly important to emphasize that the volume of the digital euro must be taken into account when changing the monetary policy rate and that commercial banks will face greater funding challenges and a reduction in their ability to pay.

The expansion of the ECB's balance sheet brought on by the introduction of the digital euro into the financial system opens the door to the potential of a more centralized system. In this scenario, the ECB serves as an intermediary and main component of credit distribution - these changes would not be advantageous for the European financial system or the ECB. This is because the changes would be contrary to its nature and goals, which include: conducting monetary policy, setting interest rates, maintaining price stability, and regulating the supply of the euro common currency. To rebalance the balance sheet, the ECB must invest the surplus money by choosing from a variety of operations, such as investing in government paper like bonds and certificates or using collateralized bank loans secured by securities or bills of exchange (Bindseil, 2020).

Current literature is not yet extensive on this subject and is based on predictions and models of hypothetical scenarios consisting of numerous variables. There is still no broad focus on many of the issues relating to the impact on bank funding as well as alternatives of action by the central bank. Regarding this matter, more specifically the role of the ECB in this process, Brunnermeier and Niepelt (2019) argue that the process of deposit losses brought on by the introduction of the digital euro does not, on its own, result in a reduction in bank funding but rather merely a change in its constitution. They also claim that this change happens practically automatically thanks to the ECB's action, which serves as a replacement for deposits lost through funding, reiterating the central bank's role as an intermediary in this scenario. On the other hand, Landau and Brunnermeier (2022) warn against the possibility that commercial banks could, over the medium and long terms, become dependent on continuous refinancing, altering the current dynamic between the ECB and commercial banks and, as a result, altering patterns of banking behavior in terms of incentives and credit. The ECB's role in the credit markets would also change, and it would adjust its role as a financial intermediary.

There is also the issue of loans, where commercial banks may be less likely to offer loans as a result of the reduction in funding brought on by the decline in deposits. This might have an impact on investment and growth. Concerning this problem Niepelt (2020) points a situation that must be considered: the replacement of deposits with financing by the ECB. Thus, the author suggests that there is no danger of a crisis in the granting of credit. Still for this to happen, ECB intervention is essential, whether by replacing deposit financing with own financing, or by acquiring loans to guarantee commercial banks a greater volume of reserves.

Because the general perception of the Central Bank has a direct impact on the behavior of markets at various levels, it will need to approach CBDC and potential bank disintermediation cautiously in order to maintain the trust that has been built up around the ECB. There may be times when financial stability is threatened by a variety of factors. In the chapter that follows, this possibility will be explored by examining how users, commercial banks, and the ECB would be impacted as well as how they would act in the event of a bank run brought on by the introduction of the European CBDC in the Eurozone financial system.

Monetary Policy

Monetary policy is critical to the effective running of the European economy and finances thus it is up to the ECB to define it in the best way possible, specifying both the cost of acquiring money and the amount of it in circulation.

ECB's major goal is to stabilize prices by keeping inflation under control, which should not exceed 2% each year. As a result, the central bank controls short term interest rates in an attempt to control the cost of borrowing. The major tool employed by the ECB is rate management. ECB employs three major rates to implement its monetary policy (Central Bank, 2021b). The first is interest rates on the primary refinancing operations, in which banks are able to obtain funds from the ECB every week against collateral at an already established interest rate. Second, rate on most deposit operations, which banks can use for overnight deposits at an established rate lower than the primary refinancing operations rate. Third is the rate on marginal lending facility, which provides banks with overnight credit at a predetermined interest rate above the primary refinancing operations rate. Other non-conventional instruments involve buying private and public financial assets and offering fixed-rate loans to commercial banks when liquidity is needed (Central Bank, 2021a).

Regarding monetary policy, there are still many unknowns, however, the literature review is enough to demonstrate some predictions. According to Bordo and Levin (2017) there is the possibility of the interest rate associated with the CBDC serving as the main tool for the conduct of monetary policy. Böser and Gersbach (2021) warn that the rise of CBDCs requires a tightening of monetary policy in terms of collateral requirements, which could lead to liquidity issues for commercial banks, putting them at risk of incurring on illiquidity penalties. While strict demands on collateral can be used to induce bankers to monitor in short-term periods, they will put at risk the financial viability of banking in the long term. The introduction of a CBDC thus poses concerns to the entire financial sector since bank's liquidity demand will likely increase as a result of a CBDC, consequently the central bank's liquidity requirements may need to be revised.

