



A digital euro for a better monetary system

The case for a public option

January 2023

Edited by Tristan Dissaux and Wojtek Kalinowski for



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Key messages for decision-makers

- Like numerous central banks around the globe, the European Central Bank (ECB) has started an investigation phase in view of the probable launch of a central bank digital currency (CBDC), the “digital euro”. **This study explains what is at stake and how a digital euro could be designed as a safer, more inclusive and cost-free means of payment** compared to current payment solutions, leading to a more resilient monetary system and more respect for individuals’ privacy.
- However, this potential will get lost if the digital euro is designed to be accessible and usable only through private intermediaries, as currently planned by the ECB. **A public option is needed for the digital euro** and this solution would be complementary to what the market can offer. This is not only desirable but also feasible to implement.
- The main argument against the public option is that it could lead to massive deposits flights from commercial banks, with dire consequences for the universal banking model and the whole economy. That is why **the ECB seems to discard any investigation that could lead to ground-breaking innovation**. However, we claim these concerns are overstated.
- The stakes are high but the policy debate about the digital euro is particularly difficult to grasp, as the issue often seems excessively technical. However, **technical choices are not neutral: they will have crucial impacts** on what the digital euro will and will not be able to perform in the future.
- **A digital euro could also improve international transfers and payments**, especially benefiting people having cross-border life situations between a eurozone and a non-eurozone country.
- Besides its payment functions, **a digital euro will open possibilities for new policies** that could be particularly useful to support the economy in times of slowdown or to accelerate the ecological transition.
- Therefore, we need a **broad political discussion about the objectives to be fulfilled by the digital euro**, and a policy debate linking objectives to technical options before any commitment is made.
- **The ongoing investigation phase will be decisive**: it should be focused on objectives and be more open to other stakeholders than the financial industry.

Executive summary

The digital euro project emerges in times of rapid changes in our monetary system

- Rapid innovation takes place in the digital payments market.
- In many countries the transactional use of physical cash is declining.
- The European Central Bank is compelled to react: as most other central banks around the world, it is considering the introduction of a central bank digital currency (CBDC).
- However, there is no consensus about how a digital euro should work. Many options are available that need to be weighed against the policy goals to be achieved.

This study makes a case for public money in the digital age (see chapter 1)

- Our monetary system rests upon the coexistence of public and private money. But with the digitalization of money also came its **increased privatisation**. In the digital age the existence of public money seems to come under threat.
- Currently, **physical cash is the only public form of money** accessible to people while the dematerialized euros we use every day only exist as private forms of money.
- **Money should be a public good**, running on means of payment that are universally accessible, mostly free to use, risk-free and respectful of the privacy of users. Private monies have a poor track record in regards to these characteristics.
- **Market driven provision of means of payment have shown their limits**: the cash infrastructure is decaying (and cash is no longer the public good it should be) and the payment cards infrastructure yields sub-optimal socioeconomic outcomes.
- While **the public / private division of labour regarding money** is claimed by central bankers to be “symbiotic”, it **raises various issues** (including some that the digital euro is supposed to tackle, according to ECB official statements).
- While there is room for improvements in **our monetary system**, it also **exhibits vested interests** that can prevent real progress. Therefore, planning for the digital euro should be a process as open and transparent as possible.
- Existing payment infrastructures and financial actors should not be the only ones to be relied on for the implementation of the digital euro. **The ECB and the Eurosystem can and should provide for a true public option for digital payments**. The digital euro is the occasion to (re)build a public service of money, i.e. a public service for accounts and payment services.

- The concept of "central bank public goods" as developed by central bankers is very narrow and inadequate for today's challenges. **Seeing the digital euro exclusively as a "raw material" for private business models is far from enough.**
- **The digital euro should exist as a full-fledged innovation offered by the ECB to the public.** This public option would complement private sector solutions while ensuring the achievement of public policy objectives.

A digital euro could contribute to a safer, fairer and more inclusive monetary system (see chapter 2)

- **Different operating models are available to the ECB** for the development of a digital euro, depending on the organisational architecture adopted and the type of transfer mechanism chosen.
- **The choice of an operating model is not an either/or decision**, and the digital euro does not need to be restricted to a single model. Synergies exist between single-tier and two-tier architectures and between account-based and value-based solutions.
- **A digital euro should be designed to best serve the society as a whole:** a digital euro should and can be safer, more inclusive, privacy-enhancing, more resilient and cheaper than existing digital payment solutions.
- The best way to achieve these objectives seems to be the **direct provision** of both digital euro accounts and of a cash-like digital euro.
- Direct provision of the digital euro by the ECB does not preclude the involvement of the private sector but **the distribution of the digital euro should not be the privilege of private intermediaries.**
- **As currently planned, the digital euro will not offer a real alternative** to the current organisation of our payment systems, giving it no clear added value compared to existing solutions.
- **In order to be widely accepted, the digital euro needs to be attractive and useful for users.** We believe this should be the focus during the investigation phase, not maintaining the attractiveness of commercial banks' deposits.

Besides being a new means of payment, the digital euro could open new avenues for economic policy (see chapter 3)

- **A digital euro would greatly ease the implementation of direct monetary transfers** in the form of helicopter money. **Direct transfers in digital euros would greatly improve monetary policy transmission** while supporting Europeans in times of economic downturn.

- Such **transfers could be targeted for specific uses**, which would be particularly relevant in the context of renewed inflation and of ecological transition.
- A digital euro could also be programmable. Promoted by various actors, **programmability is more a political than a technical issue**, as it could serve very different agendas.
- Mostly praised for its economic applications, **programmability** - if implemented - **should only serve democratically-legitimate projects** aligned with the socio-ecological transition.

The digital euro could be used for cross-border or even for worldwide transactions (see chapter 4)

- **The introduction of a digital euro will necessarily have international implications** to be considered and, ideally, dealt with in coordination with other jurisdictions.
- The **deployment of a digital euro should avoid risks of “euroization” for foreign weak economies**.
- **A digital euro could improve international transfers and payments**, especially benefiting people having cross-border life situations between a eurozone and a non-eurozone country.
- Beyond payments related aspects, **the circulation of a digital euro in countries neighbouring the eurozone could foster European economic integration**.

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Introduction

Each euro area citizen makes, on average, more than 13 transactions per week (ECB, 2020d). We use money on a daily basis, but we don't really know how it actually "works". We seldom wonder about it, as most of us simply wave our card without further thinking. As something that is "there" and that mostly works, the payment system tends to be overlooked.

Some recent evolutions made it more apparent though. In the wake of the covid-19 pandemic, our habits evolved as we were pushed to use digital means of payment instead of cash. We went further online, as did banks that closed part of their branches and with them, ATMs. Today, using cash is becoming less natural and more uncertain. But isn't cash supposed to be legal tender money? Could it disappear without provoking any difficulty? Besides these developments, our traditional means of payment are also increasingly challenged. In 2008, Bitcoin was launched and brought the promise we could pay using decentralised cryptocurrency, a type of money freed from any official entity. In 2019, we then saw a "Big Tech" company aiming at launching its own global currency. That was Facebook with its Libra/Diem project, since abandoned. But other so-called stablecoins are presented as serious contenders of our old-fashioned official currencies.

All these evolutions take place in a context of ever-increasing digitalisation of our economies and societies. Money does not escape this trend and has also evolved with technology. But when it comes to money, technological change is not only about potential gains in speed, convenience or security of our transactions. As we shall see in this study, the digitalisation of money led to its increasing privatisation, which does not go without societal implications. They raise the **question of who is better placed to manage the critical infrastructures that payment systems** are: the market, public institutions, or a mixture of both? Whatever one's opinion on this question, **current evolutions challenge the division of labour that has been in place** between these two types of actors and the implications of these changes should be carefully weighed-in. That is the aim of this study.

It is in this context that the reflection on Central Bank Digital Currencies (CBDC) is taking place. Worldwide, nine out of 10 central banks are exploring the concept (Kosse and Mattei, 2022). CBDCs are called to play a pivotal role in future monetary systems, as the foothold of all other payment and financial services (BIS, 2022). A CBDC is currently being investigated for the Eurosystem by the European Central Bank (ECB) as part of the "digital euro" project. Here, the reflection focuses on what is called a "retail CBDC" (or rCBDC)¹: a digital means of payment issued by the central bank and usable by the general public². As we shall see, a CBDC could be radically different from the electronic euros we already use. In fact, **a digital euro could be an opportunity to greatly improve our monetary system, to the benefit of all European citizens and businesses**. It is the objective of this study to outline the conditions under which this can be realised.

¹ In contrast to a wholesale CBDC (or wCBDC) that could be used for the settlement of transactions among financial institutions (see Panetta, 2022e). This type of digital currency is out of the scope of this report.

² As defined by the literature (Auer and Böhme, 2020; Bank of Canada et al., 2020; Bank of England, 2020; Bech and Garratt, 2017; BIS, 2021b; CPMI and Markets Committee, 2018; Engert and Fung, 2017; Mancini-Griffoli et al., 2018).

The introduction of a digital euro (if it is indeed decided to launch it) is scheduled for 2025-2027: it could thus appear as a distant issue. But the project is already well underway (see the timeline below) and **the choices that will determine if this digital euro will be truly transformative (or if it will preserve the status-quo) are being taken now.** They need careful scrutiny, not only from ECB experts and the industry representatives gathered around them, but also by all policy-makers and citizens. To this end, **this study will shed light on the main design choices associated with a digital euro and explore their policy implications.**

Main milestones of the digital euro project

- January 2020: Setting-up by the ECB of the “Eurosysteem High-Level Task Force on central bank digital currency” (HLTF), “bringing together experts from the ECB and 19 national central banks of the euro area” (ECB, 2020b). It “is the body in charge of steering the digital euro project. It reports to the ECB’s Governing Council.” (Panetta, 2021b)
- October 2020: Publication of the “Report on a digital euro”, prepared by the HLTF and approved by the ECB governing council (ECB, 2020c). The report identifies scenarios that could trigger the issuance of a digital euro and spells out the characteristics that a digital euro should have.
- 12 October 2020 - 12 January 2021: The ECB organises an online public consultation on the digital euro. The level of feedback is a record for ECB public consultations (ECB, 2021c, 2021f).
- 14 July 2021: The ECB announces a two-years “investigation phase” (to be started in October) for the digital euro project (ECB, 2021e).
- 25 October 2021: The ECB “appoints 30 senior business professionals with proven experience” to form the digital euro Market Advisory Group (MAG) (ECB, 2021b). The mandate of the MAG is to advise the HLTF from an industry perspective (ECB, 2021g). The group had 6 meetings between November 2021 and November 2022.
- 10 November 2021: As a second level of interaction with stakeholders, the ECB engages with the ERPB (Euro Retail Payments Board) for “the institutional dialogue” on a digital euro (ECB, 2021d). It can be noticed that the ERPB counts two consumer organisations among its 10 members. It held four technical sessions on a digital euro between May 2022 and November 2022.
- 11 November 2021: Evelien Witlox is appointed Programme Manager of the digital euro project at the ECB, as of 1 January 2022. She was previously Global Director of Payments at ING (ECB, 2021a).
- 25 February 2022: Statement of the Eurogroup in support of the digital euro project (Eurogroup, 2022).
- 16 September 2022: The ECB announces its selection of “external companies for joint prototyping of user interfaces for a digital euro” (ECB, 2022g). These are CaixaBank, Worldline, EPI, Nexi and... Amazon. Each will focus on a specific use case of a digital euro.
- 29 September 2022: Publication of the intermediary report “Progress on the investigation phase of a digital euro” (ECB, 2022i).

This study will argue for a truly progressive digital euro, that is one bringing the most benefits to European people and businesses. **Introducing a digital euro is an opportunity not to be missed**, that could allow for our monetary system to be safer, more inclusive, more respectful of individuals' privacy, more resilient and cost-free.

The study is structured around four main chapters:

- **Chapter 1 starts by looking at our current monetary system**, which is made up of different instruments running on different systems and that do not all have the same characteristics and implications. In this organisation, public money plays a pivotal role but is increasingly challenged, which is not without risks for our economies and, more broadly, for our societies. We argue that present issues call for a renewed role for public money, that a digital euro could and should endorse.
- **Chapter 2 delves into the characteristics that a truly disruptive digital euro should have**. Design options are discussed in light of their potential benefits for users. Questions of risk, access, data protection, resilience and cost are discussed in order to delineate the most desirable design for a digital euro. It is compared to the approach currently followed by the ECB, which appears to have a somewhat conflicting hierarchy of policy goals. We challenge its position, including in regards to the bank disintermediation issue often raised against an attractive digital euro.
- **Chapter 3 explores some of the new policy options opened up by the introduction of a digital euro**. Firstly, it would greatly ease the implementation of direct monetary transfers, also known as helicopter money. We discuss the rationales for such a policy and how a digital euro could be mobilised in this context. We then examine what a “programmable digital euro” would entail: programmable payments and programmable money applications are introduced and discussed. We show that they can serve very different projects that need to be politically discussed.
- **Chapter 4 looks at the international implications of the introduction of a digital euro**. Beyond intra-eurozone transactions, a digital euro could also be used for transactions between the eurozone and non-eurozone entities, as well as for transactions taking place between two non-eurozone entities. We discuss the implications of these different uses in terms of potential risks and benefits.

I. The monetary system and the case for public money

Our monetary system is a structuring element of our societies and lots of things depend on it: the everyday economic life and the financial system on all levels, but also the ability of each member of the society to fully participate in the social life, as well as a collective sense of belonging and trust in public institutions. And yet, as everyday users of the monetary system, we only see its interfaces (the visible parts we interact with), while its structures remain mostly out of sight. As a consequence, these structures are seldom put in question.

In order to grasp the potential evolutions of our monetary system made possible by the implementation of a central bank digital currency, it is first necessary to examine its current state. In this chapter, we'll see that it consists of a coexistence of public and private money, with this coexistence becoming more and more challenged. Following central bankers, the public-private partnership in money is supposed to lead to an economically and socially optimal monetary system. But that is far from being the case: the current organisation shows various issues and the role of public money is shrinking, bringing new risks. These evolutions call for action through the issuance of a truly public digital euro.

A. The current monetary system: a coexistence of public and private money

From the user's perspective, the monetary system materialises itself firstly through our *monetary instruments*: the objects we use in order to pay (or, more precisely for digital payments, the objects we use to initiate payments). These objects do not exist and operate on their own, they are underpinned by *payment systems*: infrastructures that allow for the availability and usability of these monetary instruments. Payment systems are the "plumbing" that makes money flowing through the economy.

Monetary system = monetary instruments + payment systems

In the case of a card payment for example (and as we will see in more detail below), the card is a payment initiation device that triggers communications among diverse actors and on different networks, which ultimately result in the settlement of a payment.

Each component of each part of the monetary system will have concrete implications: the next two sections aim at disentangling them.

1. Different monetary instruments with contrasting characteristics

We can broadly distinguish three types of monetary instruments: physical cash, electronic book money, and central bank reserves, the last one being invisible to the general public.

a. Cash (Eurosystem notes and coins)

Coins and notes are forms of money that have long been associated with States' privileges, used both as financial and symbolic tools of ruling powers³. With the emergence of central banks, managing the production and the issuance of coins and notes became one of their core tasks, with the aim of ensuring monetary stability and uniformity that only a public entity could guarantee.

History showed the importance of this public function, as starkly illustrated by the “free banking” period in the United States (from 1838 to 1863), when each private bank was free to issue its own paper money (see Chaudhuri, 2014). Following liberal / libertarian theories, market forces were supposed to ensure the regulation of the system, with the value of money to be guaranteed by the soundness of the banks and their assets. The market was supposed to naturally discipline banks and their money issuance, in particular through the demand for conversion to silver and gold in case of over-emission. Yet, the system quickly showed its limits, with thousands of different varieties of paper money issued by local banks coexisting in the economy. Notes were seldom accepted at face value, but with a discount rate that incorporated the uncertainty about the emitting bank (and the transport costs incurred to deposit them if the emitting bank was located far away). Each person had to regularly inquire about the reputation of the emitting bank before accepting a note, which he could do using specialised journals (the “banknote reporters”). Combined with rampant fraud from wannabe bankers and counterfeiting, it led to frequent banking crises and chronic difficulties in the conduction of economic activities, as doubt about the value of money was pervasive. Consequently, public action was paramount and legislative acts were passed to make cash uniform and risk-free. It led to the creation of an official body charged with the responsibility for organising and administering a common national currency.

Today, as part of the Eurosystem, euro notes and coins are issued by national central banks and mints, in coordination with the ECB. This gives cash diverse socially desirable qualities:

- Cash is a liability of the Eurosystem: from the perspective of users, cash represents a direct claim upon the Eurosystem⁴. As such, physical cash is the only form of public money accessible by people (as we'll see below, electronic euros are currently only accessible in private forms).
- As a direct claim upon the Eurosystem, physical cash is completely risk-free as its issuer (the system of central banks) cannot default.
- It is also the only means of payment whose use is not associated with charges: a cash transaction does not rely on any intermediary that could collect a fee. Hence, a cash transaction always settles at par.
- Cash is issued on non-commercial terms, without a cost-recovery constraint or a profitability motive. It can thus be provided to society in the fairest way.
- Cash is non-excludable: one cannot be prevented from using it. Every person can use cash regardless of its socioeconomic or legal situation. Cash is therefore also the only

³ This was primarily true for coins, as notes can be traced back to receipts issued by goldsmiths and other proto-bankers (see Ryan-Collins et al., 2012).

⁴ In our post-gold standard monetary regime, it could be argued that as nothing can be *claimed* from the central bank (cash is no longer convertible into gold), cash is no longer a claim. The notion of liability should not be reduced to a metallist understanding though: in our so-called “fiat” monetary systems, the central bank is liable for the value of the currency, be it only by *nomos*.

universally and unconditionally usable form of money. It is the most inclusive and for many, it is an important empowering tool.