In terms of CBDC remuneration, Kim et al. (2022) claim that this remunerated currency will act as both a store of value and an innovative policy tool. That is, the application of the remuneration will serve as a tool to define, through interest rates, the level of attraction of the currency as a form of store of value (which is not the purpose intended by the ECB). They also argue that a freely accessible and widely accepted, intermediated, and remunerated CBDC will help the ECB to prevent financial system disruptions by addressing users directly, snatching market share from the private sector of payment methods.

Monetary policy has a significant influence on the economy, impacting not just price stability (the ECB's primary goal), but also household spending, job creation, purchasing power, economic development and financial stability (Banco de Portugal, no date).

3.1. Can the CBDC reinforce European monetary policy?

To understand the influence that the digital euro may have on European commercial banks, it is necessary to first determine if it will have an impact on the environment in which these banks operate. It is critical to assess whether the digital euro will be able to strengthen the monetary policy or if it will undermine its effectiveness.

There are four significant monetary policy aspects that must be examined, two of which are of particular importance. According to Mancini Griffoli et al. (2018), interest rate channels and bank lending are strengthened if the CBDC has a favorable interest rate because it would incentivize consumers and enterprises to rebalance their spending and investment influenced by the interest rate associated with the CBDC. Additionally, the credit channel and the exchange rate channel do not experience changes as a result of the new currency's implementation. However, Meaning et al (2021) state that the real impact of the CBDC is still unknown, but with possible adaptations, CBDC would increase the monetary transmission mechanism. There are conflicting views on the credit channel – an approach that states that monetary policy influences the economy through changing short-term interest rates, as well as the availability and conditions of bank loans. Essentially, refers to the effects on the liabilities of the credit system, for example, money supply (Hernando, 1998). According to Ahnert et al (2022), this component has a significant weight in terms of monetary policy since it is an essential way of transmitting monetary policy. However, the adoption of CBDC may result in changes in its operation, particularly changes in the typical dynamics of the bank's activities, such as the services provided. Furthermore, there is an influence on bank capital as well as on funding costs (the causes for these effects have previously been examined in the section on bank disintermediation - Chapter 2).

Impact analysis, like other aspects of the European CBDC, is not always unanimous. The CBDC's impact must always take two factors into account: the first is the final design of the digital euro, which will shape its impact in the most diverse aspects, and the second is an analysis of the impact of these designs both in times of financial stability and in times of stress and panic, such as the phenomenon of bank runs.

3.1.1. Interest rates

Interest rates may undergo a change thanks to the introduction of the digital euro, that is, it will be possible for the ECB to apply interest rates to CBDC. It is important to note that the other public form of central bank money (coins and banknotes) do not allow the bearing of interest rates meaning thus a positive evolution in the level of efficiency in the application of monetary policy since, in practice, there is now a greater amount of public money in circulation sensitive to ECB control through interest rates. This aspect is also enhanced by the possibility of applying a negative interest rate to this currency, which, according to Landau and Brunnermeier (2022), can guarantee two system improvements. First, makes it easier to guarantee both negative and null interest rates, ensuring greater speed and effectiveness of the central bank's response when this type of measure is required. Second, negative rates can now be applied directly to households if convenient, which until now was not possible, ensuring, as such, a greater capacity to combat the risk of price instability and deflationary pressures.

The remuneration of the digital euro is a fundamental point to consider when evaluating the currency, and it is necessary to understand its added value but also the associated risks. Thus, the remunerated digital euro might help minimize the possibility of consumers exploiting the currency for investments, altering the ECB's purpose for the currency. This is because the application of a negative interest rate, for example, would make the use of the digital euro as a store of value unattractive due to the associated cost. Moreover, the ECB would then become a middleman for investments. Furthermore, remuneration could be used to persuade users to acquire the currency to ensure greater competition against other forms of digital currencies, as well as to ensure that the euro remains the currency of primacy in Europe, thus developing the field of digital format where bank notes lack the capacity to fulfil this mission (European Central Bank, 2020).