- Cash does not require electricity or connectivity to be usable.
- Cash is anonymous: no data is generated by a cash transaction as no third-party is involved in it (a cash transaction is fully peer-to-peer). It thus participates in protecting privacy, which is a fundamental right and a desirable feature for our democracies. Bewilderingly for libertarians, it is indeed a State creation that offers citizens a space of protection from (State's) surveillance and control.

Part of the qualities of cash are linked to its material form: cash is a bearer instrument, whose sole possession is sufficient to be able to use it. In the case of a bearer instrument, it is the quality of the means of payment that is checked (in this case the authenticity and integrity of notes and coins), and not the identity of the holder (cash therefore does not require any identification of the user). In more technical terms, cash is a “value-based” means of payment (as opposed to “account-based” ones).

Due to these qualities, cash is akin to a public good (Dalinghaus, 2019). This is true for cash as a monetary instrument, but we will see that the cash infrastructure, mostly private, largely reduces this public good characteristic.

b. Book money (private banks' electronic money)

The main form of money that we use in our daily lives is the one we inquire about when we check our bank accounts. It is “book money”, held and accounted for by private banks: the units on our bank accounts are the euros that we transact in electronic form, thanks to the cards provided by private banks. This form of money is currently the only retail digital form of money available. These euros are not only held by private banks, but also - and more importantly - issued by them: “in the modern economy, money is largely created by commercial banks making loans” (McLeay et al., 2014). The main form of money currently in use in our economies is therefore a private form of money. Euros in our bank accounts represent claims upon a particular private bank and are thus not risk-free, as a private bank can go bankrupt: the bank is exposed to market risk (the value of its assets can drop due to shocks) and liquidity risk (it may not be able to sell its assets at the right price when needed). These risks can translate into a solvability crisis for the bank, which is then no longer able to honour the liabilities it has issued, that is the money it has created and that we use. The central bank as lender-of-last-resort and public deposits insurance schemes have been put in place to prevent these situations, but they still don't make this form of money risk-free.

Book money is also not universally accessible, as one needs to be “financially included” to be able to use it. This means having the right status and correct documentation, and being able to pay the fees attached to it (FSUG, 2021). Private banks can then operate a direct or indirect selection of their customers, which translates into exclusion from the digital monetary system (and by extension from a large share of society). Book money is therefore a “club good”: one needs to qualify to be able to use it, and has to pay for its actual use. This is because the provision of account and payment services have been left solely to private banks, who operate in their commercial interests and not in the public interest⁵. Yet, access to a transaction

⁵ Cooperative banks may be less profit-oriented and more mission-oriented than traditional private banks, but they still have a modest market-share.

account and to digital means of payment with free basic services should be guaranteed to all, as it is a condition of full participation in society, especially in the digital age. Fabio Panetta recognises this situation (and its undesirability) when he states that “Money would then be reduced to a “club good” offered in return for the payment of a fee or membership of a platform.” (Panetta, 2020). But he sees this possibility only in regards to the development of stablecoins, while it equally applies to present private banks’ book money.

Recognising the crucial importance for everyone to be able to use an account and have access to digital means of payment, the EU directive on payment accounts enacts the right of every EU resident to a basic payment account, that “should be offered free of charge or for a reasonable fee”⁶. But as banks are neither legally bound nor incentivised to provide a service free of charge, they rarely do, and as the definition of what a “reasonable fee” actually is has been left to Member States, banks remain largely unrestrained to set their own terms. In practice, they often hide or deny this possibility of a basic banking service to potential beneficiaries.

In the Euro Area, financial exclusion could be seen as an already solved problem when viewed in its narrowest sense, as virtually every person has an account. But as the figures below show, owning an account does not necessarily translate into being adequately equipped to pay digitally. There is indeed a gap between the share of the population having an account and the share of the population owning a payment card, and a further gap with the share of the population actually using it. In all, 13% of the Euro Area population does not pay digitally because they are unable to do so or because they choose not to. This monetary exclusion (Lupo-Pasini, 2020) is highly correlated with the socioeconomic status of the persons: it is all the more pronounced for the poorer segments of the population and already vulnerable groups (Jérusalmy et al., 2020). Among the poorest 40% of the population, some 20% do not use a debit or credit card. This is largely caused by the club good nature of commercial banks’ book money outlined above.

Table 1: Financial inclusion data for the Euro Area in 2021

	General population	Poorest 40%
Have an account	99%	97%
Own a debit or credit card	93%	90%
Used a debit or credit card	87%	Data not available <i>Estimate: 84%-78%</i>

Source: Demirgüç-Kunt et al. (2022). Estimate based on extrapolation of available data.

Finally, as an account-based system in which the user is identified and all transactions have to be authorised, book money can also be associated with privacy concerns as data is compiled for each transaction of every individual. These data can be used by involved parties for commercial purposes or - which is even more problematic - be sold to third-parties or shared with public bodies for surveillance purposes. As affirmed by the French data protection

⁶ https://finance.ec.europa.eu/consumer-finance-and-payments/retail-financial-services/access-bank-accounts_en

authority, with the digitalisation of money, “our payment data are no longer in the shadows of banking secrecy” (CNIL, 2022). This is largely due to the organisation of the payment card infrastructure that we will describe later.

c. Reserves (wholesale central bank money)

Besides cash, the Eurosystem provides another form of public money, this one in digital form, but which is not accessible by people and businesses as it is used only within the financial system by its direct participants: central banks, private banks and some other financial institutions. This “base money” or “high-powered money” is used only for central bank operations (primarily relating to monetary policy) and for interbank payments and loans. It is the money of the European RTGS (real-time gross settlement) system, that allows to process large-value payments and enables EU banks to transfer money between each other with immediate finality. The RTGS system of the Eurosystem is called TARGET2 (Trans-european Automated Real-time Gross settlement Express Transfer 2). In essence, with this system “banks already benefit from a wholesale central bank digital currency” (Panetta, 2022b).

Though this form of central bank money is public money (as it is - like cash - issued by the Eurosystem), it is in this case akin to a club good as only selected financial institutions have access to it (around 1,800 banks are direct participants in TARGET2). Once part of the system, they enjoy access to risk-free central bank money. Participants pay fees for their participation to the system (a monthly fee + flat or volume-based transaction fees).

d. Synthesis: comparison of the different characteristics of available monetary instruments

The contrasted characteristics of these different monetary instruments are synthesised in the table below. We highlight in green the characteristics that are the most desirable from a societal perspective. In the next section, we turn to the payment systems that underpin these monetary instruments (last line of the table below) and can affect their availability and usability for users.

Table 2: Characteristics of available monetary instruments

	Cash	Book money	Reserves
Issuer	The Eurosystem's central banks	Private banks	The Eurosystem's central banks
Issuance mechanism	On-demand substitution (conversion) of book money	People and businesses borrowing from private banks	Private banks borrowing from central banks and purchases by central banks (QE)
Accessibility	Universal	Financially included people	Selected financial institutions
Nature	Public good	Club good	Club good
User cost	Free	Fees	Fees
Risk	Risk-free	Market and liquidity risks	Risk-free
Privacy	Anonymous	Identified	NA
Form	Value-based	Account-based	Account-based
Underlying infrastructure	Public/private cash infrastructure	Private payment systems (in connection with TARGET2)	Eurosystem's TARGET2 Single Shared Platform (SSP)

Source: author's elaboration

2. The current actors and organisation of payment systems

The payments space is filled by commercial banks, card schemes, payment services providers, fintechs and bigtechs. They are all part of what is referred to as the “payments industry”, in which public entities including central banks play a minor role. As payments are an essential element of our economies, the payments industry is a highly profitable one: its global annual revenues are around \$2tn (OMFIF, 2020). Shedding light on its operation allows to uncover the respective roles and powers that payment infrastructures' actors have (and may be reluctant to lose in the case of the introduction of a CBDC).

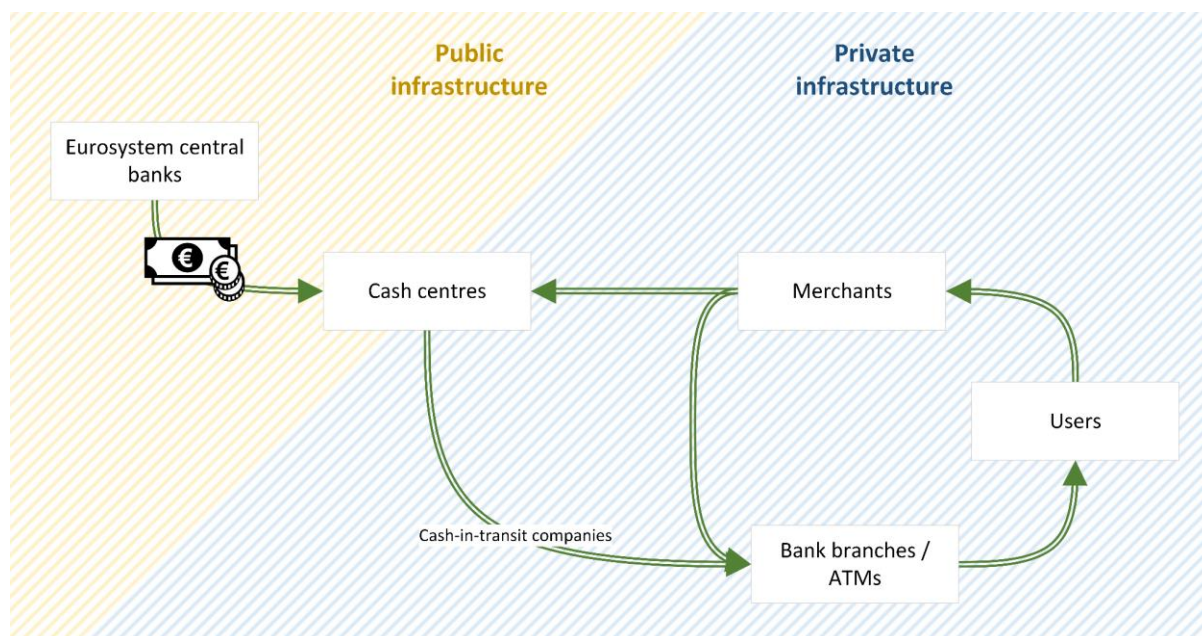
a. The cash infrastructure: an uncertain sustainability

We've highlighted in the previous section the fact that cash is a form of public money, in fact the only form of public money currently accessible to all. Coins and notes are effectively issued by Eurosystem's central banks, but as we shall see now, their actual distribution to and among users (which determines the actual accessibility and usability of cash) relies on various private actors forming what is called the “cash cycle”, a cycle that is increasingly broken as we shall see below.

Coins are produced by national mints and notes are either printed by national central banks or by private printers. When coins and notes leave their production sites, their first stop is in “cash centres” from which dispatching to the covered region will originate. These cash centres can be owned and managed by the public issuing authority, or by private “cash-in-transit” companies. In all cases, it is these cash-in-transit companies that will supply cash distribution points: commercial banks branches and ATMs (ATMs can be run by dedicated private companies called “independent ATM deployers”). From there, cash is withdrawn by users and spent at merchants, who themselves deposit the cash they received in payment in banks’ deposit facilities or use the services of cash-in-transit companies. The cycle is closed by cash-in-transit companies bringing back cash to cash centres, where it is checked to be recirculated or replaced.

The figure below synthesises this cash cycle and materialises the border between the public and the private infrastructure. Public involvement is limited to the wholesale side, while all retail aspects are devolved to the market. This is worth noting as the same type of organisation and division of labour between the public and the market is considered for the digital euro (as we’ll see in the next chapter).

Figure 1: The cash cycle and its public/private division of labour



Source: author’s elaboration

The issuance of cash doesn’t follow a for-profit motive but can be viewed as public service tasks: this should make cash a public good. But first, as access to cash is only possible via commercial banks⁷, the same restrictions apply as for book money: one needs to be financially included to be able to access it. Foremost, as all retail aspects of the distribution of cash are in the responsibility of private actors, the actual supply of cash is conditioned on its profitability for all the actors involved in its cycle. Cash-in-transit companies, commercial banks and

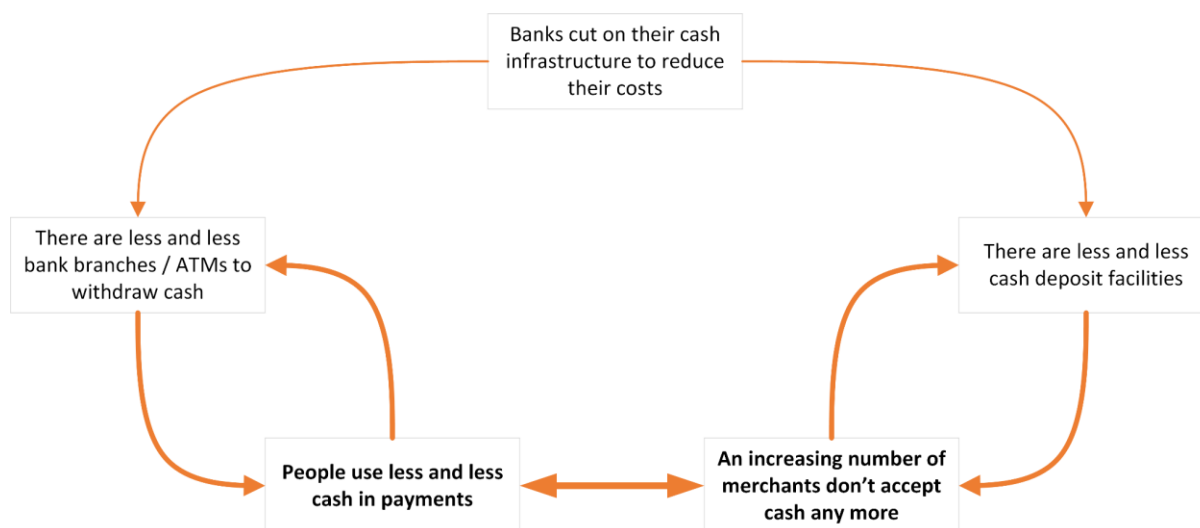
⁷ Besides directly accepting it in payments, but salaries have to be paid on a bank account.

independent ATM deployers all need to earn a profit on cash handling in order to effectively provide it to the economy. When it's not the case, it is the entire cycle which is jeopardised.

According to some experts, we would simply be naturally moving towards a “cashless society”. According to this narrative, consumers increasingly prefer to pay using digital means of payment (ECB, 2020d), so they turn away from cash while the market simply adapts to this evolution, notably by closing bank branches and shutting down ATMs. But rather than a true choice from its users, it is the profitability constraint put on the cash cycle that is the main source of its current breakdown. The Euro Retail Payments Board itself notes that “there are increasingly voiced concerns that access to cash and banks’ cash service levels is generally deteriorating” (ERPB, 2021).

As cash is increasingly seen as a source of costs for those who have to supply it, the number of cash access points is being rapidly reduced - which makes access to cash more difficult. At the same time, the availability of deposit facilities is also reduced, while it is the main factor of acceptance of cash on the merchants’ side. The cash infrastructure is stuck in a vicious circle, with two feedback loops that have as a common origin the for-profit motive, as synthesised by the following diagram.

Figure 2: The profitability pressure put on the accessibility and usability of cash



Source: author's elaboration

Indeed, an opinion widely shared in the industry is that the cash infrastructure is under mounting pressure and getting close to a tipping point, beyond which it will no longer be sustainable. As the number of cash transactions decline, the cost of the cash infrastructure increases: “The lower the share of cash payments, the higher the relative costs for maintaining the infrastructure/equipment and for using cash services of CIT companies, as these are to a large extent fixed cost.” (ERPB, 2021) As profitability cannot be reached any more below a certain level of cash usage, cash services by commercial banks and other actors of the cash cycle are now on the verge of dying out. Several governments are considering taking action and making cash a true public good, the cost of which needs to be socialised to support its public function (see for example, in the case of the Netherlands, van Anholt (2022)). This is particularly the case in countries where digitalisation is more advanced.

Regarding cash - similarly as for other means of payment - the position of the ECB is one of “neutrality” (as stated by the institution itself): it does not want to interfere in “consumers’ choices” about means of payment and puts the emphasis on “the principle that every individual in the euro area should be able to decide how to make day-to-day payments” (Zamora-Pérez, 2022). But the dynamics at work within the cash infrastructure should lead to question the effectiveness of this freedom of choice for users, largely reduced by the liberty of the market to choose the services to offer. The commitment that “The Eurosystem will continue to offer banknotes and support their usability *as long as people demand them.*” (ECB, 2022), our emphasis) is therefore quite short-sighted. As stated by a member of the Executive Board of the Deutsche Bundesbank: “as central banks, we should not stand passively on the side-lines. To the extent that the decline in cash usage is not due to demand-side but supply-side adjustments, central banks need to pay close attention. Being neutral with respect to consumer choices does not mean that we remain passive.” (Beermann, 2022)

This potential passivity also applies to the enforcement of the legal tender status of euro coins and notes. Despite them having to be accepted in payments by all merchants, an increasing number of them shift to cashless, in contradiction with this principle. Unclear EU legislation gives room to interpretation of this principle, but even in countries where it is legally enacted, it is little applied as no controls exist and no sanctions are imposed.

As we see, cash that is issued as a public good actually transforms into a club good when its (mostly privately run) infrastructure is taken into account. These evolutions of the public/private cash infrastructure should be kept in mind when deciding upon the infrastructure for the distribution of the digital euro (the introduction of which is precisely motivated on the basis of a declining use of cash).

b. The payment cards infrastructure

Although our card payments are completed in just a couple of seconds following a simple tap, they involve a complex infrastructure. If at each end of a card payment are two banks (the payer’s and the payee’s), these two banks do not settle payments by themselves: they need intermediaries to establish point-of-sale interfaces for merchants and their customers, to organise and route communications among them, and to exchange their respective euros⁸.

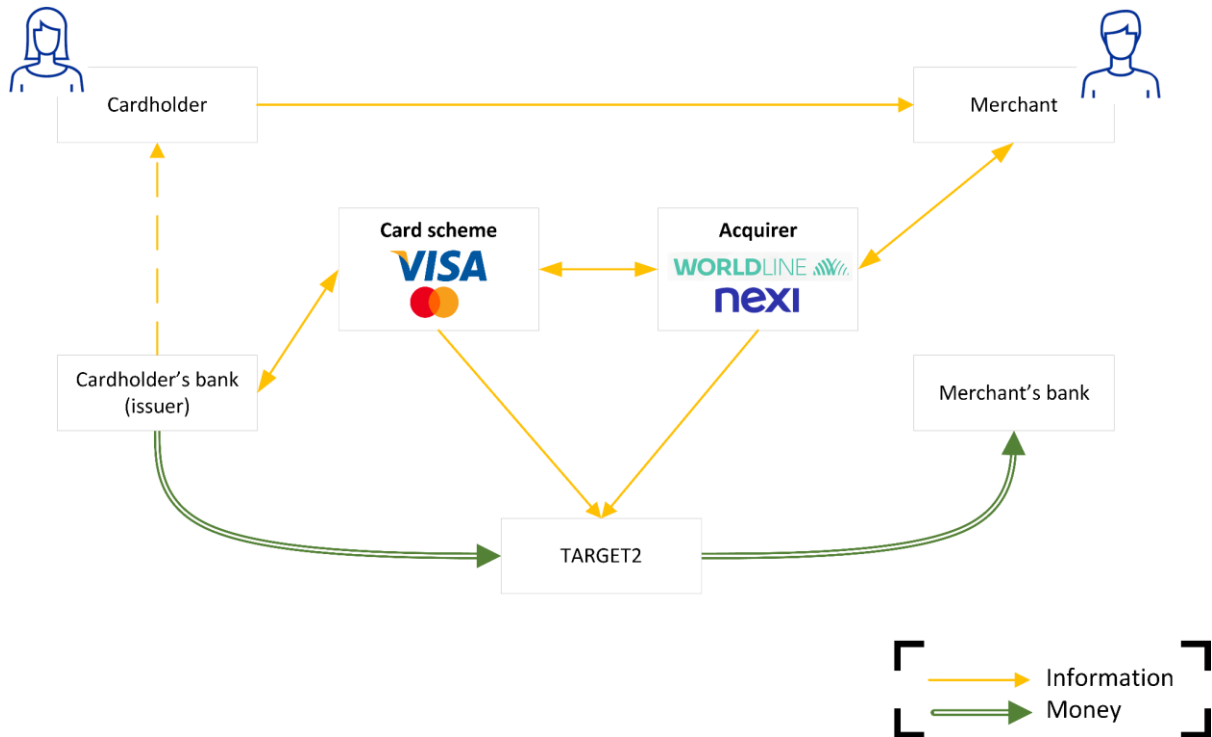
The following diagram represents the typical organisation of a card payment, called the four corners model⁹. In each corner we find: the payer who’s the cardholder, the payer’s bank who’s the issuer (the bank issued the card), the payee, and the payee’s bank. Between these two banks are two central actors:

⁸ From the user’s perspective, electronic euros are undifferentiated but in fact there are “Bank A euros”, “Bank B euros”, etc.: as many coloured euros as they are Euro Area banks, with these various euros not directly fungible with each-other.

⁹ In opposition to the three corners model of card payment where issuing and acquiring are integrated and carried-out by the same entity: that is the case of American Express. This model is marginal compared to the four corners model.

- The acquirer, that allows the initiation of the payment through its point-of-sale payment terminals (or online payment gateways) and receives confirmation of the payment. In Europe, the two main acquirers are Worldline and Nexi¹⁰.
- The card scheme, that communicates with the issuing banks (via standardised protocols it developed for and with the banks) and receives and transmits the authorisation of the payment. In Europe, the two main card schemes are Visa and Mastercard, handling around 70% of European payments.

Figure 3: The typical organisation of a card payment



Source: adapted from SPF Economie (2019)

As with cash, the various private actors involved in the payment chain have to remunerate themselves: the acquirer pockets a “service fee”, the card scheme takes a “scheme fee” and the issuing bank receives the “interchange fee”. These different fees make up the “merchant service charge” that is paid by the merchant to the acquirer and then distributed along the payment chain. As any other merchants’ costs, payment costs are included into prices and passed on to the end consumer.

This four corners model remains the core of our current payment systems despite new entrants in the payment space. “Bigtech” companies plug into it, but do not fundamentally disrupt it: Apple Pay, Google Pay and the likes are “overlay systems” that just add a new layer (at the payment initiation stage), marketed as enhanced user-experience - but aiming at capturing personal payment data.

¹⁰ Let us note that both of them are members of the Market Advisory Group set-up by the ECB for the Digital Euro project (ECB, 2021b) and have been selected for the prototyping of the front-end payment solutions of the Digital Euro (ECB, 2022g).

What should be noted at this point is that “payment systems constitute markets of their own, where providers of payment services compete for customers” (Bergman, 2020: 34). As Scott (2022: 33) puts it: “in addition to the original supply and demand [of the goods and services exchanged], we must add supply and demand for the resolution of supply and demand”, that is for payment services. We’ll see in the next section that this can lead to a sub-optimal situation from a societal perspective. Especially because the customers of payment services providers are not only individual users (whether them being citizens or merchants) but, most importantly, banks. The interests of these different customer types are not necessarily aligned and can be at odds with societal perspectives.

Current payment systems involve actors interested in maintaining high fees or access to personal payment data. This can prevent any change even if it’s initiated by the industry itself, as illustrated by the failure of the European Payments Initiative (EPI), an initiative founded in 2020 by 31 European banks and 2 payment services providers with the aim of creating a pan-European payment system, intended to become the new standard for payments across the EU with a European card scheme and wallet. As various banks from several countries withdrew from the project, in March 2022 only 13 stakeholders confirmed their continued participation in the initiative. As a result of these defects, the EPI had to give up on its European card scheme plans (Pincovski, 2022), despite this effort originating from within the industry.

As a digital euro is meant to foster competition and innovation on the market for payment services, it will have to tackle present vested interests to achieve this goal.

c. Eurosystem’s TARGET2 Single Shared Platform (SSP)

We saw above the central role of private payment services providers in current payment systems. As shown by the previous diagram, these providers don’t directly channel money. They channel information (via standardised messages) that ultimately allows money to flow from one account to the other. These interbank settlements take place in wholesale central bank money and through TARGET2.

TARGET2 is owned and managed by the Eurosystem and is based on a central system known as the Single Shared Platform (SSP). It has been developed and provided by three European central banks (the Deutsche Bundesbank, the Banca d’Italia and the Banque de France). This makes TARGET-2 a good example of in-house development, by public European institutions, of an integrated and efficient payment system. This contradicts the argument - defended today at the highest level - according to which the ECB would be unable to develop a new system for the digital euro by itself, since it would have neither the capacity nor the required expertise. But public ownership of such an infrastructure is crucial given its systemic nature, and TARGET2 shows that such an endeavour for the digital euro is feasible for the European system of central banks.

The functioning of TARGET2 also illustrates the operational role that central banks can have in payment systems. In the case of this wholesale payment system, each national central bank is in charge of managing relationships with the national participants to the system, including opening accounts and offering assistance services. This shows that central banks can have customer-facing activities (also contrary to the current narrative). Many will argue that

managing operations only with a limited number of specific agents (in this case, mostly banks) is incomparable to providing services to the entire population of a country. Yet, historically, central banks had a much larger footprint (in particular in terms of branches) and thus a much bigger operational capacity. In France for example, until the end of the 1960s, the Banque de France had 259 branches, with financial services offered directly to the population. This potential operational capacity should also be kept in mind for the distribution model of a digital euro.

B. The (unfulfilled) promises of the public / private division of labour in money

The “hands-off” approach of public institutions in general and central banks in particular in relation to payment systems is supposed to be for the best, as market participants are deemed to be more efficient for the development and provision of payment services. But as we’ll see now, this approach falls short on several aspects, calling for a more ambitious role to be played by public money.

1. The central bankers’ view on public money

Following Fabio Panetta (2022d), “The consensus among central banks on the coexistence between public and private money was summarised 20 years ago”: it has been laid down by the Committee on Payment and Settlement Systems of the Bank for International Settlements (CPSS, 2003). It formalises the principle of “multiple issuers, one currency”: while the currency is defined and controlled by the central monetary authority, money is issued by private banks. This multiplicity of issuers has to foster competition, innovation and efficiency, thus leading to an optimal monetary system. In this architecture, central bank money is recognised as having particular qualities in comparison to private money: safety, availability, efficiency, neutrality and finality. But as the role of the central bank in payment systems has so far been limited to one of a “settlement institution”, central bank money is viewed as a simple “settlement asset”. It is there to be put at the service of private monies in order to allow their convertibility and thus to ensure money “singleness” or “uniformity”.

This doctrine becomes quickly outdated but still frames the views of central bankers in regards to the operational role to be taken by central banks. It implies that access to central bank money (via accounts at the central bank) is to be available only to a limited range of entities. Furthermore, “central banks do not in general want to compete with commercial banks in providing banking services to the public.” (CPSS, 2003: 3) So while Carstens (2019) refers to “central bank public goods”, in this central bankers’ perspective public goods are only about “giving the private sector greater scope to innovate”, as central banks are only there to “amplify the efforts of private sector innovators, by giving them a solid base to build on.”

Central bankers claim that there is a “symbiotic” relationship between central bank money and commercial bank monies: in this mutually beneficial relationship, all would be well. But this approach shows many limits calling for a more substantial approach to central bank public goods.

2. The issues of the current monetary system, all the more deepened in a cashless society

In their current organisation, our monetary systems exhibit important economic, social and political issues.

a. Economic inefficiencies

By far the main argument among central bankers for having no direct role in payment systems is to ensure competition on the payment services market. Following standard economic approaches, competition is the best way to ensure efficiency: market forces lead to the most optimal situation for all parties. But this argument has no real bearing when it comes to money. Money is a network good whose use produces positive externalities. In the same way that it makes the most sense to join the social network already used by the largest number of people, it also makes the most sense to join the most widely adopted payment network. As a consequence, payment markets can see the emergence of oligopolies (or monopolies), following a “winner takes all” dynamic. In economic terms, the contestability of payments markets is very low, as new entrants are unable to enter them. As we’ve already seen, it is the case for the card payments market in Europe, largely dominated by two players. In several cases, these market actors adopted abusive practices that are made possible by their dominant position.

Besides network effects, payment markets also have the particularity to be two-sided. On a normal market, there is a seller on the one hand and a buyer on the other. But on payment markets, there are two types of buyers: payment services providers have to recruit on both the issuing and the acquiring sides (Bergman, 2020). Concretely, for a payment card scheme to be operational, it needs to be joined by both banks (on the issuing side) and merchants (on the acquiring side). So card schemes operate on two-sided markets: they have two types of clients, whose interests may not align. In this case, competition can actually operate at the expense of those supposed to benefit from it, as competition can have the paradoxical effect of raising costs for users. Indeed, as card schemes compete to recruit banks, they are incentivised to offer them higher interchange fees (what the issuing bank receives for each payment). This translates in higher merchant service fees, and ultimately into higher payment costs for consumers. So despite the claimed beneficial competition, costs of payments are not pushed down, but remain high and even show tendencies to increase: “According to EuroCommerce, the average cost of card acceptance in Europe is now even higher than in 2015.” (ERP, 2021).

Finally, the concentration inherent to payment markets is a source of systemic risk for economies. As they rely for their activities on the functioning of centralised private systems, they show very little resilience in the event of technical issues. As recently shown by nationwide payment card systems outages (in both Norway and Germany in May 2022), these events disrupt all socioeconomic activities that now depend on them, with high costs for economic agents.

b. Social inequalities

Besides economic inefficiencies, private payment systems also exhibit strong social inequities. Not only are their costs kept high, but their cost structure is also unfairly distributed across

socioeconomic segments of the population. Those at the bottom of the income distribution pay a disproportionately high price for their payment services, in comparison to those closer to the top of the income distribution. The poorest are therefore those on which most of payment costs fall and those who contribute the most to private payment systems' revenues. This is also true of businesses: the smallest are the ones bearing the highest payment costs.

To different means of payment are associated different costs, and - more and more - are also attached different advantages for those using them. High-end premium payment cards come with various benefits, from cash-back programs to personal concierge services. As the ownership of the different types of cards is highly correlated with the socioeconomic status of each person, it is the wealthiest who benefit the most from these advantages. Taken together, unfairly distributed costs and benefits of private payment systems result in a net transfer from the poorest to the wealthiest: private payment systems have regressive distributive impacts (Felt et al., 2021; Schuh et al., 2010).

Beyond these pecuniary aspects, the segmentation of payment products illustrated by the several levels of cards available also mirrors and reinforces socioeconomic inequalities. In the same way as a premium card is a visible sign of positive distinction in society, low-end payment methods are increasingly stigmatising for those forced to rely on them. Combined with the financial exclusion that affects part of the population, particularly vulnerable groups, the societal implications of payment tools also need to be understood.

c. Societal risks

The dependence on centralised private payment systems and the associated lack of resilience can translate into economic costs, but also exposes society to other sources of systemic risks in payment systems - even more prevalent in the current uncertain context with the multiplication of natural disasters, conflicts, cyber-attacks, ... Payments systems should be considered as critical public infrastructures that need a dedicated management mode. It is also relevant to national and European sovereignty when payments are dominated by foreign companies as they are today, in as far as they can be "weaponized" as part of sanctions or retaliation measures, as recent events also showed.

Additionally, the digitalisation and associated privatisation of money and means of payment leads to an increasing collection and use of payment data. This can lead to unfair commercial practices from private companies, as well as to negative impacts for citizens' civil rights (CNIL, 2022).

C. Public money and the digital euro

The digital euro should improve our monetary system and tackle its current problems and inefficiencies. For this it needs to be considered in its role of public money.

1. Public money as currently viewed as part of the digital euro project

In European central bankers' talks, the public nature of money can appear to be given significant importance as part of the digital euro project. It is often with this theme that speeches are opened: "if we are to preserve a stable and reliable payment system in Europe, we need to preserve the role of central bank money in the digital age." (Lagarde and Panetta, 2022). And "The primary policy objective of a digital euro would be [...] to ensure that public money remains widely accessible and usable for daily transactions." (Panetta, 2021e)

Yet, past these opening remarks, this public money aspect is given little substance. Most crucially, the public dimension of a digital euro does not come into being in the planned operational implementation of the digital euro project. The approach followed remains fully in line with the traditional doctrine described above, despite it appearing quite dated in the face of the new avenues that CBDCs open up for central banks. The plans for implementing a digital euro put the emphasis on private intermediaries and give only limited operational roles to the central bank. A digital euro would be offered to the public via these same intermediaries, and the ECB refuses to consider any concrete implication, to such an extent that the digital euro is not meant to be a full-fledged innovation, but a mere "raw material" provided to the private sector for it to offer its own services:

"we don't want to use the digital euro to change the structure of the financial system or to destabilise the functioning of the financial sector. Banks already provide citizens with a large number of services, and in the future they would add access to the digital euro as one additional service to build a business model with the "digital euro inside". [...] What we want is for the digital euro to be a sort of raw material that we would hand over to banks to provide the services they are providing now, plus access to the digital euro, in the same way they're already providing access to cash." (Panetta, 2021d)

"A digital euro [...] would be designed to be interoperable with private payment solutions and would thus represent the "raw material" that supervised intermediaries could use to offer pan-European, front-end payment solutions." (Panetta, 2020)

Far from being considered as a true new payment option, the digital euro is mainly seen as a "monetary anchor", as extensively developed by Panetta (for example in Panetta, 2021a). This anchor is provided mostly to ensure the convertibility of the various forms of private money. Approached in this way, a digital euro runs the risk of replicating the same issues that the current monetary system exhibits and that have been highlighted here.

2. A genuine public money fit for the challenges of our time

The introduction of a digital euro is an opportunity not to be missed. An occasion to reinvigorate the fundamental public nature of our money, for it to be geared towards the public interest. An occasion to decommodify our means and payment, for them to become safer, fairer and more inclusive. Really tackling the challenges that our monetary system currently faces cannot come down to simple market fixes, but needs bold action that would make the digital euro a true public good. Not in the narrow sense that central bankers give to this concept, but in its full sense.

Concretely, a digital euro needs to be a public good from a socioeconomic perspective: it has to be universally accessible and usable, and mostly free to use. For this purpose, a digital euro needs to be a publicly owned and run infrastructure. But it also needs to be a public good in the more civic sense: it needs to attract a sense of collective ownership, for citizens to be able to relate to it. In the following chapter we will see what design options of a digital euro would fit for these tasks.

II. A digital euro for a safer, fairer and more inclusive monetary system

This chapter assesses the key design options open to the European Central Bank (ECB) while it prepares for the implementation of a digital euro. Design choices are of crucial importance for the way the digital euro will operate in practice, the services it may or may not provide and the functions it will be able to fulfil. Furthermore, **design options currently being tested in the investigation phase may later induce policy constraints** and greatly influence how attractive the future digital euro may be. Design choices are key factors in shaping a digital euro fit for purpose.

We first show that a digital euro could come in different shapes as various operating models possible. We then assess these different operating models in light of the benefits a digital euro could bring to Europeans, as a safe, more accessible, respectful of privacy, resilient and cost-free digital means of payment. We finally contrast this approach with the one followed by the ECB, which appears to have a different policy goals hierarchy.

A. What kind of digital euro? Broadening the view on CBDC operating models

A CBDC is first and foremost a means of payment, denominated in the unit of account¹¹ of the official currency. The nature of this means of payment, as well as the features that it will have, are determined by two main aspects: its **institutional organisation** and its **technical infrastructure**. These two aspects need to be considered together in order to assess which functions can be carried out by a CBDC and the opportunities it can bring to people and societies.