This plausible feature of the digital euro might also allow interest rate adjustments to have a higher and faster impact than the adjustments to interest rates in the banking system, which act more slowly, resulting in a strengthening of monetary policy transmission. Additionally, by controlling the supply of CBDC, the central bank may target both the store of value and the means of exchange functions of money. This provides an extra way for economic stabilization by leveraging a tradeoff between payment efficiency, bank financing factors, and the opportunity cost of retaining money (Assenmacher, Bitter and Ristiniemi, 2023).

3.1.2. Two-tier remuneration as a safeguard option

The concept of two-tier remuneration has already been mentioned in this work. It is now important to understand what this concept consists of and how its integration into the digital euro could be useful. This form of limitation of the European CBDC stands out for not requiring a maximum ceiling that each person or company can hold. As such, it proposes a system with different interest rate levels to regulate the currency. As a result, any owner of a digital euro would initially have a neutral interest rate (r_1), which is equal to 0% like banknotes. The ECB should then establish a ceiling for holding the digital euro at rate r_1 in this context, and if that ceiling is exceeded, the account holder (a company or individual) would automatically switch to rate r_2 , where the interest rate is less favorable and carries a cost (Bindseil, 2020). This functionality enables the ECB to adjust the r_2 rate for negative interest whenever necessary if there is, on the one hand, a genuine risk of bank runs, which would reduce the appeal of this digital currency in times of crisis, and, on the other hand, rising use of the currency as an investment vehicle rather than a form of payment.

The European CBDC's limiting option is not static, therefore it would always be possible to change the value of the interest in r_2 as in r_1 , however Bindseil, Panetta and Teroll (2021) suggest that the ECB commit to certain parameters in order to create a certain level of stability in the eyes of currency holders – “For tier one CBDC, the central bank could commit to never charge negative rates and never reduce the amount of tier one CBDC below a certain level”.

However, these do come with some obstacles to be addressed, much like the other proposals previously mentioned. The first step is to determine the maximum amount that an individual or organization can store before transitioning from r_1 to r_2 , adding the importance of distinguish this barrier for residents, non-residents, and organizations. The *waterfall method* might be used in this circumstance, particularly for residents who could always specify that when they reached the maximum amount of r_1 , the surplus would automatically convert into private money in their bank accounts to avoid r_2 .

The possibility of a two-tiered remuneration provides access to a digital euro at costs equivalent to current notes in circulation (with zero percent interest rates), without holding limitations, and with the possibility of different conditions for businesses and non-residents. At the same time, it functions as a tool for managing digital currency, encouraging or discouraging possession of the currency depending on the financial situation (Mai, 2021). This point raises some issues with the ECB's response to bank runs in particular, as it is acknowledged that the central bank alters the value of the r_2 interest rate whenever it is justified, as previously explained. An alteration in the r_2 can signal to currency holders that an unstable financial period is approaching or has already begun, which could unintentionally trigger an acceleration of bank runs, a rise in them, or even a financial crisis. However, this possible derivation of remuneration is still a possible new tool whose use could strengthen monetary policy and consequently the financial system.

CHAPTER 4

Bank runs – financial stress

The risk of bank runs is genuine and should not be underestimated; indeed, even within a well-functioning financial system, this can occur if the conditions are met. In general terms, a bank run is defined as a race to bank deposits due to a generalized perception of financial instability, of a specific bank, or of the existence of a generalized perception that the central bank does not intend to assist in situations of failing banks, resulting in a banking disruption, a shift in bank assets, and, in the worst-case scenario, a generalized crisis (Diamond and Dybvig, 1983).

According to Iyer and Puri (2008), despite the existence of CBDC, there are two basic different types of explanations for the occurrence of bank runs. The first happens when there is a difficulty with coordination among the bank's clients. So, expectations and worries about the actions of other customers can lead to a mass withdrawal of money. The other sort of bank run occurs when panic and insecurity surrounding the bank leads to widespread fear, resulting in a bank run. These are not the only forms of bank runs, there are other possible forms that will be explained shortly. This chapter focuses on the attempt to determine whether there is, in fact, a serious risk of bank runs caused by the introduction of the digital euro into the European financial system.

There is a distinction on bank runs with and without CBDC, according to Auer et al (2022). Their argument is based on the premise that while the bank run phenomenon is still possible, the existence of CBDC can change its dynamic and impact. According to the authors, in the event of a bank run, consumers transfer their deposits to another bank, thus keeping the money in the banking system. If CBDC exists, it is possible that during bank runs, commercial bank clients will begin to shift their capital to the CBDC, which is located outside the banking system. So, as the argument states, CBDC has no effect on the type of bank run but raises the likelihood of a systemic bank run.

In the opposite direction, the model elaborated by Keister and Monnet (2022) stresses a positive influence of CBDC on the possibility of bank runs since CBDC enables governments to detect and solve troubled banks quicker by observing capital movements from bank deposits to CBDC. Thereby reducing depositors' motivation to withdraw their deposits. Therefore, an efficient CBDC may reduce instead of increasing your financial fragility.

4.1. Bank runs in the pre-CBDC system

Throughout history, there have been several episodes of bank runs caused by various factors, some of which have already been mentioned. A bank run can occur when customers decide to move their

deposits to another bank due to a perceived risk associated with the original bank. Additionally, a bank run can occur when depositors decide to invest in safe assets such as government bills (Juks, 2018). As a result, the existence of other external investment possibilities, as well as their attractiveness and availability, contributes to the likelihood and volume of bank runs.

The *failure hypothesis* and the *recession hypothesis* help to comprehend the causes of the current bank runs more thoroughly. The first refers to the withdrawal of deposits due to recessions. In contrast the second refers to the withdrawal of deposits due to uncertainty regarding a bank's potential future viability following the failure of a major financial institution (Gorton, 1988).

In 2008, Washington Mutual failed after its customers withdrew deposits totaling \$16.7 billion. The causes of this run can be linked to the housing market crisis, which also contributed to the financial crisis the same year.



Figure 4.1 - Silicon Valley Bank stock price from January 03 to March 09 of 2023. Retrieved from <https://www.axios.com/2023/03/09/silicon-valley-bank-svb-spooks-venture-capital>. Accessed on 23 August 2023

Another more recent example is Silicon Valley Bank, whose customers withdrew approximately \$42 billion, prompting regulators to step in. This is the second-largest bank collapse in the world on record as of today. After the stock market opened on March 9, 2023, there was a 30% decline in the price of Silicon Valley Bank's stock, which increased to 60% by the end of the day (as shown in Figure 4.1). Additionally, there was a mass withdrawal of the previously mentioned deposits caused by panic and loss of confidence in the bank due to questions regarding the bank's liquidity.

This figure illustrates the idea of instability and hysteria typical of bank runs, where the stock market simultaneously serves as a consequence, symptom, and accelerator of the financial environment concerning this bank. Therefore, it is possible to verify not only the speed but also the potential of bank runs to affect numerous financial and economic factors, while also being affected by them.

The introduction of the digital euro into the financial system may force us to reflect and adopt new ways to avoid and combat possible bank runs, since due to the technological dimension and design typology, classic forms of bank runs can be changed. Traditionally, a way of preventing the growth of phenomena such as bank runs is through decisions such as suspension of convertibility and the creation of deposit insurance.

In order to prevent the panic that usually follows a bank run, the United States established the Federal Deposit Insurance Corporation (FDIC) in 1934. This organization seeks to ensure the stability and confidence of commercial bank customers. To this end, this corporation ensures the standard insurance amount is \$250,000 per customer, per insured bank, for every account ownership category. Deposits remain intact in the event of a bank failure, strengthening public trust in institutions (Corporation, 2020). A similar mechanism can be implemented in the EU with the European Deposit Insurance Scheme (EDIS). Currently, each country provides an insurance deposit of 100.00 euros, in accordance with EU requirements, even in the event of a bank failure. The European Commission proposes amending Regulation (EU) 806/2014 in 2015 to establish a European Deposit Insurance Scheme. This mechanism attempts to reinforce the European financial system, as a united and fully integrated financial system, so, is critical for successful monetary policy transmission, appropriate risk allocation across Member States, and overall confidence in the eurozone banking system (Calore, 2020). Deposit insurance is still completely national, preventing cohesion under critical circumstances. Later in this work, possible new forms of control will be analyzed.