- The institutional organisation of a CBDC relates to whose claim it is (its legal framework) and how it comes into existence (the ways it's issued and distributed).
- The underlying technical systems of a CBDC allow it to fulfil its functions: in particular, they determine how CBDC units are transferred between users.

The following discussion about the design options will therefore encompass these two distinct aspects. While they are interrelated, in policy discussions they are most often considered independently from each other. Here, we will consider them together and bring a broader view on CBDC design. Available options will be specified and weighed against their benefits for citizens and business as well as policy goals.

1. CBDC architectures

A first criterion to assess crucial CBDC design choices relates to how it will be issued and distributed among users: that is the CBDC architecture. Various design options have been

¹¹ Money is usually considered as fulfilling three “functions”: unit of account, means of payment and store of value.

discussed in the literature. Yet, there is no established typology for these potential architectures and different terms can be used, which can bring some confusion in policy discussions. Thus, we start by mapping out the different options and clarifying the terminology.

The first design choice relates to the issuer, *i.e.* whether the CBDC should be issued directly by the central bank or by intermediaries (commercial banks in particular). In other words, which entity writes down the CBDC unit as a liability on its balance sheet while the same unit is being held as an asset by end-users. In most models, a CBDC must be a liability of the central bank, though there are some exceptions.

Other options relate to the management and the distribution of CBDC units, in which the central bank and intermediaries can have various levels of operational involvement:

- CBDC users' accounts can be kept by the central bank itself or by intermediaries only; in the latter case the central bank only sees aggregate balances.
- Retail payments can be processed by the central bank itself or by intermediaries, in the latter case the central bank only processes wholesale payments.
- Finally, end users can interact either with the central bank or with intermediaries for accessing and using the CBDC.

The following table summarises the characteristics of these different CBDC architectures, bringing together terminologies used by the International Monetary Fund (Soderberg et al., 2022) and the Bank for International Settlements (Auer, Frost, et al., 2021; Auer and Böhme, 2020, 2021; BIS, 2021a).

Table 3: Major characteristics of different CBDC architectures

CBDC architecture (IMF)	CBDC architecture (BIS)		Claim on central bank	Central bank records retail balances	Central bank handles retail payments	Central bank interacts with end users
Unilateral CBDC	Single-tier	Direct CBDC	☑	☑	☑	?
Intermediated CBDC	Two-tier	Hybrid CBDC	☑	☑	✗	✗
		Intermediated CBDC	☑	✗	✗	✗
Synthetic CBDC	Alternative design	Indirect architecture	✗	✗	✗	✗

Source: author's elaboration

A **unilateral / single-tier direct digital euro** would be managed and distributed by the Eurosystem (*i.e.* the ECB itself and the national central banks of the eurozone). Retail balances would be recorded on the ECB's books and payments would be handled by the ECB, meaning they would run through the institution's own payment systems. While it is often argued that in this model the central bank would have to perform all end-users services

(including onboarding, KYC, AML/CFT¹², ...) - which would be too much of a burden for it, this model does not rule out the implication of intermediaries for front-end services (while the Eurosystem would take care of all back-end services).

A **two-tier digital euro** would be a claim upon the ECB while being largely managed and distributed to the general public through private intermediaries. In practical terms, the ECB would make units available to selected intermediaries (mostly likely commercial banks), who would then distribute these units to end-users. Intermediaries would issue digital euros to the general public against bank deposits, converted at the demand of end-users. This would be very much akin to the way physical cash is issued today.

In the **hybrid** version, while the distribution of the digital euro takes place through intermediaries, the central bank records retail balances (that is, balances of all end-users) on its own books. In both cases, payments would be handled by intermediaries.

In the **intermediated** version, the central bank only records wholesale balances (that is, aggregate balances of intermediaries) while individual digital euro holdings remain on intermediaries' books.

Finally, a **synthetic / indirect digital euro** would be issued by intermediaries (mostly private banks) and backed by assets acquired from the central bank. As a result, digital euro units would be liabilities of each particular intermediary in the very same way as book money today (see chapter 1). Therefore, it could not be considered as a retail CBDC¹³: this option will not be explored in this report (this option has also been excluded by the ECB for the digital euro).

Deciding upon the architecture of the digital euro calls for a proper look at which functions are best fulfilled by what type of actors. Which functions should be taken care of by the Eurosystem and which could be delegated to intermediaries? If some functions are to be operated by intermediaries, what type of intermediaries would be fit-for-purpose, i.e. would bring the most value to European citizens? We'll explore these questions in the remainder of this chapter.

2. CBDC transfer mechanisms

The taxonomy presented above, which focuses on who would provide front-end services to the general public, is insufficient to fully grasp how CBDC design impacts its features. The second main difference between potential CBDC operating models relates to the way units are transferred and registered on accounting and ledger books. Here, two types of transfer mechanisms should be considered.

Account-based systems means that transactions must be cleared on the books of a financial institution (be it the central bank or an intermediary). When conducting a transaction, the end-

¹² The "onboarding" is the registration process the user goes through, conducted by the service provider to fulfil its Know Your Customers (KYC) obligations, in particular for the purposes of Anti-Money Laundering (AML) and Countering the Financing of Terrorism (CFT).

¹³ This "model is not a CBDC, but rather a stablecoin, or a special type of e-money, as it is not issued by a central bank and may be referred to as synthetic CBDC or sCBDC. But as it is backed one-to-one by central bank-issued assets, it may be considered by some central banks as an alternative to CBDC" (Soderberg et al., 2022).

user has to interact with this institution, which will transfer units on the user’s behalf by altering the records of his/her account.

Value-based¹⁴ systems imply that the units in circulation exist in themselves: they do not need to be traced to a definite account on a balance sheet to be verified. This is the case of physical cash: when conducting a transaction in cash, the payee only has to check the authenticity of the instrument (notes and coins). The same can apply to digital tokens.

It should be noted that these two types of transfer mechanisms are not necessarily associated with a particular underlying technology. More precisely, an account-based system is not necessarily based on centralised standard databases, while a value-based system is not necessarily based on distributed ledger technologies (DLT)¹⁵. Different technologies will have various advantages or limitations, but they do not constrain the choice of a transfer mechanism (nor of a CBDC architecture). If DLTs are promoted by some actors for their innovative uses-cases, they have also been shown to have technical limitations when used for a retail CBDC (in particular regarding their capacity to handle a sufficient amount of transactions)¹⁶.

3. Four main operating models

One can already see from this introduction how the general term “CBDC” lacks the depth needed for the general public and policy makers to be fully aware of what is at stake. Based on aforementioned CBDC architectures and transfer mechanisms, we map-out four major options to be considered, as summarised by the table below. These four models will serve as a basis for the rest of this chapter, in order to discuss their implications from users’ perspective. Benefits to be expected for users discussed below tightly depend on the choice of operating models: it thus requires deepest attention from the authorities and the general public.

Table 4: Four main CBDC operating models

		Transfer mechanism	
		Account-based	Value-based
Issuance and handling	Single-tier	M1 Direct CBDC account	M2 Direct cash-like CBDC
	Two-tier	M3 Intermediated CBDC account	M4 Intermediated cash-like CBDC

Source: author’s elaboration

¹⁴ Also referred to as *token-based*, but this latter term sheds confusion regarding the use of DLT technologies, which is no way required for this transfer mechanism.

¹⁵ DLTs build on the technology popularised by Bitcoin, the blockchain, to decentralise the management of data. For monetary applications, transactions are recorded in a shared ledger maintained by numerous nodes rather than by a unique central actor.

¹⁶ For a discussion of the use of DLTs for CBDCs, see Guo, Kreitem, and Moser (2022).

While these four models are distinguished here for the clarity of the discussion, it is important to note that **they are not mutually exclusive: a digital euro could combine several of them**. In what follows, we will indeed argue that a digital euro should follow more than one of these models, as important synergies are to be found between them. Each model yields different properties and advantages for the general public so it should be considered how several models could co-exist.

4. The operating model currently considered by the ECB as part of the digital euro project

We have already stressed that in the current state of the ongoing investigation phase, the ECB considers to provide the digital euro only as “raw material” that the private sector would then supply to end-users (see chapter 1). We can now give a more precise description of this approach in terms of operating model.

The ECB “Report on a digital euro” (2020c) already stated that “While the Eurosystem would always retain control over the issuance of a digital euro, supervised private intermediaries would be best placed to provide ancillary, user-facing services and to build new business models on its core back-end functionality. A model whereby access to the digital euro is intermediated by the private sector is therefore preferable.” More recently, Panetta (2022c) declared without much room for interpretation that “intermediaries will be responsible for transaction management tasks, in a similar manner to current payments. This means they will be responsible for initiating transactions in digital euro, as well as customer authentication and transaction validation”.

As currently being considered by the ECB, the digital euro would thus most likely follow a two-tier account-based model (M3) with intermediated CBDC accounts. This has been made very clear to the members of the digital euro Market Advisory Group and of the Euro Retail Payments Board: “While digital euro will be a direct liability of the Eurosystem, accounts/wallets are to be opened by supervised intermediaries: no direct contractual relationship shall exist between Eurosystem and citizens” (ECB, 2022a, 2022c). The digital euro would only be a “payment scheme” (ECB, 2022b), that is a platform on which private intermediaries would build their own services.

An offline option is also considered for the digital euro. It would most certainly need to be a value-based solution, complementing the account-based one. But this option is currently only “[explored] beyond the baseline scenario” (Witlox, 2022): its implementation is still uncertain and its details remain unclear. But following the ECB mindset, it would most certainly also proceed from a two-tier logic and offer an intermediated cash-like CBDC (M4).

B. CBDC design options from user’s perspectives: making the digital euro serve the people

In order to assess which operating model(s) would be best suited for a digital euro, we explore how much concrete benefits they would bring to its main users: Eurozone residents and businesses.

1. A liability of the Eurosystem broadening access to a genuinely risk-free asset

As explained above, the proper issuer of the digital euro would be the institution that holds it as a liability on its balance sheet and thus maintains a legal relationship with the end-user. In other words, the issuing institution is liable to the owner of the digital asset through law enforced mechanisms.

In a direct account-based CBDC model (M1), the central bank directly issues the digital euro to the public and has the responsibility to manage accounts on its own books on behalf of those account holders. In such a scenario, no other legal entity stands in-between the central bank and end-users. Just as with banknotes, citizens and businesses thus hold an “I owe you” (IOU) issued by the Eurosystem, that is a direct claim on the ECB. Third party intermediaries could still be involved in such a scheme with PSPs connecting to the system hosted at the central bank, to manage transactions orders, but the accounts would remain on the books of the ECB.

The direct value-based model (M2) also translates into a IOU / claim relationship between the central bank and end-users, but changes the nature of the claim from account-based to unforgeable tokens that can be directly held by end-users. This form of value-based digital euro would still be a direct claim from the end-user upon the central bank. However, though the claim exists, the token allows for flexible peer-to-peer transactions just as physical cash does. This token feature of the value-based model is similar to a banknote serial number. This model would be the most “cash-like” digital euro in terms of direct claim and circulation properties (as well as level of anonymity as discussed below).

Two-tier models involve regulated intermediaries that hold the CBDC on their books, even though CBDC units remain issued by the central bank. This makes them very much dependent on the current banking system, as private banks would be the main type of intermediaries involved.

- The intermediated CBDC account model (M3) allows end-users to hold accounts in the same way as bank deposits currently do. Intermediaries not only manage CBDC accounts of digital euros but also hold counterparts on the asset side of their books. This solution provides little competitive advantage and leaves commercial banks unchallenged, as we discuss throughout this chapter. In such a case, the same private actors would serve as user-facing intermediaries, managing accounts and providing customers services in the same way as they already (sometimes insufficiently) do.
- The intermediated value-based CBDC model (M4) would mean that tokens are created by the private intermediary with central authority oversight. Private intermediaries would manage access to wallets for end-users and validate transactions.

In both two-tier models discussed above, private intermediaries play an important operational role. As a consequence, it is not clear that such a digital euro would become the safest asset class available to the general public. These models raise questions about the integrity, the value and the legal framework of the issued units. The digital unit would hardly constitute a claim on the central bank, or would only be an indirect claim. In any case, private intermediaries would be the liable entities for all digital euro related issues.

One of the objectives of a digital euro should be to broaden access to a risk-free asset similar to physical cash today. To ensure this, a digital euro needs to be a direct claim on the Eurosystem / a direct liability of the ECB. Single-tier models (M1 and M2) are more fit for this purpose.

2. An accessible and inclusive means of payment

As seen in chapter 1, we're not equal in our ability to access and use payment services. Opening an account at a bank may be a hassle, as private banks are selective with offering their services to clients. As a result, a minority finds itself unbanked or underbanked, i.e. unable to access and properly use all financial services necessary. In the context of massive digitalisation of payments, marginalised groups can increasingly be victims of monetary exclusion if they do not have access to all types of means of payment, digital in particular.

This state of affairs already suggests that we should opt for a CBDC model that is conducive to financial inclusion. As they rely on private intermediaries, two-tier models (M3 and M4) could show the same exclusionary patterns as those associated with commercial bank money. Indeed, there is no reason for private institutions to welcome less attractive clients just because a digital euro has been introduced. They would still offer their services - including digital euro services - following market terms and for profit motives.

Single tier models do not rely on private intermediaries and allow for direct access to CBDC accounts and services offered by central banks. And central banks do not operate on the same terms as private intermediaries. As noted by Panetta (2021d), "We're not a profit-maximising institution, we work in the interest of citizens. So we're a different animal than private service providers." This "different animal" could thus better provide for segments of the population that are usually under-served by the market. Thus, single-tier models (M1 and M2) should be considered if a digital euro is to serve financial and social inclusion objectives. This would not contradict central bankers' doctrine, as "central banks typically open accounts only where there are good public policy reasons for doing so" (CPSS, 2003).

This direct provision of CBDC services is an option considered by the Swedish central bank, for example. Recognising that it "would entail a completely new role for the Riksbank", they recognize the fact that the market is not going to accommodate all needs and consider that "It could also be possible to implement a small-scale version of this [direct] model where the Riksbank would provide a basic supply of services that could for instance be catered to the needs of vulnerable groups." (Nessén and Söderström, 2020) We believe the ECB should also look into that direction if it is to really work in the interest of citizens, as claimed by Panetta and other ECB executive board members.

This direct option would allow for the digital euro to be non-exclusive and non-rival, thus truly becoming a public good. Indeed, as long as intermediaries are in a position to "filter" end-users at the entrance of the ecosystem of the digital euro, we're missing the target of overall inclusivity that should be expected of a public good. Rather than forcing private institutions to increase access (which proved to be inefficient, as the insufficient enforcement of the right to a bank account shows), the ECB could take matters in its own hands and provide the public with an easily accessible, freely available means of payment.

Technology would greatly facilitate this option. For instance, the ECB already plans on developing and providing a “digital euro app” (ECB, 2022d). But it doesn’t plan to make it directly accessible to the public: the app will only be provided to supervised intermediaries, who would only have to add their own logo on it to start to distribute digital euro services. The ECB could, without much more investment, make this app directly available to citizens, under its own ECB “brand”. As many other apps show, onboarding could be done directly via the app and automatised¹⁷. Only if directly provided to citizens could this app “increase the choice for end users [...] and contribute to ensuring financial inclusion” as claimed by the ECB (*Ibid.*).

a. A diversified intermediaries landscape

We emphasised above the limits that two-tier models would have for financial inclusion. In doing so, we assumed that intermediaries would be *private* intermediaries. That is the position followed by the ECB: the digital euro is to be provided by intermediaries and these intermediaries are to be private ones. Yet, two-tier models do not need to rely only on private intermediaries. As stated by the IMF itself: “Most [intermediaries] would likely be privately-owned and for-profit firms, but state-owned intermediaries and cooperatives may also be involved.” (Soderberg et al., 2022)

This avenue is completely unexplored by the ECB’s digital euro project, but it merits serious investigation if the digital euro is to add real value for citizens. The direct option does not necessarily mean that the ECB provides all services attached to accounts by itself - indeed, this might be considered impractical. The central bank might also rely on a broad range of potential intermediaries to make the digital euro flow throughout the economy: commercial banks and other private intermediaries but also more traditional businesses (following the “agents” model implemented for mobile money systems) and public entities – who sometimes already are regulated for providing payment services. In other words, building an independent infrastructure does not ultimately require the central bank to internalise all processes.

For example, postal networks, public service centres, digital public spaces¹⁸, ... could also be intermediaries for the digital euro. They would ensure territorial outreach (while private bank branches tend to close down) as well as social inclusion (for people in a situation of financial exclusion or without access to digital services). Public options for the access to and the use of the digital euro would be necessary complements to private ones. Besides increasing the digital euro inclusiveness, they would also assert and give substance to its public character. Though often asserted in central bankers’ speeches - “creating a digital euro must be a public project” (Lagarde, 2022b) - it has still to be given a concrete reality.

The role played by intermediaries has major impacts on access and thus on inclusiveness: public access options might be best suited to onboard all Europeans, including already marginalised ones.

¹⁷ For example by taking a picture of the required document(s) and of oneself, which can be automatically processed and analysed (including via artificial intelligence).

¹⁸ Spaces dedicated to supporting the public in their uses of digital technologies.

b. Tiered identification for an account-based digital euro

For account-based CBDC models, more suitable for larger amounts, identification is necessary, as the account holder must be properly identified. So citizens willing to access an account-based digital euro may need to go through a registration process (for KYC/AML/CFT compliance), which could require the same level of identification and validation process as with regular bank accounts. For users, this means having an identification document recognised in the European Union and having a residency address in a Euro area country¹⁹. This identification requirement may impair access to digital euro for homeless people, refugees, migrants, displaced persons, ... Yet these persons still need an account, at least to transact for their everyday needs, as well to potentially receive aid or welfare benefits.

The solution we recommend in this case would be to implement account tiering, based on different identification levels. Accounts would be opened with cumulative KYC steps and accounts would be associated with different levels of limits depending on the KYC steps completed. For instance, it should be possible to open an account with just a simple identification element, such as a mobile phone number or an email address. Further KYC steps could be to provide a proof of residency, a valid ID document, and link a bank account. Each KYC level would entail an account with a maximum amount to be held on the account at all time, and for a maximum transaction value for any given period of time. These limits would increase with each KYC step completed.²⁰

The obvious upside associated with tiered accounts would be to allow small amount transactions to be carried out even by lightly registered citizens. Accounts would be easily accessible, but capped proportionately to the identification level. Upper-tier accounts would have stronger identification requirements in order to allow larger amounts of digital euros to be stored and exchanged. This could be implemented for both account-based digital euro models, rather single-tier (M1) or two-tier (M3).

c. Universal access devices for a value-based digital euro

Compared to account-based models, value-based CBDCs do not require an identification of the user. So a value-based digital euro could be a more accessible and inclusive means of payment, especially for those who cannot qualify for the account-based version. A value-based digital euro could be offered without any identification requirements and for capped amounts to be determined. For this form of digital euro to be exchangeable as freely as cash, universal access devices could be provided to ensure every person is able to use it.

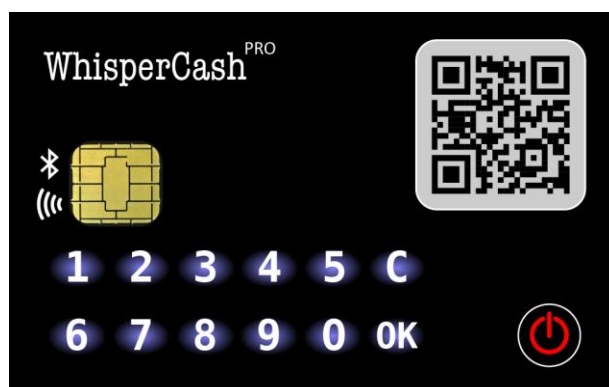
The device should be autonomous, i.e. it should not require any terminal to operate. For example, the device could take the form of a card that embodies communication technologies (such as NFC or Bluetooth), an e-ink display showing the balance on the card and a capacitive keyboard to input transaction amounts and PIN. The company WhisperCash develops such cards, displayed below. The ECB could develop or acquire such technologies and provide it to European citizens. This is something the Bank of Canada explores: "Such a device should

¹⁹ Here, we assume that a digital euro would firstly be accessible to European residents. This is further discussed in chapter 4.

²⁰ That is the approach followed with the Chinese E-CNY (Xu, 2022: 241).

be manufactured at a low cost and issued by the Bank to ensure maximum inclusion.” (Miedema et al., 2020)

Figure 4: The WhisperCash PRO card



Source: *WhisperCash (2021)*

The device should be universally accessible. It could for example be sold in every store for a price of a few euros. As the card would not be nominative, accessing and using it would not need any proof of identity or any other document. Anybody could use it regardless of his/her situation. This solution would thus prevent situations of monetary exclusion.

Such a device could also be useful for the persons that do not have a sufficient level of electronic literacy or who lack an internet connection or a smartphone (that would surely be necessary to use the account-based digital euro).

This value-based digital euro would certainly widen the scope of potential users and bring real added-value compared to existing means of payment. The ECB could provide it as true public service, even if it is meant to be used only for limited amounts. Gaining access to the digital euro should be as easy as possible in order to ensure the largest adoption as well as to lift the exclusion barriers that some users may face (especially when they have to open an account with an intermediary). A value-based digital euro issued by the ECB (M2) should be implemented to fulfil these objectives. Considering the limited operational role an intermediary would play in this model as well as its mostly peer-to-peer nature, a two-tier value-based model (M4) would make little sense.

3. A means of payment respectful of privacy

Data protection when using a means of payment is a key concern for the general public. Privacy was the main concern raised by the respondents to the ECB’s public consultation on the digital euro (ECB, 2021f) and a very large share of the feedback collected as part of the call for evidence of the European Commission expressed a deep-seated rejection from European citizens of the idea of a digital euro, based on concerns of surveillance and control²¹. Coverage of the topic in the press and on social media also often stumbles on this matter. If there is one critical topic for the trust of Europeans regarding a digital euro, it is privacy.

²¹ See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13392-A-digital-euro-for-the-EU_en

Privacy is a fundamental right, as enshrined by the Charter of Fundamental Rights of the European Union and the General Data Protection Regulation (GDPR). It has far reaching implications, from personal freedom and security to the respect of the rule of law and democracy. While physical cash provides an anonymous means of payment, the technological nature of a digital euro inevitably challenges this anonymity in payments, as a retail CBDC could further traceability of payment and financial data transmission and analysis. This led the European Data Protection Board to state that there could be “possible high risks for fundamental rights and freedoms” (EDPB, 2022) associated with the development of a digital euro.

The current position of the digital euro project team is that “User anonymity is not a desirable feature” (ECB, 2022f), as it would fuel unlawful uses of a digital euro and prevent any possibility of limiting its use. The “baseline” regarding privacy is thus that “a digital euro would provide people with a level of privacy equal to that of private digital solutions” (ECB, 2022f). However, as stressed in Chapter 1, the current situation with regard to payment data protection is far from satisfactory and should not be taken as a baseline. Furthermore, a digital euro, as a public innovation, should rather aim at raising the bar on that matter, as on others.

A well-designed digital euro could improve privacy and data protection, as well as provide some anonymity in digital payments. Such anonymity does not exist with current payment solutions (apart from some privacy-oriented cryptoassets²²). A privacy-enhancing digital euro would clearly differentiate itself from existing means of payment in a positive way: “As compared to the physical cash and its beneficial properties for privacy and liberties, it is certain that the distinctive value proposal for a digital euro in an already highly competitive and efficient payment landscape would be its high level of privacy, which is the task of the public sector to provide and would be a decisive trigger in its adoption by EU citizens. For this reason, a digital euro should be designed as close as possible to physical cash.” (EDPB, 2022)

Concretely, a digital euro should be designed with data protection by design and by default, which would be implemented in different ways depending on the transfer mechanism used, as we will see in the rest of this section.

CBDC architectures discussed above also have implications for privacy and data protection. Two-tier models would further increase the amount of payment data collected by intermediaries, while single-tier models would lead the Eurosystem to centralise the data collected. If in both cases a principle of data minimisation²³ should apply, this leaves open the question of who is best placed to handle personal data. As often recalled in official speeches, “The Eurosystem has no interest in exploiting individual payment data for any purpose. This stands in contrast to the monetisation of individual payment data by private companies.” (ECB, 2022i) This pleads in favour of single-tier models (M1 and M2). Private companies, for their part, are lobbying to be able to access and use personal data, so that they can build and provide “value-added services” to their customers. But data sharing should be a personal choice, not a feature of the digital euro.

²² As most of them, like Bitcoin, are only pseudonymous.

²³ As defined by the EDPS, “The principle of “data minimisation” means that a data controller should limit the collection of personal information to what is directly relevant and necessary to accomplish a specified purpose.”

a. A privacy-enhancing account-based digital euro

According to current legislation, any type of account needs to comply with appropriate KYC/AML/CFT regulations. An account-based digital euro would certainly need to comply with *ad hoc* legislation but would most surely follow the standards of deposit accounts. In this case, digital euro accounts would need to comply with identification requirements. This would be in line with the approach followed by central bankers, who consider that “compliance with anti-money laundering (AML) and combatting-the-financing-of-terrorism (CFT) regulation is somehow more stringent and necessary than compliance with the fundamental right and laws on privacy and data protection. This suggests that AML/CFT rules are the first regulatory constraint to abide by, and that privacy should only feature as a design consideration after compliance with AML/CFT regulation is technologically ensured. However, privacy – as a fundamental right and object of several EU laws such as the GDPR – is by no means less legally important than AML/CFT regulation.” (Beckmann, 2022)

Surely, there is a balance to strike between allowing for a truly private means of payment and controlling all its uses to prevent unlawful ones. If privacy is taken seriously, then application of KYC/AML/CFT regulations should be weighed against this objective and could be proportionate to the risks associated with the different uses of a digital euro. In particular, capped accounts and low value transactions are associated with lower risks. So the tiered identification we recommended above in the context of financial inclusion could also apply to data protection policy, as each level of KYC would be associated with gradually decreasing levels of privacy as the amount of money at stake gets higher. Low level accounts associated with a low level of identification should be associated with a high level of privacy. Indeed, “A validation of all (each and every) transactions in digital euros might not be in line with the data protection principles of necessity and proportionality” (EDPB, 2022).

Exploratory works have shown the technical feasibility of privacy-enhancing CBDCs. Various types of “privacy-enhancing technologies/techniques” (PETs) have been identified that allow to balance confidentiality and auditability (ECB and Bank of Japan, 2020). It has been proposed that users could have access to a certain amount of “anonymity vouchers” they could use to protect their data-sensitive transactions (ECB, 2019). More generally, the use of cryptographic protocols (Chaum and Moser, 2022), including zero-knowledge proofs (Gross et al., 2021) allows the serious consideration of a privacy-enhancing account-based digital euro. Considering the high stakes associated with this issue, privacy should not be an optional feature only explored “beyond the baseline scenario”, as it currently is as part of the digital euro project.

b. A fully anonymous value-based digital euro

Anonymity is a key feature of physical cash. It is of societal importance for the protection of fundamental rights and is highly valued by the general public. A digital euro should replicate this feature in order to preserve the possibility of anonymity in digital payments. **A value-based digital euro would be the most adequate for this purpose.** Indeed, a value-based digital euro could be used completely peer-to-peer, without the implication of a third-party: the payer and the payee do not need an intermediary for a transaction to occur. In this case, as no data is needed to settle a transaction, no data trail is left after the transaction is conducted. Value-based digital euros would change wallets in the same way as physical cash changes hands. If no identity is associated with the wallet (as in the case of a Universal Access Device

discussed above), transactions would be fully anonymous. Again, such wallets could be capped in order to remain within a low value / low risk domain.

Chaum, Grothoff, and Moser (2021) have shown the feasibility of such a hardware-dependent token-based system (without using distributed ledger technology). Such a solution should be part of available digital euro options.

In sum, the question of privacy / anonymity and data protection is related to the technology deployed. It is associated with normative choices which would surely need further debate. In our opinion, allowing for different options associated with several levels of privacy - including anonymity - would leave the greatest scope for citizens' choices.

4. A more resilient payment system

When digital payment systems are shut down, almost all social and economic activities are impacted. The general public and all economic actors need to be able to transfer value in all conditions, including energy shortage or economic breakdown. In the face of extreme events, payment systems have to be resilient and a digital euro should bring extra resilience in this field.

In times of bank runs and financial panic, this role has traditionally fallen to cash (or complementary means of exchange). But if crises are associated with bank collapses, potentially ensuing credit crunch or freeze of bank accounts will limit the accessibility of cash and its ability to serve as fall-back means of payments guaranteeing a continuous functioning of our economies. For a retail CBDC, its design choices will also have strong implications on this matter, as the resilience of any payment system depends on its infrastructure.

In two-tier models, the ability to continuously process payments is directly linked to the resilience of the intermediaries involved. So a two-tier digital euro would not increase the resilience of the payment system. The “payment scheme” currently planned by the ECB would still be dependent on issuing banks (on the customers side) and on acquirers (on the merchants side) for transactions to be processed. In any type of system, a great source of resilience is to be found in redundancy. Single-tier CBDC models would add such redundancy to payment systems, as a direct digital euro would operate on an infrastructure parallel to - and thus fully independent from - existing ones. A strong public technological backbone that does not rely on private actors' own systems (but could permit a large number of actors to connect to it) would provide stronger resilience and offer more continuity while strengthening the integrity of the payment system as a whole.

Account-based systems are dependent on the availability of the institution managing the account to be operational (regardless of the type of institution involved). In case of network failure, such systems thus become non-functional. Value-based systems would bring the most resilience as they remove the risk associated with third-party operators as it does not require any external system to be up and running. Such a value-based digital euro could operate completely peer-to-peer and offline, thus ensuring transfers can be managed at all times under the most various circumstances. Besides other benefits, it would be an ideal contingency means of payment, for which offline transfer is to be considered under any circumstances. A portable, non-registered means of payment could allow quick fall-back on a means of payment

of last resort in the form of a value-based digital euro, transferable peer-to-peer in a secured manner. Such an option would bring diversification in available means of payments, diversity being another important source of resilience, especially in times of distress. Following the outbreak of the war on its territory, the National Bank of Ukraine now considers offline payments as a necessary feature for its CBDC (Zhabska, 2022).

A digital euro should be able to be used as a “means of payment of last resort” and thus come as close to the properties of cash in serving as a public safety means of payment.

5. A cost-free means of payment

According to Lagarde (2022a), a digital euro should be “a convenient, cost-free means of payment”. So its access and use should indeed be essentially free for users. Introducing a digital euro is the occasion to reduce costs of digital payments, which have followed quite some specific patterns. Network effects led to oligopolistic situations that have impaired true competition on these markets (see chapter 1 of this report).

One of the main goals currently assigned to a digital euro is to foster competition and thus competitively reduce payment costs for businesses and consumers: “A digital euro would also increase choice and reduce costs, contributing to a level playing field in payments” (Panetta, 2021c). But this might also depend on the chosen design.

Two-tier models imply that services are provided by intermediaries, notably commercial banks. In this case, intermediaries would remain free to price their services - including digital euro services - according to their own strategic plans. Even if digital euro services were provided by the ECB to intermediaries for free or at very low costs, they would not necessarily be passed on to users on the same terms, as instant bank transfers well illustrate. While they are priced € 0.002 to banks by the TIPS²⁴ system (run by the Eurosystem), banks frequently charge their customers € 1 per instant transfer (500 times the initial cost). Even if provided free of charge by intermediaries, digital euro services could be bundled with other services provided by the intermediary, thus reducing their affordability. Intermediaries could even deter the access to and the use of digital euro services if their uptake is not in their interest (in the same way as with reduced access to ATMs today).

In the “payment scheme” approach followed by the ECB, costs of payments could be reduced of the scheme fees (currently mostly paid to Visa and Mastercard). But the acquirer’s service fee and the bank interchange fee would remain. Furthermore, it is not even certain that payment services providers would fully pass-on the cost reduction to final customers, as they could simply increase their margins.

A single-tier digital euro would exert much more direct competition on the payments market and would more surely reduce the price of payment services. It could be provided free of charge and with no strings attached to end-users. Costs could be covered by ECB revenues (notably seigniorage) or the European budget. A direct model would not rule-out the use of the digital euro as a platform for innovation by market actors. On the contrary, it would secure the “level playing field” to which the ECB is attached, while ensuring best value for users.

²⁴ TARGET Instant Payment Settlement

Allowing for a true public option can serve both objectives of inclusive access and of competitive payment options availability.

6. Synthesis: comparison of a digital euro design choices

The following table synthesises the implications of a digital euro design option from users' perspective.

Table 5: Characteristics of the four main digital euro operating models

	Direct digital euro account (M1)	Direct cash-like digital euro (M2)	Intermediated digital euro account (M3)	Intermediate d cash-like digital euro (M4)
Form	Account-based	Value-based	Account-based	Value-based
Distribution	ECB and intermediaries	ECB and intermediaries	Intermediaries only	Intermediaries only
Accessibility	Direct access and public intermediaries that can increase accessibility, possible account tiering for different KYC levels	Can be universal if allowing for non identified transactions	Same as current book money, accessible to financially included people	Can be universal if allowing for non identified transactions
Nature	Public good	Public good	Club good	Club good
Privacy	Identified, with possible account tiering for different privacy levels	Can be fully anonymous	Identified, with possible account tiering for different privacy levels	Can be fully anonymous
Resilience	Strong contribution to resilience (independent infrastructure)	Strong contribution to resilience if allowing for offline P2P exchanges	No increase in resilience (dependant on intermediaries' systems)	Strong contribution to resilience if allowing for offline P2P exchanges
Cost	Can (should) be free for users	Can (should) be free for users	Bundled with intermediaries' other services	Bundled with intermediaries' other services

Source: author's elaboration

Weighing the different benefits and limits of each model, we arrived at following conclusions as for the most desirable design of a digital euro from the point of view of the society as whole:

- The model currently favoured by the ECB, the one of an intermediated digital euro account (M3), is the least innovative and the least prone to bring any substantial benefits for Europeans. A two-tier account-based digital euro would be a complement to the current monetary system but not a ground-breaking alternative. It would offer very limited added value for citizens and businesses and would not challenge existing digital means of payment.
- A direct digital euro account (M1) would be much more suitable to attain policy objectives of accessibility and financial inclusion, protection of privacy, increasing the resilience of the monetary system, and provision of a cost-free means of payment.
- This direct model truly ensures a level playing field without ruling out the implication of intermediaries for the provision of digital euro services. Not only private intermediaries should be involved in the provision of digital euro services, but also public ones to cater for the needs that the market cannot satisfy.
- Considering their synergies, an account-based model and a value-based model should coexist and both be part of a digital euro first release: a value-based digital euro should not only be an optional “add-on”, but an integral part of the solution offered.
- In light of its mostly peer-to-peer nature, there is no rationale in favouring an intermediated model for the provision of a value-based digital euro. So a direct cash-like digital euro (M2) should be followed.

C. Should we fear a “too successful” digital euro?

Previous sections have assumed that a digital euro should be designed with serving Europeans’ interests as the main policy objective. However surprising this might be, it remains unclear if the ECB shares this view for the digital euro project, as on multiple occasions ECB representatives have declared that with a digital euro, “We do not want to be “too successful”” (Panetta, 2022a). Why launch such an innovation and aim for mild success?