4.2. Possible causes of bank runs carried on by the adoption of the digital euro

As mentioned, bank runs are not new. However, the application of the digital euro can revive this phenomenon with new dynamics, so it is important to understand the reason why the introduction of the currency is pointed out by many authors as a generator of bank runs.

The danger of a bank run may increase because the new currency may be utilized as a new store of value that is immediately and easily accessible. As a result, in times of financial crisis, the transition from bank deposits to digital euros is more likely than a rush to ATMs, for example, and the likelihood of the phenomena reducing the robustness of the financial system rises (European Central Bank, 2020).

However, as in other areas related to the digital euro, there is no agreement on the impact and likelihood of this phenomenon. For example, the Governor of the National Bank of Denmark, in October 2017, in a speech at the Copenhagen Business School regarding the creation of a digital currency by central banks, stated the following: “It would, therefore rather open a highway to bank runs, challenging financial stability, unless the amount allowed would be limited to an extent where it could not serve useful transactions purposes. It would add competitive distortions at the expense of private institutions and very substantial costs in terms of IT, staff, and regulatory compliance”.

In times of uncertainty and financial strain the digital euro would not enhance the number or speed of bank runs from one bank to another because current technology already allows for amazing efficiency. This argument is reinforced by the fact that CBDC may not be the only safe and attractive alternative in times of crisis and as such a run on the digital euro may not happen and could be directed, for example, at a state bank whose balance sheet promotes an idea of security for deposits. Mancini Griffoli et al. (2018) claims that electronic money issued by central banks does not have to be a disruptive agent, and as such, it may have positive aspects, and, contrary to common belief, this currency may even reduce the risk of bank runs.

As previously stated, the impact of the digital euro will be heavily impacted by the financial climate. Thus, it is now critical to understand what design features this currency may have to further increase the phenomena of bank runs. One of the major elements of the digital euro's design is its nature, particularly because it becomes the first central bank digital currency in circulation, projecting a sense of security to users. This concept of security can trigger a *flight to safety*, which is defined as a flight of deposits in banks (private money) to CBDC accounts since this currency belongs to the ECB, in the European case. As so its level of security is higher because the central bank does not default, and thus the investment is always safeguarded (Williamson, 2022).

Another area where the architecture of the digital euro can have an impact, in terms of bank runs, is the amount of currency created. More specifically, in a scenario where there is no holding limit or where it is very high, there is an increased probability of users withdrawing deposits from commercial banks and converting them to CBDC, as it is possible to transfer more funds, this question was previously addressed in section 1.1.3 (Bank for International Settlements, 2021). Finally, if the ECB allows free or low-cost digital euro transactions, it may attract depositors such as consumers or businesses to shift cash from commercial banks to CBDC, making it even more appealing (Tan, 2023).

4.3. Models of bank runs

The attempt to understand the impact of CBDC on bank runs led to the development of models and scenarios to try to predict the risks, consequences, and dynamics caused by the euro digital in this

specific situation. These models then function as warnings about the importance of making an informed decision about the design of the euro digital.

4.3.1. Bank runs scenarios

The causes of bank runs may alter not just the extent, but also the repercussions for the financial system. Thus, Kumhof and Noone (2018b) describe three separate bank run scenarios that start from the following situation: a group of bank deposit holders (group A) intend to transfer their funds to CBDC in a panic reaction.

- i. The first scenario presents a circumstance in which another group (group B) wishes to sell their CBDC holdings, resulting in a general equilibrium in which both parties swap assets with no significant difference in deposit amounts. This circumstance can occur in one of three ways, with the overall equilibrium achieved in all. In the first instance, commercial banks operate as intermediaries, purchasing digital money from group B and selling it to group A. In the second variant, rather than CBDC, group B is ready to sell eligible assets to group A. As previously, group B receives group A's bank deposits, while group A receives the needed CBDC by trading their newly gathered eligible assets against CBDC at the ECB. Finally, in the last variant, banks operate as intermediaries for group A by purchasing eligible assets from group B in the private market, converting those eligible assets into CBDC, and then selling those to group A. Banks issue fresh bank deposits to group B in order to purchase the extra eligible assets, while group A withdraws its deposits in order to obtain the CBDC.