The issue of getting to a digital euro that would be “well designed”, “properly designed” or “carefully designed” is commonplace in ECB representatives’ speeches. However, the question of the right design is not primarily raised in regards to the various opportunities we have highlighted in this chapter. For the ECB, the design features that a digital euro should have are specifically the “features that are necessary to preserve the stability of the financial system” (Panetta, 2021c). Hence the second part of the previous quote: “We do not want to be “too successful” and crowd out private payment solutions and financial intermediation.” (Panetta, 2022a) Conversely, a wrongly designed digital would have too strong adverse effects for our economies:

“if it is incorrectly designed, it [...] could crowd out banks from the payments market. In addition, in the absence of limits to its use, it could attract large volumes of deposits. This could make banks’ funding unstable and more costly and have a negative impact on their profitability and credit offering. Ultimately, it could affect the real economy.” (Panetta, 2021f)

This approach is in line with the very first “General requirements” identified in the *Report on a digital euro* (ECB, 2020c): “The digital euro should be an attractive means of payment, but should be designed so as to avoid its use as a form of investment and the associated risk of large shifts from private money (for example bank deposits) to digital euro”.

We here touch on a crucial point that has far-reaching implications for the policy objectives given to the digital euro and the associated design choices. If a digital euro is introduced with, as the main concern, the “aim to minimise the possibility of crowding out the private sector”, then it justifies that the digital euro is given the “narrower functional scope” (Bindseil et al., 2021). This rules out all progressive options, such as those we have recommended in this chapter. This position should therefore be made very clear, as it strongly constrains the design space of a digital euro, and be justified on the basis of clearly objectified risks and not on conservative principle positions.

1. The digital euro as a source of “digital bank runs”?

The main concern shared by both central bankers and the banking sector²⁵ about the potential introduction of a CBDC are the undesirable consequences for the current business model of commercial banks. A digital euro with no holding limit would put too much pressure on deposit money markets and the “universal banking” model where banks are both deposit institutions and investors.

More precisely, a shift of bank deposits to digital euro might result in shrinking balance sheets. This process of balance sheet reduction, if unabated, fast, and voluminous, could equate to a “digital bank run” (Mersch, 2020): massive outflow of deposits from banks. For the banking sector, it would translate into a reduced access to a stable source of funding, which creates additional liquidity risks banks will have to manage on their balance sheet.

The main argument put forward by the banking industry, however, is not about liquidity risks but about financing the real economy: shrinking bank deposits would reduce their ability to provide credit to businesses and households, and thus endanger the smooth functioning of the economy. But this argument rests upon a truncated vision of banks as simple intermediaries, channelling pre-existing savings towards credit-takers. The reality of money creation is completely different: banks *create* deposits the moment they grant a credit to a business or a household, which means that it is not the volume of deposits on their balance sheet that limits their capacity to finance the economy (Jakab and Kumhof, 2015; Werner, 2016).

These concerns primarily relate to the direct issuance model discussed above, in which digital euro accounts would be held directly at the ECB. As commercial banks lose a fraction of their liabilities, in order to balance their books they must also transfer a corresponding fraction of their assets to the central bank, resulting in a reduction of the size of their balance sheets. The tables below illustrate how the introduction of a CBDC would affect the composition of various agents’ balance sheets.

²⁵ See for example the position of the European Banking Federation (EBF, 2021).

First, let us consider the case in which households or firms were to transfer physical cash to a digital euro account. Since in both cases, assets (cash or CBDC) are held directly by citizens and corresponding liabilities (bank notes or CBDC units) are held by the central bank, no quantitative change occurs.

Central Bank		Household or firm	
Assets	Liabilities	Assets	Liabilities
	- cash in circulation + CBDC in circulation	- cash + CBDC	

In the case where digital euros are exchanged against bank deposits, two scenarios can occur depending on the chosen model, two-tier or single-tier. In two-tier schemes, the digital euro accounts remain on the commercial banks' balance sheets and following operations occur:

Central Bank		Commercial bank		Household or firm	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
	- central bank reserves + CBDC collateral	- central bank reserves + CBDC collateral	- deposits + CBDC	- bank deposits + CBDC	

In this situation, there is no quantitative change on commercial banks' balance sheets, only a qualitative one as different types of assets and liabilities are substituted for one another. It should be noted however that even this situation is seen as harmful by commercial banks, who argue that the digital euros they would have on their books would not be as available for investment as their other resources. (So commercial banks oppose even a two-tier model.)

By contrast, the shrinking of commercial banks' balance sheets would occur in single-tier schemes:

Central Bank		Commercial bank		Household or firm	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
+ security	+ CBDC in circulation	- security	- deposits	- bank deposits + CBDC	

Central bank authorities share the concern of the banking sector about deposits flights on massive scale that could lead to dire consequences for the universal banking model and the whole economy. That is the main reason why they have discarded any investigation that could lead to ground-breaking innovations associated with a digital euro.

It should first be noted that this type of reasoning is always conducted “all other things being equal”: the focus is on potential outflows of deposits from commercial banks without considering other adjustments that could take place at the same time. In particular, commercial banks could find alternative, stable sources of funding, including from the central bank reallocating the funds it would collect.

Assessing the relevance of the CBDC risk for commercial banks is not an easy task. Yet, the scientific literature allows to at least nuance the alarmist claims of the banking sector. For banks with large liquidity holdings and diversified funding portfolios, Gorelova et al. (2022) find that following the introduction of a retail CBDC, banks could cope even under “extreme scenarios” of large deposits outflows. Barrdear and Kumhof (2016) find that “a system of CBDC offers a number of clear macroeconomic advantages, with few obvious large costs”. Infante et al. (2022) review the literature on the macroeconomic implications of the introduction of a CBDC and exhibit that there is no unique answer, including in regards to commercial banks.

What is clear however is that there is “a tradeoff in CBDC implementation, reducing the extent of potential benefits of a CBDC in exchange for reduced disruption to the business models of banks, a smaller presence of the central bank in the financial sector, or reduced risks to financial stability” (*Ibid.*). In this context, the ECB takes very seriously the concerns expressed by the banking industry, to such an extent that it seems ready to reduce the attractiveness of the digital euro and renounce to a truly innovative CBDC. This will have strong policy implications and is not without risks for the digital euro project itself, as we discuss in the next section.

2. The risks of designing an unattractive digital euro

With the aim of easing any potential pressure on bank deposits, the ECB plans on limiting the attractiveness of a digital euro, in order to deliberately maintain the attractiveness of commercial banks' book money. Central bankers try to follow a difficult path, trying to foster the use of the digital euro as a means of payment while disincentivizing its holding. In an ECB research paper, Bindseil et al. (2021) explore the ways to achieve this: two main options are being considered.

The first option is to quantitatively limit the amount of digital euro any individual could hold. This means imposing a cap on every digital euro account. The second option has to do with the remuneration of the digital euro. As central bankers claim that a digital euro would never be made less attractive than cash (so that it would never be penalised by negative interest rates), it is a system of tiered remuneration which is considered. Every user could hold as much digital euro he desires, but beyond a certain threshold, a "penalising remuneration" (Panetta, 2021c) would apply²⁶. For both options, the amount of € 3,000 is put forward as limit or as threshold.

Both options raise potential problems. The application of the cap creates complications as any type of digital euro account would have to be nominative (for the ECB to be able to enforce the cap) and every digital euro account would have to be linked to a bank account (the "waterfall account" to which would be automatically converted any digital euro received in excess of the cap). This may contradict objectives of financial inclusion and resilience as it may rule out tiered identification or offline circulation discussed earlier. In the case of a tiered remuneration, in addition to the fact that it is not certain that such a system would have the expected effects, it would not be easy to get people to accept a penalising rate on their digital euro holding, as it would be interpreted as an additional tax.

In sum, the bank disintermediation risks placed on top of the central bankers' checklist constrain the design of the digital euro. At the current stage of the investigation phase, the direction taken is based on unproven and conservative assumptions about potential consequences from the introduction of a retail CBDC. If this direction is to be pursued, the digital euro is likely to be burdened with limitations as for its use. This amounts to reducing the value and attractiveness of the digital euro for its users, while user adoption is far from granted. User adoption of a CBDC is a "gordian knot" (Zamora-Pérez et al., 2022) and an unattractive digital euro runs the risk of being seen as irrelevant by potential users. If the digital euro is to be adopted, central bankers may have to reconsider their policy goals hierarchy.

3. The digital euro as a source of reduced systemic risk

Rather than a source of excessive risk for the banking sector, the introduction of a retail CBDC can also be considered as an effective means to actually improve this sector. As an alternative to bank deposits, CBDCs "can challenge commercial banks market power over retail deposits, pressuring banks to increase interest rates and offer better financial services to depositors."

²⁶ This mechanism can also be considered for monetary policy purposes that would make it easier for the central bank to reach its inflation target. A high rate in a period of inflation would encourage agents to save, and a low rate in a period of deflation or below-target inflation would encourage agents to spend more.

(Lannquist, 2020) A digital euro would bring some more competition on the market for deposits, ultimately benefiting depositors. This would be particularly true for a sector that actually exhibits low levels of competition: “If banks have market power in the deposit market, a CBDC can enhance competition, raising the deposit rate, expanding intermediation, and increasing output.” (Chiu et al., 2019)

Furthermore, there might actually be a case for reducing the size of “too-big-to-fail” financial institutions. A CBDC could be used to challenge the universal banking model - where deposits provide safe funds for (often speculative and short-term) investments - by re-introducing some sort of separation between deposit-taking and investment banking activities. The link between deposit-taking and investment banking is a source of moral hazard and explains why governments had no other choice but to rescue distressed banks following the 2008 crisis. In light of this, it seems that moving a significant fraction of retail deposits to the central bank balance sheet would reduce the systemic importance of commercial banks since deposits represent one third of banking liabilities.

In sum, among the operating models outlined in this chapter, the public option seems the most disruptive one and challenges commercial banks in their role as deposit-taking institutions. But it's far from clear, contrary to what the ECB seems to assume, that risks and disadvantages of such a model outweigh potential advantages - at the very least, this issue calls for a thorough policy discussion. It could be argued that the public option, by introducing an alternative and risk-free deposit possibility, would increase the market discipline among commercial banks and reduce the need for complex regulations and public protection mechanisms. This could in turn help to rebalance profits and power within the financial system.

III. New policy options opened up by the introduction of a digital euro

Looking beyond the operational and design choices discussed above, the digital euro could have various impacts on the European economic environment and renew public policies in several ways, depending on the political will.

First, the digital euro would create a link between the ECB and euro area residents (both individuals and non-financial firms), and this link could be mobilised for policy purposes. The first section of this chapter discusses how it could be used for alternative monetary policies such as direct monetary transfers. Second, a digital euro could be “programmable”, i.e. fit for autonomous payments or coded with rules (for instance, to assign specific digital euros to the purchase of particular goods and services). As developed in the second section, a programmable digital euro would radically increase the field of new policy options; for instance, if the ECB and national treasuries agreed to coordinate their actions more closely, digital money could also facilitate fiscal policy, environmental policy and industrial policy. But programmability of money also raises important questions about the legitimacy of this type of measures, as they can be used for very different ends.

Most of the possible features and functions flagged below would require legal feasibility studies - in this report we only point out new possibilities opened by the digital euro and possible impacts, and discuss their implications for the economic environment and policy making.

A. Direct monetary transfers

In this section we discuss how the digital euro could allow for direct transfers of central bank digital money to residents. Such transfers imply specific design choices for the digital euro but remain compatible with the current legal and institutional framework, where monetary policy is conducted by an independent central bank.

By making monetary transfers to residents possible, the digital euro would offer a useful tool to fight a recession, as previous years have shown that central banks struggle to achieve this in the current financial system, where they rely on commercial banks and financial intermediaries when stimulating the economy.

The money transferred can be either *created* for the purpose by the central bank - what is often called “helicopter money”, as we discuss below - or be taken from its retained earnings; in the latter case the transfers do not imply creation of fresh money but rather a consent from the central banks’ owners (member States of the Eurosystem) to use the banks’ earnings in this way rather than paying out dividends. In both cases, however, the transfers are general and not targeted, as their legitimacy depends upon being a *monetary* policy tool, which means they are put in place for macroeconomic and not redistributive motives.

1. How could the digital euro be used for direct transfers?

As pointed out by Wieladek and Kumar (2021) “Digital currencies will help to broaden the monetary toolkit of central banks” and CBDCs “may enable central banks to boost economic activity by facilitating direct transfer of funds to consumers and businesses”. A digital euro could thus become a high-tech form of “helicopter money”, allowing transfers of central bank money to individuals via their digital euro account. It would be a “drone” (Couppey-Soubeyran et al., 2020) digital money.

The very existence of digital central bank money accounts would de facto resolve the main technical difficulty presented by the implementation of helicopter money, namely the identification of beneficiaries. To facilitate this option, the central bank should opt for a single-tier model in order to directly maintain accounts in central bank money for individuals and businesses. Indeed, with nominative digital euro accounts, the central bank could, without any additional technical difficulty, make transfers to these accounts within the framework of its monetary policy (and, if necessary, set an expiration date for these transfers according to the terms chosen and as discussed in the next section). Each beneficiary would access the amount transferred in the same way as he/she accesses his/her account in digital euro. Users could then, if they wish, credit this transfer onto the value-based solution: as already pointed out, the two types of solutions are complementary to each other. A two-tier model that lets intermediaries manage digital euro accounts would not make helicopter money impossible, but would complicate it and make the central bank dependent on intermediaries for its implementation.

2. About helicopter money

Helicopter money would consist of the central bank making a transfer of central bank money, free of charge and without repayment, to households and potentially also to firms, over a limited period of time. The recipients would immediately see their spending capacity increased by the amount transferred. They would spend all or part of it and their spending would lead to a cascade of income for the whole economy.

If the central bank looks for the most efficient measures to stimulate the economy, direct monetary transfers to non-financial actors (households and/or firms) would have the advantage of freeing the central bank from the transmission problems it traditionally encounters when it simply provides more funding to commercial banks. However, it is only an instrument of monetary policy: it pursues neither social aims (it is not a fiscal policy instrument) nor environmental aims (it is not an instrument for the ecological transition). It is only an instrument of monetary stimulus to be used when needed by the macroeconomic situation.

This option has been increasingly discussed since 2013-2014 by well-known economists and has made its way in recent years into institutions such as the International Monetary Fund (Buetzer, 2022) or the French Council of Economic Analysis (Martin et al., 2021). NGOs such as Positive Money Europe (Jourdan, 2017) and think tanks such as the Veblen Institute (Couppey-Soubeyran, 2020; Couppey-Soubeyran et al., 2020) have also contributed to the debate.

Oxford University economist John Muellbauer (2014) was among the first to revive the idea of helicopter money, arguing that the ECB, rather than following the Fed's lead in adopting QE (which it did from 2015 onwards once it had obtained the approval of the European Court of Justice), would achieve more with a "QE for people", paying every adult a € 500 cheque. Willem Buiter (2014) provided a formal demonstration of the effectiveness of helicopter money to escape from "secular stagnation" in a situation of liquidity trap and zero interest rates.

Helicopter money is thus not a crazy idea, but a solid alternative monetary policy option to be mobilised in case of stagnation. An alternative option that a CBDC would make much easier to implement.

a. Macroeconomic effects of general transfers

A general monetary transfer would have a macroeconomic impact similar to that of a fiscal transfer, with a multiplier effect. A transfer to companies in parallel with that to households would provide support for supply, in conjunction with demand, which would be useful for initiating a recovery in activity or for helping companies in particular economic circumstances, without weighing on States' budgets.

It would a priori have a more direct and stronger impact on the real economy than the unconventional measures used in the wake of the financial and health crises, without adverse distributive effects, and potentially less destabilising than QE for financial stability in the medium term (asset prices would be much less affected).

A very simple exercise, like the one proposed by Couppey-Soubeyran et al. (2020), can be used to approximate the macroeconomic impact of helicopter money: assuming that the recipients of the money transfer spend even half²⁷ of it, and that the multiplier effect resulting from the cascade of spending caused by the transfer doubles²⁸ the initial transfer, the central bank would manage to increase overall spending in the economy by the amount of monetary base issued to implement the transfer: € 100 of central bank money transferred would lead to € 100 of increased spending under these conditions (50% propensity to consume, a multiplier coefficient equal to 2). With helicopter money, the central bank would find in the real economy the equivalent of the amount of monetary base issued, something far from achieved with unconventional measures such as QE (which is why QE has not increased inflation and does not explain the rise in inflation since 2021).

b. Monetary versus fiscal transfers

Money and fiscal transfers are often confused because they target the same beneficiaries (households), and have a similar macroeconomic impact on overall spending via a multiplier effect. However, there are two key differences between the two: funding and targeting.

Regarding their funding, fiscal transfers are paid for by governments and potentially increase the debt unless they can be financed by additional tax revenues. Monetary transfers are issued

²⁷ In empirical studies, the marginal propensity to consume is estimated between 0.3 and 0.7 (Renault and Savatier, 2021). The "0.5" assumption is therefore in the middle of this range.

²⁸ Ramey (2019) estimates multipliers associated with fiscal transfers to be between 2 and 3. It is reasonable to assume that multipliers of a monetary transfer would be quite similar, even if higher estimates exist.

by the central bank and do not burden States' budget or debt. In a phase of rising sovereign interest rates and a continuous increase in public debt, this would be a particularly appropriate option. A digital euro transfer would offer a stimulus that does not increase public debt and, on the contrary, is likely to improve public finances, because of its positive impact on overall income and therefore, a priori, on tax revenues.

Regarding their targeting, monetary transfers would not be socially targeted, because the central bank is not the legitimate institution for this purpose. Monetary transfers are monetary policy tools and not social policy tools as opposed to fiscal transfers which are generally targeted precisely to achieve a redistributive objective. As a consequence, monetary transfers would provide the same amount to everyone, independently from their income and wealth. This does not mean that these transfers would have no redistributive impact (they seem less unequal than that of QE) but this would not be their purpose. As their objective is not redistribution, this justifies their use on an ad hoc, temporary basis.