This situation allows us to consider two aspects. The first is connected to the virtually automated form of CBDC, which means that consumers would know without having to research that this money is secure and, as such, is the solution in times of financial crisis. The second point concludes that CBDC, as in the scenarios described above, can provide a quick solution to a rush for withdrawing deposits, implying that this digital currency can even prevent bank runs from spreading to other banks.

- ii. In the second scenario, commercial banks do not serve as intermediaries, and group B does not exist. Banks' balance statements include a surplus of eligible assets, so they may decide to liquidate their eligible assets at the central bank in exchange for CBDC and then sell it to group A. The amount of bank deposits reduces the bank's balance sheet. However, this is an ordered decline, at least initially, and so does not impact the overall amount of liquidity in the economy. The authors emphasize the need to study whether there are enough eligible assets to accommodate a large-scale increase in CBDC.

- iii. Finally, the third scenario depicts a significant increase in demand for CBDC by group A, such that neither banks nor group B can meet the needs of the group intending to purchase digital currency. The central bank may now be forced to establish a pricing rule. This might happen if group A continues to desire to convert deposits into CBDC at (nearly) any cost, potentially due to concerns about the bank's viability, despite the central bank placing the CBDC interest rate at the lowest politically possible level. As a result, the previously indicated general equilibrium may end since it no longer exists, in this situation, the banks will no longer have acceptable assets to sell. Despite this, there may be a method to avoid the end of the equilibrium by modifying deposit interest rates, which commercial banks may change by raising them. Thus, the goal of this action is to encourage and attract deposits from businesses and households, and the cost of this change would be borne by a possible increase in lending rates. While this change may have other consequences, it will certainly be less severe and difficult to manage than a bank run.

The third scenario thus represents the occurrence of bank run phenomena, with the specific presence of CBDC having no significant impact on this forecast. That is, none of the previously listed pricing mechanism adjustments requires CBDC and is thus viable in both a world with and without CBDC. Hence, this is possible to happen as long as there is an alternative to deposits (i.e., cash). The authors also state that if CBDC is adopted gradually, the size of bank balance sheets may, but need not, be reduced and that the implementation of CBDC does not necessarily result in a reduction in bank financing.

4.3.2. Two models: coexistence of cash and digital euro in bank runs

Another approach examines the influence of CBDC on the occurrence and intensity of bank runs. Adalid et al. (2022) developed two separate models with points in common: CBDC is commonly favored in both models, and bank liabilities are employed exclusively as a store of value, moreover, consumers have the option of turning their deposits into both cash and digital euros. The first model simulates bank runs and compares them to previous cases of economy-wide bank runs to establish what might have happened if a digital euro coexisted with cash. The second is an adaptation of the Diamond and Dybvig (1983) model that includes cash and CBDC. These models allow us to analyze not only the speed but also the scale of bank runs in both scenarios. Only with the design of the digital euro defined will it be possible to carry out models with a higher level of rigor, additionally, the context of the financial environment is another variable that can change possible predictions.

Nevertheless, these models highlight measures that the banking sector might consider when the digital euro comes into circulation, such as decreasing surplus reserves, banknotes in circulation, and refinancing through the central bank to ensure bank liquidity. Another conclusion drawn from the model analysis is that the level of intermediation of banks is directly proportional to the existence and volume of market imperfections. That is, in the absence of market imperfections, the introduction of the European CBDC does not affect bank intermediation, only changing the dynamics of banks in terms of funding, forcing the ECB to intervene in a funding operation for banks, with the economy's liquidity remaining unchanged. On the other hand, the presence of market imperfections, such as imperfect competition in the banking sector, liquidity regulation and Eurosystem collateral requirements, would have a direct impact on banks' financing capability, increasing the amount of bank disintermediation. In terms of bank runs, the author's analysis of the models suggests that an unconstrained CBDC increases not only the speed but also the volume of bank runs, whereas a constrained CBDC can even help to reduce the scale and speed of this phenomenon when compared to scenarios in which this European digital currency does not exist. These models also emphasize the significance of CBDC holding limitations and remuneration.