Certainly, digital central bank money would facilitate, on a technical level, the exchange of information between tax authorities and central banks. Technically, digital money would make it possible to target monetary transfers according to the income and wealth levels of recipients. But at the institutional level, this would exceed the mandate and missions of the central bank, or would necessitate a reform in order to deeply review the boundaries and coordination of monetary and fiscal policies.

c. General transfers and sustainability

Direct money transfers to households would be a stimulus instrument, as are fiscal transfers, with the advantage of not burdening public debt. However, both have a common disadvantage, which is becoming more and more salient as the ecological crisis unfolds. As long as the use of a transfer is not restricted and the recipient of the transfer (monetary or fiscal) can spend it as he or she sees fit, the stimulus objective of these transfers may conflict with other vital policy goals such as sustainability and climate policy: the additional demand will feed current consumption patterns and boost fossil fuels consumption.

Of course, from this point of view, monetary transfers providing the same amount to everyone, independently from their income and wealth, can be more problematic than fiscal transfers, exposing people to a greater risk of unnecessary expenses. But even a socially targeted fiscal transfer may conflict with environmental sustainability goals. Social targeting is not ecological targeting. All stimulus instruments may be in contradiction with sustainability and climate policy goals, if the additional expenditure they allow is used on consumption of polluting products or with disastrous carbon footprint.

This points out that, on the one hand, monetary transfers should only be used as exceptional measures in exceptional times, and, on the other hand, more thought should be given to targeting transfers for their use.

Concerning the targeting of the uses of the transfer (what the transfer can and cannot buy), it remains to be invented. Technically, the digital euro would make this possible because of its potential programmability: a digital euro could be programmed to be bound to certain recipients and certain uses (which we will discuss in the second part of this chapter).

Institutionally, however, this would imply a very thorough coordination between the ECB, in charge of monetary policy, and eurozone national authorities in charge of fiscal policy, with social and ecological motivations. It might need a reform of the ECB's mandate not only because social targeting of monetary transfers would bring the fiscal authorities into the conduct of monetary policy, but also to achieve a governance framework that ensures democratic validation of the restrictions on the use of the digital euro.

Exceptional and general (non targeted) monetary transfers escape these institutional considerations. They would be easily implemented with a digital euro and nothing the ECB's mandate forbids. Indeed, helicopter or drone money transferred to households or companies on their digital euro accounts would not contravene the provisions of the Treaty on the Functioning of the European Union, as there is nothing in the Treaty to prohibit it. Such transfers are therefore perfectly feasible within the current legal and institutional framework.²⁹

d. What would happen if only a small portion of the transfer was actually spent?

The amount to be transferred varies according to the proposals made. Generally, the amount offered is a few hundred euros, paid in one or more instalments, over a limited period of time.

From the point of view of the expected stimulus effect, a low propensity to consume the transfer received is a problem. However, it should be noted that, even if we take the lowest estimate of available survey results, helicopter money would have a stronger macroeconomic impact than QE. We should keep in mind that in the eurozone, between 2015 (start of QE) and 2022 (end of QE), the monetary base grew by an annual average of 27% (ECB data), twelve times more than consumer spending (2.2%, according to Eurostat), and 20 times more than GDP (1.4%, according to Eurostat). With helicopter money, each increase in the monetary base resulting from a direct monetary transfer would translate at the very least (assuming that households spend only a quarter of the transfer and a multiplier effect equal to 2) in half into increased consumption spending and thus GDP, which would be a much greater macroeconomic impact than with QE. Even without any multiplier effect, a change in the monetary base that would pass on a quarter to the real economy would be a better macroeconomic impact than QE, which has done little to stimulate the real economy and has mainly served to raise asset prices and lower sovereign rates (a non-negligible effect).

To date, studies have been more concerned with the propensity to consume associated with transfers to households than with the type of expenditures made with them. This is however an important aspect from the point of view of the compatibility between this type of instrument and sustainability objectives. Spending allowed by direct money transfers can run counter to these objectives. This is part of the concern about helicopter money, but it is true for any kind of stimulus instrument, whether fiscal or monetary. As of today, it should no longer be possible to conduct stimulus policies independently of ecological considerations.

²⁹ In contrast, under the current framework, a State could not be the beneficiary of helicopter money. A direct transfer of central bank money to governments would violate Article 123 of the Treaty, which formally prohibits Eurosystem central banks from providing direct financial assistance to governments. The re-establishment of a direct financing link between governments and central banks would cause a major institutional upheaval. It would, however, make it possible to finance investments that markets do not (as they are not profitable) but that are required for the ecological transition, for instance the preservation of biodiversity, the restoration of public services, specific social transfers, etc.

Nevertheless, if there are times when monetary policy must be used to support the economy, then helicopter money remains a useful option compared to other stimulus. Does it apply only to deflationary times?

e. Does the return of inflation disqualify helicopter money?

It was in a period of latent deflation post 2008 that the idea of helicopter money gained popularity. It has often been presented as an alternative to QE for central banks faced with a liquidity trap, when there is no more room for manoeuvre to increase spending through interest rate cuts. In other words, helicopter money is most often presented as an instrument to be used against deflation. Today, the context is completely different. Inflation is back, and probably more persistent than central banks imagined when the general level of consumer prices began to rise in the summer of 2021 in Europe as in most Western countries after several decades without inflation.

The most classic criticism of helicopter money being its inflationary effect, one might think that the current context disqualifies it as a mobilizable instrument. But it all depends on the sources of inflation and the demand situation. Inflation necessarily comes from a misalignment between the respective levels of supply and demand. But the problem can come from insufficient supply or from excessive demand. If monetary transfers support demand in an already overheated economy, it is obviously not the appropriate instrument because it will accelerate inflation. But if the source of inflation is not excess demand carried by an excess of money in the economy, helicopter money is not necessarily to be excluded as an option in a situation of inflation. Inflation cannot be reduced to a monetary phenomenon: it can come from a problem of supply, or be structural, as it is currently the case with ecological and geopolitical crises pushing up energy and raw materials prices.

When (non-monetary) inflation coincides with a lack of demand, then direct money transfers remain a potentially very useful alternative instrument for central banks. In the specific case of stagflation, it could be a useful complementary instrument, not least when the ECB identifies excessive delays in the transmission of its monetary policy or an obstruction of certain transmission channels. Helicopter money would bypass these obstructed channels.

In short, it is above all on the state of demand that the central bank must base its decision on whether to use helicopter money. When demand and spending capacity are strong, helicopter money is not the right instrument. On the contrary, it becomes a relevant instrument in a context of low spending capacity. Therefore, if after having tried to fight inflation, the ECB was facing stagflation (stagnation + inflation) or worse, slumpflation (recession + inflation), helicopter money would be a useful instrument.

f. What impact does monetary transfers have on the central bank's balance sheet?

As explained before, helicopter money is a free and debt-free access to central bank money. The beneficiaries of the helicopter money would have nothing to pay back afterwards (unlike a credit operation) nor would they need to present any security beforehand (unlike a QE operation). For the central bank, helicopter money means creating central bank money without any financial counterpart for its beneficiaries. The impact on its balance sheet is - from an accounting perspective - a loss. Yet, it does not require recapitalization because negative

equity is not a problem for a central bank (Archer and Moser-Boehm, 2013). That said, in order to avoid the risk of a misunderstood action that would undermine its credibility - its balance sheet is often mistakenly assimilated to that of a company or a commercial bank - the central bank could record the transaction in its balance sheet under a non-redeemable asset. In this way, it would avoid recording a loss and would keep a record of the operation in order to be able to regulate the resulting stock of permanent money.

3. Direct transfers without helicopter money

If the will to create new money was lacking, it would still be possible to implement transfers on digital money accounts with a neutral impact on the central bank's balance sheet. Wieladek and Kumar (2021) consider some ways in which an independent central bank could transfer funds to CBDC account holders without creating new money: central bank could redistribute to holders of digital central money accounts their income from seigniorage, from interests on their private and public assets portfolio, and interests charged to the banks on the deposit account when the deposit facility rate is negative. Of course, transfers without creation of new digital money would be smaller than those of helicopter money and have a smaller macroeconomic impact, but the authors estimate it between 0.5% and 1.5% of GDP, sufficient according to them to counter small to medium-sized recessions.

4. Political and social acceptance of the gift of central bank money to households

In the event of a necessary stimulus, issuing central bank money and transferring it to households, or even to firms, would have a stronger macroeconomic impact than transfers without new money, but remains a complicated political issue for public authorities.

The central bank would have to make citizens understand that it can issue money without having to lend it or buy securities in return. This new mode of issuance would reveal great monetary power. The central bank would also have to explain that the resulting loss does not compromise its proper functioning, that it does not prevent the institution from providing banks with the liquidity they need, that its balance sheet should not be read like the one of a company or a commercial bank. Current realised or anticipated losses, generated by quantitative tightening and the remuneration of bank reserves at a rising policy rate, show the misunderstanding that they can cause. The major central banks are all currently in this situation. These losses, which they should be able to explain as not compromising their operations, will paradoxically be compensated by the Treasury for some of them. This is the case in the United Kingdom, for example, where the British Treasury could have to pay back losses to the Bank of England even though this is not necessary for the Bank of England and could further deteriorate UK's public finances.

The recording of a non payable accounting position on the asset side of the central bank's balance sheet to avoid having to record a loss could also be misunderstood by observers and citizens and be perceived as a "manipulation". It is also the "gift" that could simply be misunderstood by society as "undeserved" aid, especially if the same amount is distributed to everyone. This lack of targeting, which is justified by the monetary nature of the instrument used by the central bank and not by a tax authority, may not be perceived as progress in terms

of inequalities, already fuelled by the asset purchases made by central banks as part of their unconventional monetary policies. Finally, the fact that the expenditures made with these aids may run counter to ecological objectives and defy public awareness in this area could also hinder the social acceptance of monetary transfers not allocated to objectives recognized as being of public utility.

The risks of misunderstanding are numerous and could only be overcome with a strong political will or a crisis situation such that the central bank would have no choice but to support spending in this way. Digital central bank money could above all facilitate the technical implementation of helicopter money and would not easily remove these more political obstacles. But it could allow to target the uses to be made of transfers.

On the one hand, digital central bank currency could facilitate the implementation of fiscal targeted transfers, which could even be made automatic if the fiscal authority deems it appropriate. For Sahm (2019), automatic payments to individuals by tying their disbursement to recent changes in the unemployment rate would accelerate the stimulus and the exit from a recession. Digital central bank money would make it easier to implement. The author does not mention the possible use of a CBDC but one can imagine that it also serves for fiscal transfers. They would remain under the responsibility of States, while their distribution could be delegated to the central bank.

On the other hand, digital money could pave the way for targeted money transfers in terms of its uses, by being programmed to enable spending for public purposes. However, this will require a much stronger coordination than today between monetary and fiscal authorities, and will likely require a revised framework. In the second part of this chapter, we analyse what programmability could mean for the digital euro.

B. A “programmable” digital euro for what purposes?

The programmability of payments and money is a recent yet growing topic and various actors push for the digital euro to be programmable. What would it be about? Programmable payments would automate the execution of transactions in digital euro, triggered by predefined conditions. Such a digital euro could be used autonomously by objects or machines for example. Programmability of money would consist in pre-assigning certain rules to digital euro units (for example in regard to their circulation and use), making them special-purpose money (rather than all-purpose money). For example, such a special-purpose digital euro could be used to access only a specific basket of goods and services (local, sustainable, ...), it could have an expiration date (like vouchers or gift cards), it could be valid only in some geographical areas, etc. Targeting the digital euro towards certain uses could be a lever for public policies (environmental, industrial, etc.). But it also raises questions about the restrictions on freedom these policies would entail.

We'll see in this section that a programmable digital euro could serve very different ends. We highlight two main directions of travel, not necessarily convergent and in some respects even pulling in opposite directions. One can be qualified as technician and productivist as it aims at the optimization and automation of production and consumption through the integration of

autonomous payments to machines and objects. The ECB is investigating in this direction³⁰. The other aims to make the programmable digital euro a monetary lever for ecological transformation, to guide or facilitate the individual expenditure choices necessary for the transition to a less energy-intensive, less consumerist model oriented towards the respect of planetary limits. In what follows, we discuss the issues and pitfalls of both projects.

1. A programmable digital euro as a natural component of the digital economy to spearhead new business models

Programmable digital money is seen by some actors as the indispensable monetary counterpart of an increasingly digitised economy (Klein et al., 2020; Sandner et al., 2021). For example, “German private banks are convinced that, in a digitised economy, this form of digital currency will rapidly gain in importance.” (Association of German Banks, 2019) For the FinTech Council of the German Federal Ministry of Finance, there is “a growing demand for a programmable euro” while in Europe “progress is currently too slow” in this area (FinTechRat beim Bundesministerium der Finanzen, 2020; Sandner and Gross, 2020). For the proponents of this approach, it is necessary that the digital euro has programmability features and that it is based on distributed ledger technology, the only one capable of allowing the full potential of programmability.

This approach has close connections with the world of cryptocurrencies. Its promoters generally have negative perceptions of CBDC projects, seen as a misappropriation of digital ledger technologies such as the blockchain by authorities that these technologies were supposed to make obsolete³¹. Here, programmable money is put at the service of private companies. It would operate in particular on the basis of “smartcontracts”, a central element of DLTs. Smartcontracts enable the automated execution of predetermined contractual arrangements and the transfer of money that usually goes with them. In concrete terms, when the initial conditions are met, a payment is automatically triggered, without any human intervention being necessary. These arrangements are encoded (in the computing sense of the term) in the blockchain on which the distributed ledger is deployed, which should guarantee their respect and immutability. DLTs and smart contracts would thus pave the way for a fully programmable digital currency (Sandner, 2020), which would circulate in part autonomously, following pre-assigned rules and without human intervention.

According to some experts (for example Sandner, 2022; Seidemann, 2021), programmable money would allow new business models to emerge, characterised by highly automated supply chains where, for example, “machine-to-machine payments” would be implemented. The European Commission, in its consultation on the digital euro, did question this aspect (EC, 2022). This development would be nothing short of a fourth industrial revolution, enabled and fuelled by programmable money. It would be largely based on digital networks and data, and would give way to the “Internet of Things” (IoT) in which objects such as industrial machines, autonomous cars, domestic appliances, sensors, etc. would take direct part in economic activity. They would have their own digital wallets, managed autonomously to make

³⁰ As shown by the recently published call for interest for technical talks on programmable digital euro payments (ECB, 2022e).

³¹ On the history of the crypto movement and its anarcho-libertarian ideological background, see Brunton (2019).

payments from machine to person, but especially from machine to machine. For example, in the case of autonomous cars, "driverless vehicles could negotiate directly with charging stations, pay for the electricity used, and drive away without any human intervention." (Seidemann, 2021)

This "Internet of Things" would be the basis for an "Industry 4.0" in which production and supply chains would be much more automated than today. For example, "Industrial machines would be able to buy supplies when stocks run out, diagnose reliability problems and pay for repairs autonomously. Programmable payments make business more efficient and consistent. When transactions can be settled automatically, huge cost and time savings can be realized." (Seidemann, 2021) This "Industry 4.0" would work with distributed ledgers recording not only information about money, but also about the goods and services it would put into motion, as tokens would also be issued as representations of goods or services. Monetary tokens and assets tokens could then be exchanged efficiently and automatically within the same platform. The two spheres, real and monetary, would become one. There would no longer be time lags (and associated risks) between the payment and the delivery of a good, a service or a financial asset, as with current payment systems: programmable money would enable "delivery versus payment" or DvP.

New business models would emerge, based on the differentiation between ownership and use of an asset. For example, an industrial equipment rental company could charge a customer for the use of an equipment according to the duration of use, but also according to the type of use, thanks to the telemetric data that the sensors embedded in this equipment can collect (Kaiser-Neubauer, 2022). This is the "asset as a service" model (Katilmis et al., 2022), associated with pay-per-use, paid not in a punctual way but in the form of "streaming money": a continuous flow of digital money during the whole period of use of a service.

Primarily geared toward industrial applications, programmability of payments is an idea that appeals particularly to German stakeholders and policy makers: "The use of the programmable euro is particularly beneficial in the context of the machine economy - the next stage of the digital transformation - especially for Germany." (FinTechRat beim Bundesministerium der Finanzen, 2020) Germany also sees it as a way to strengthen its position as a European financial centre (Sandner et al., 2021).

2. A programmable digital euro at the service of the socio-ecological transition

The programmability of money is the possibility of defining the properties of each unit of money issued, of directing its use to certain products or expenditures that "one" considers should prevail or are necessary for the realisation of certain objectives. It can also be about setting a space of circulation in order to promote exchanges within a given territory in the manner of local currencies, of fixing an expiry date, etc. In this sense, programmability makes it possible to reduce the "fungibility" of money, i.e., to issue monetary units that are not fully interchangeable and that do not confer an absolute and undifferentiated purchasing power.

How would such restrictions be useful? It would be fundamentally useful in the context of environmental policy, because it is precisely the fungibility of money, its absolute liberatory character, which is an obstacle to its ecological conversion. Even if we assume that monetary policy is green, that the refinancing of commercial banks by the central bank is subject to

ecological criteria³², a fungible currency with an absolute liberatory character cannot be "ecological" in the long term, since there is nothing to prevent it from being used in its circulation to buy goods or services whose production is too carbon-intensive or polluting or that degrade biodiversity (Couppey-Soubeyran and Delandre, 2022).

A programmable digital currency, whose use would be targeted to goods and services compatible with or favourable to the ecological transition, would thus be a powerful lever for accelerating it. Of course, in the absence of a complete information system associating a sort of environmental score to each good and service, the general environmental programmability of digital money would necessarily remain very limited. But sectoral applications are totally conceivable. For example, a transfer of digital euro to households could be programmed to allow only the purchase of services for thermal building renovation. Companies providing such services would be certified by national authorities and would be the only ones to be able to receive these particular digital euros. Once received, they would automatically become regular digital euros. This type of measure would undoubtedly improve the achievement of transition policy objectives.