4.4. Options of safeguards and considerations

As previously stated, the danger of bank runs exists in both an economy with and without CBDC. It was possible to comprehend that the introduction of the digital euro may or may not increase the likelihood, speed, and volume of bank runs, depending on its design and characteristics. Still, there may be ways for this not to occur or for these repercussions to be reversed. It is critical to identify potential protections so that the adoption of this currency can foster a more robust economy. For this reason, it is imperative that commercial banks and the ECB incorporate the relevant elements in order to provide effective safeguards. In point 1.1.3 of this study, different strategies for managing CBDC have been identified to prevent negative impacts when implemented, namely: such as quantity limits, like flow and stock limits, price limits, such as remuneration, or even a combination of both, such as two-tier remuneration (Bank for International Settlements, 2021; Bindseil, Panetta and Terol, 2021). Moreover, the waterfall technique is another tool that has the potential to reduce the impact of bank runs (European Central Bank, 2020).

In addition to designing choices as a form of safeguard, there is also a need for a correct response to the entry of the digital euro into the economy by commercial banks and ECB. The following scenario illustrates a possible approach taken by commercial banks to reduce the chance of bank runs.

Ahnert et al. (2023) states that an increase in the interest rate of the digital euro represents an increase in the probability of bank runs. For these reasons, there is the necessity for proactive involvement by commercial banks and, more indirectly, by the ECB (through efforts to enhance liquidity in the banking system). The authors suggests that a possible solution would be made by banks changing the deposit contract to counter a possible migration of funds to CBDC. Banks improve the guaranteed return to depositors by increasing it, on the one hand, to compete with the most attractive external alternative (digital euro) and on the other to try to reduce the growing banking fragility. For this reason, there would be a reduction in the desire to withdraw deposits and, as a result, the probability of a bank run. There is an inverse relationship between CBDC remuneration and banking stability. In this situation, some beneficial but not excessive CBDC compensation decreases financial instability compared to a cash-only economy.

Another factor to consider is the overall financial climate since in times of increased stress, stronger restrictions and a higher level of intervention may be required. This is an example of how the architecture of the digital euro, together with the activities of commercial banks, may help to avoid negative currency consequences, even allowing the European CBDC to provide stronger stability conditions, as previously noted.

Conclusion

The digital euro is expected to be a new method of payment whose qualities promise to be incomparable with previous digital currencies, ensuring electronic issuance by the ECB and universal availability. There are still many uncertainties about the design of this currency, which will influence not just its operation but also its results. Given this, it is critical to decide on such traits, additionally is also necessary to develop restrictions and safeguards based on predictions in order to minimize adverse impacts when implemented.

The growth of virtual assets and private sector payment methods are one of the reasons for the creation of the currency. According to the ECB, a CBDC should mitigate the possible decrease in the relative importance of the euro due to the prevalence of private digital forms of payment. Thus, issues such as decreasing cash use, the need to strengthen monetary sovereignty, and the rise of crypto-assets are expected to be tackled through the implementation and use of the European CBDC. The ECB extends the expected benefits of this currency to the strengthening of monetary sovereignty and monetary policy, as well as ensuring strategic autonomy, data protection, and, finally, the promotion of retail payments and economic efficiency.

This thesis seeks to understand the impact of the digital euro on European commercial banks. As such, it is important to analyze three essential key issues: bank disintermediation, monetary policy and bank runs.

Bank disintermediation is one of the possible consequences of the introduction of the digital euro. The level of disintermediation depends on the level of user adoption of the digital euro and the possible design choices of the new currency. Thus, bank disintermediation results in a decrease in deposits at commercial banks as well as in their reserves. As commercial banks lose a large part of their funding due to the withdrawal of deposits, they might turn into riskier and more unstable sources of funding and/or increase their dependence on ECB lending operations. In short, bank disintermediation means the growth of financial instability in Europe. This situation will not arise if there is a sufficient financial response, such as rising deposit interest rates and reducing lending interest rates. This response would make commercial banks more competitive, due to their more attractive deposits as a result of the change in interest rates and minimize the effects of potential disintermediation. Also, implementing the waterfall approach would reduce the amount of bank disintermediation, allowing banks to continue to play a more active and crucial role in the operation of the digital euro.

Another important issue has to do with monetary policy, more precisely with the possibility of the digital euro becoming a new monetary policy instrument. The digital euro may be the first money the ECB issues bearing interest, providing monetary policy with yet another tool at ECB's disposal. The

ability of the ECB to manage holding and spending of CBDC by regulating the interest rate—which may be zero or even negative—could be advantageous. The influence on monetary policy will therefore be determined by the currency's design, and more especially by how it is remunerated. As a result, remuneration might be applied, using unfavorable interest rates, to discourage the use of the digital euro as a means of investment. Additionally, the Central Bank can use this monetary policy instrument to emphasize the currency and make it more attractive than other payment forms. The adoption of two-tier remuneration could guarantee the attractiveness of the digital euro with zero or negative interest rates, discouraging excessive accumulation of the currency with interest rates that carry a cost and are therefore unattractive.

There is also the question of how bank runs could be exacerbated by the introduction of the digital euro. In times of financial instability, the digital euro could be seen as a safe way to store money, as it is easily accessible and is issued by the ECB, which conveys a greater sense of security. This process, called flight-to-safety, is one of the possible consequences of the introduction of the digital euro. The digital euro increases the likelihood of bank runs, but this likelihood could be eliminated or mitigated under certain conditions. Thus, the measures used to limit bank disintermediation, such as interest rates on deposits and loans, the remuneration of the digital euro, and the waterfall approach, also apply to the phenomenon of bank runs, since both seek to limit the transfer of capital from deposits to digital euro wallets. In addition to these, holding limits can be used, ensuring that all deposits are not transferred to digital euro as there is a maximum possible limit for holding the new currency. The constrained digital euro could even mean a reduction in the scale and speed of bank runs, since once the holding limit is reached it is no longer possible to transfer deposits to digital euro.

Regarding the question “Is CBDC a potential threat to European commercial banks?”, this work can certainly offer an answer: yes. As explained throughout the work, the risk of the digital euro posing a threat to commercial banks is real and should not be disregarded. The risk, although real, does not seem likely since, as has been shown, the ECB has taken into account, in several digital euro reports, the existence of various instruments to minimize and sometimes even null, particularly through the adoption of limits and remuneration. Thus, the digital euro could cause negative impacts but offer new dynamics and possibilities for the European financial system. In sum, the consequences of the digital euro's launch will be determined by developing two independent factors: the design of the digital euro and the reactions of the parties involved (users, commercial banks, and the ECB).

As previously stated, this investigation met certain limitations, such as significant ambiguity surrounding data linked to the digital euro and, more precisely, its influence on crucial components of the financial system. However, the constant update on the digital euro over the last few years, with a higher frequency between 2021 and 2023, means that this subject is increasingly developed and

deepened not only in Europe (with the case of the digital euro) but also internationally with other CBDCs.

This work, therefore, aims to contribute to understanding of the digital euro, still unknown to many. This research aims to reinforce the literature on the digital euro and commercial banks by providing a review of the main issues affecting European commercial banks in connection with the introduction of the digital euro into the European financial system. As a result, it is hoped that this work will highlight important issues that must be carefully considered when the European CBDC is implemented, particularly in the banking industry, as well as the need for in-depth reflection on the structure it must take.

The study on the digital euro and its implications needs to be further developed. It is important to understand if its implementation will be successful and if it will strengthen the euro while improving people's and businesses' lives. This emphasizes the need to invest in detailed research in areas where there is currently little information, such as monetary policy and specifically how it will change with the introduction of the digital euro, as well as how this new currency will interact with other CBDCs globally. In addition, it is also important to study the effects of the digital euro on non-financial companies, thus trying to understand to what extent the ECB's CBDC could be used to promote growth and innovation in the private sector.

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