Such programmability would be particularly appropriate in the case of monetary transfers, discussed above. Yet, these operations would no longer be strictly within the framework of monetary policy (as it would no longer be helicopter money paying the same amount to each beneficiary), so the central bank would not be the competent institution to discriminate between uses. If programmability was used to make targeted transfers of digital money to certain categories of households, the operation would be part of a social, or even social-ecological policy aimed at helping low-income households bear the cost of the transition. In both cases, however, the digital currency would become an instrument shared between central banks and States, requiring close coordination between the two. The current governance of central banks, in particular that of the Eurosystem, does not facilitate this coordination.

3. Who decides on the programmability and its objectives?

If they are not totally antinomic, the two approaches of programmability presented above outline two very different projects for society. In one case, programmability is at the service of the private sector and of a growth-oriented project (or at least one aiming at extending and deepening the digital revolution), more accommodating of free enterprise but at the potential cost of an increase in energy and resources consumption that runs counter to the objectives of carbon neutrality that the European Union aims to achieve by 2050. In the other case, programmability is an instrument at the service of the public authorities to lead the social-ecological transformation, potentially at the price of some restrictions on the use of money.

The answer to the question of which of these two approaches would best serve society is eminently "political". The first approach to programmability is a priori more "liberal", and would result mainly from a decentralised decision-making process. The second is part of a more "interventionist" or "voluntarist" agenda, resulting in a fairly centralised decision making process about programmability and its objectives.

³² In this case, banks are encouraged to direct their financing towards investment projects that are compatible with the ecological transition or that promote it.

Vigilance and safeguards would be necessary in both cases. In the first approach, it would be necessary to take account of public policy objectives defined elsewhere, which could imply guiding the use of programmability by placing it within the framework of an industrial or reindustrialisation policy. In the second approach, it would be necessary to ensure a sufficiently democratic definition of the objectives set and the legitimacy of the institutions responsible for implementing them, which a sufficient degree of decentralisation of the decision making process could help achieve.

IV. International dimensions of a digital euro and its use outside the Eurozone

The prospect of introducing a digital euro raises the question of whether this kind of central bank money would be used by euro area residents alone or be available to non-euro area residents as well. This question is strongly linked to the broader policy discussion of the euro's status as an international currency, as the digital euro could be used both for cross-border transactions (between euro area residents and non-euro area residents) and for international uses (between non-euro area residents). These issues are discussed in this chapter.

Although the international implications of introducing a CBDC have been explored for some years now (Bindseil, 2020; Ferrari et al., 2020), there's no scientific consensus as for which option should be preferred. These implications will also strongly depend on the design features of the CBDC being considered.

From a technical point of view, the international circulation of the digital euro would mean allowing foreign citizens access to a European payment system for use in settlements with eurozone counterparties, or even with another non-resident entity (possibly in their own currency zone). This would mean either providing digital payment services to agents who previously did not have access to these services, or substituting foreign domestic means of payment with digital euro transfers. In any case, an international circulation of a digital euro which would not imply a currency exchange operation will have the effect of reducing the control of foreign authorities over the money flows within their jurisdiction. It is important to keep this implication in mind when deciding whether or not to allow the digital euro to become an international currency on its own, and, if the answer is yes, to do so in consultation with foreign political and monetary authorities.

Without going into the details of the process of dollarization (Ponsot, 2019; Winkler et al., 2004), we can say that it has:

- Well identified advantages: the import of macroeconomic stability (exchange rate stability, solution to the credibility dilemma of the inflation target), lower interest rate on external debt (due to the elimination of the exchange rate risk) and easier economic integration with the issuing country.
- As well as disadvantages: the loss of the independence of its monetary policy and the use of the lender of last resort as well as the disappearance of seigniorage revenues normally gained by the central bank.

The issue of the international circulation of a digital euro should also be put into the context of the general EU strategy of supporting the international use of the euro (European Commission, 2018). Indeed, monetary institutions' reforms and especially those which impact the international monetary system - the rules that govern international imbalances financing - are, first and foremost, political economy questions.

This chapter will highlight the advantages, disadvantages and difficulties that could arise from the circulation of the digital euro outside our currency zone. We will see that the international circulation of the digital euro will have to avoid two pitfalls: rampant monetary substitution and

increased capital flight in times of crisis. Neither of these is inevitable, but safeguards must be put in place to avoid them.

In order to circumscribe our object, we first make some plausible assumptions about the design of the digital euro. We consider a retail digital euro, the use of which would not imply any foreign exchange operation (except when specified), i.e. all accounting movements would be recorded on accounts situated in the eurozone. Indeed, just as a digital euro could be “intermediated” or “hybrid”/“direct” (Auer and Böhme, 2020) depending on whether the transactions are recorded on the liabilities of commercial banks or on the balance sheet of the central bank (see chapter 2), digital euros circulating abroad could either :

- Give rise directly to account movements on the balance sheets of European banks (direct holding by non-residents) ;
- Give rise to movements on the books of foreign commercial banks before they transmit the transfer orders to the European correspondent banks which manage their digital euro accounts at the ECB (or directly to the ECB).

The study of this second solution is excluded for two reasons. First, because this model is very close to the current international architecture and the gains are likely to be small. Second, because the legal barriers to supervision of this type of architecture are significant. Indeed, European banking authorities would have to ensure that the coverage of commercial banks' digital euro assets is equal to the holdings of non-resident agents. This last point would imply supervision of banking institutions, which, while not impossible, is highly unlikely. We will therefore assume that accounts are held directly by non-residents on the books of European commercial banks.

We will also assume a maximum holding amount when necessary for our reasoning. Finally, our analysis also relies on the fact that account opening will require credentials similar to those currently governed by the EBA technical guidelines (European Banking Authority, 2022).

Because the digital euro is a public policy project, it is important to explore the goals it would be able to achieve in order to assess its potential merits. Listening to many regulators, it is sometimes difficult to determine what tasks they intend to accomplish with their respective digital currencies, including on international aspects. Beyond its domestic objectives, should the digital euro promote the efficiency of international payments? The ECB's current priority is the completion of a domestic infrastructure (ECB, 2022d), but nothing prevents the digital euro from being part of the international payment architecture in the future. However, this development could come at a later stage, once the digital euro is operational and interoperability agreements have been reached with foreign payment systems.

It is also worth considering the different features that will have the greatest impact on international circulation. For example, the geographical scope of this circulation could greatly influence the volumes exchanged and with them the risks for financial stability. Indeed, circulation in countries already firmly anchored to the eurozone (Denmark and Bulgaria, for example) will not have the same impact as if the digital euro was to circulate throughout the whole world. Thus, it seems to us that if credible alternatives are available to compensate for the flaws of foreign national payment systems or financial settlement services, they will have to be evaluated in terms of the shortcomings and advantages they provide in comparison to

the digital euro. To paraphrase Timbergen's Law, the creation of a new means of payment cannot eliminate all the shortcomings of those currently in use.

In fact, it would seem that CBDC projects that may have appeared monolithic until now are instead breaking down into a diversity of infrastructures with circumscribed tasks. Thus, the digital euro project would no longer represent a single asset carried by a single digital infrastructure, but as several assets (retail, wholesale and possibly international) supported by several IT protocols, each component of which would meet a partial objective. This would include a retail CBDC for individuals, a wholesale version interoperable with private blockchains and possibly a final version for international use. It is with this potential variety of projects in mind that we limit ourselves to the type of digital euro that is most likely to be created in the short term: a retail digital euro focussed on the euro area. Furthermore, it is interesting to note that the vast majority of retail CBDCs currently in preparation are not intended to allow for international transactions (BIS et al., 2021). Only the Chinese Central Bank and the Hong Kong Monetary Authority (two monetary areas with strong economic and political links) have stated their intention to allow cross-border use of the e-Yuan (Yue, 2020).

Our analysis is organised as follows. First, we look at the international tasks that could be assigned to the digital euro and the advantages that it could have in accomplishing them. Next, we examine the design features that are most likely to influence the international circulation of the digital euro. Finally, we analyse the different solutions that could serve as credible alternatives to the international use of the digital euro.

A. The potential cross-border missions of a digital euro

First and foremost, it seems essential to consider the cross-border missions that could be entrusted to the new digital retail currency as well as the conditions under which they could be carried out. Thus, we will structure our discussion around the analysis of the objectives that the digital euro could pursue, namely:

- to provide a means of retail payment between residents of the eurozone and non-residents,
- to allow transactions between non-residents of the eurozone.

In both cases, it seems to us that one must weigh the benefits of the international circulation of the digital euro against the work that would be required to coordinate the monetary authorities in order to fulfil their mandate (i.e., the preservation of financial stability and the security of the means of payment). Between these two main cases, one can also identify the situation of cross-border workers who share their lives between their country of residence and the country where they work (one in and one out of the eurozone).

A final international task could be to allow tourists visiting the eurozone to pay their expenses in digital euro. Although this case gives rise to international transfers (at the time of initial funding and refunding of foreign accounts), it will not be discussed here because its purpose is not to allow circulation outside the eurozone. The creation of a holding scheme for tourists (especially offline) could, however, have the side effect of allowing this circulation if barriers to this use were not put in place.

In the first case, which concerns transactions in which one counterparty is in the eurozone and the other is not, the use of a digital euro could potentially provide an institutionalised, inexpensive and probably very fast solution for international transfers. Such an infrastructure could be used by foreign workers for remittances or even during the time they spend working in the eurozone. This solution, if it were to become more accessible than current European basic payment accounts (European Parliament and European Council, 2015), could also reduce the under-banking of foreign workers while drastically lowering remittance costs. This solution could also be a condition of access to the formal economy for the most precarious workers in that it would allow them to receive their salaries into a digital euro account and thus be able to justify their income for all the activities that require it (real estate rental, other financial services, etc...). It could also be allowed to provide accounts in digital euro to residents of other countries in the world that have close ties with the eurozone (the countries part of the European Free Trade Association for example). The same benefits would apply to them and the international circulation of the CBDC would then largely contribute to the achievement of the objectives that the G20 has set for the cost of remittances (Financial Stability Board, 2021).

If the objective is to provide means of payment between foreign countries residents, for example to tackle financial exclusion or, more generally, to complement dysfunctional payment systems, a digital euro could provide a suitable means of payment which bookkeeping would occur in the eurozone and that would undoubtedly promote the international use of the currency. It would allow non-residents to collect and make international retail payments such as remittances or purchases of consumer goods. However, it is questionable whether the institutions of the eurozone can legitimately take the place of those of another currency zone to solve the problems of its payment ecosystem. A potentially more appropriate solution would be to make available the experience gained in the area of wholesale payments (with the TARGET system) and retail payments (with the research on the digital euro and former technologies) to alleviate the difficulties that these economies are experiencing in this area. It seems that the digital retail euro is not the most suitable solution for this purpose.

Finally, there is the case of people living in cross-border life situations - typically, but not exclusively, cross-border workers who share their lives between one Eurozone and one non-Eurozone country. Workers who receive their salary in euro could benefit from being able to pay their expenses in their country of residence in digital euro without being charged extra fees. There are two possibilities to achieve this.

The first would be to use the classic correspondent banking chains which would see the account of the corresponding bank in the eurozone credit the account of the receiving bank: this transaction would result in a classic exchange operation and would probably reproduce the advantages and disadvantages of the current system. The second solution, which is the only one that could improve the payment system, would be possible if both the sender and the receiver of the payment had a digital euro account. In this case, the payment could be made in a much simpler way (even instantaneously and free of charge) since both operations (credit and debit) would take place within the same payment system (possibly on the same account book: the ECB's one). It could therefore be envisaged to facilitate access to digital euro accounts in areas bordering the eurozone. Northern Ireland would be a case in point, given the importance of the all-island economy and the fact that it is still part of the EU's single

market following the post-Brexit Northern Ireland Protocol. This could also be relevant for other EU / non-euro area members where the euro is widely used. Beyond the concrete benefits for cross-border workers, the circulation of the euro in these regions could also be a factor of economic integration.

B. The design features that will influence an international circulation of a digital euro

Let us now consider the implications that the international circulation of a digital euro might have on foreign economies as well as on the eurozone itself. The Digital euro project team (2022) cites two different supports for the digital euro: an on-line version and an off-line version. This duality therefore implies two distinct IT architectures and possibly a dedicated physical device for the off-line version (prepaid card or some other electronic devices, see chapter 2 of this report). We will see that the presence of an off-line alternative implies de facto that the digital euro will be able to circulate internationally.

First, the fact that the digital euro is built for retail transactions has important implications for its potential international circulation. Compared to a multi-CBDC wholesale payment system (Auer, Haene, et al., 2021) that would link national digital currency systems by allowing non-resident entities to hold euros directly on the books of the European Central Bank - as the mBridge project led by the People's Bank of China might allow (BIS et al., 2022), a retail digital euro will circulate in much smaller proportions (in terms of amount and number of transactions) and on a smaller geographical scale. However, a smaller circulation does not necessarily imply less systemic risk in times of crisis for the foreign economies where the digital euro will potentially circulate.

Indeed, it is certain that the circulation of a few billion euros that could be involved in the adoption of the digital euro by a small neighbouring country would have no chance of impacting the stability of the eurozone. However, in a panic situation, massive exchanges of domestic bank deposits of a small country into digital euros could destabilise the exchange rate (depending on the central bank's foreign currency reserves amount), lead to capital flight and consequently put financial stability at risk. It is all a question of proportion and it could seem logical, maybe in more fragile countries, to adapt the maximum holding thresholds to the GDP per capita of each country, or to the size of a monetary aggregate (presumably M1) of the foreign economy in question.

Also, it should be noted that with respect to capital flight through retail operations, the digital euro is not a game changer. Indeed, retail conversion tools already exist today (Western Union, MoneyGram as well as cryptoassets, etc...) and offer transfer possibilities relatively similar (except concerning the transfer fees) to what a digital euro could enable (Western Union allows for example to transfer 1,000€ every 5 days in France with a simple ID). Also, the linguistic, legal (law restricting access to non-residents' accounts), geographical (distance between the foreign country and the eurozone) and technical barriers that limit access to non-residents' euro bank accounts today will probably not disappear with the introduction of the digital euro. Thus, it will only create a new transfer channel - likely less expensive for end-users than the existing ones - that will operate within the institutional limits of the country in

question. The possibilities of holding and transferring amounts that it will offer will have to be regulated so as not to aggravate the risks of monetary instability in times of crisis.

The legal framework within which digital euro accounts will be opened also raises questions about access methods. Indeed, if the digital euro retains the same holding characteristics as currently planned (2.000-3.000 euros), the opening of an account will be conditional on the submission of the same supporting documents as in the eurozone (identity papers and possibly other documents) that certain selected intermediaries will be asked to evaluate. It will be necessary to establish for each jurisdiction the list of documents to be provided. More difficult, if not impossible without a strong political will, the European intermediaries (or the ECB itself, depending on the architecture adopted) will have to supervise and evaluate the onboarding processes of these foreign intermediaries situated possibly outside the European jurisdiction, in accordance with regulations including the one of the EBA (European Banking Authority, 2022). Here we see the classic problems linked to the differences in regulatory frameworks that prevent the implementation of a truly international settlement system.

These formalities will increase the cost of access to the digital euro vis-a-vis the eurozone and could discourage commercial intermediaries from offering this service. If the provision of a digital euro service could be partially subsidised or made compulsory in the euro area, could it be the same abroad? Without an incentive framework, it is possible that even if it was legally allowed to circulate abroad, an international digital euro would not be an effective reality because of higher provisioning costs related to banking regulations (see Rice et al. (2020) on the links between regulatory costs and international payment service provision).

Another issue related to access arrangements concerns the degree of anonymity of digital euro payments abroad. On the one hand, it does not seem justified that foreign nationals be discriminated against with respect to the anonymity of digital euro transactions (if offered). On the other hand, it is necessary to be certain that due diligence regulations are properly implemented in the country of use so as not to create regulatory loopholes in the European supervisors' racket. Although the risks for the financial stability of the eurozone are probably much smaller, access to this potentially anonymous means of payment should not allow the financing of illegal or terrorist operations, or money laundering.

Regarding financial stability and the amount of digital euro in circulation, an important question concerns the geographical area in which the digital euro will be allowed to circulate. Indeed, will it be allowed to be owned in the whole world or in a set of strategically identified countries? As indicated in the introduction, the euro area is already linked to other currency areas by different institutional frameworks. While some jurisdictions are linked to it by monetary agreements (Andorra, Monaco, San Marino and the Vatican) because of their geographical proximity to the eurozone and the importance of their economic links with it, others are only linked to the eurozone through the European Exchange Rate Mechanism (ERM II) and a linkage of their national payment systems (as is the case for Bulgaria with its connection to TARGET 2 in 2010 or Denmark, which will allow the settlement of its retail transactions on TIPS (Target Instant Payment Settlement) system in 2025 (ECB, 2020a). Other countries have unilaterally adopted the euro (Montenegro and Kosovo) against the advice of the European regulators. Finally, some countries belonging to the European Union have committed to joining the eurozone at an undetermined date and have not ratified any exchange rate agreement with it (Hungary, Poland, Romania, Sweden and the Czech Republic). In parallel to these

monetary agreements and the links between payment systems, 9 countries outside the eurozone have adopted the Single Euro Payments Area (SEPA) standard, which facilitates the transfer of funds between participating jurisdictions and, in particular, allows certain transactions to be carried out instantaneously by means of the instant payment scheme TIPS.

In view of these different situations, it seems that the decision to circulate the digital euro internationally has specific implications and brings distinct benefits from case to case. Indeed, for those countries that have adopted the SEPA standard, that participate in TARGET2 and TIPS and whose currency is credibly linked to the euro, the added value of adopting the digital euro could be small. For those jurisdictions that do not have a monetary agreement with the eurozone, do not use European payment systems or are not part of SEPA, the adoption of the digital euro could be an opportunity to overcome these regulatory differences to create an efficient international payment system. In any case, these decisions will have to be made in consultation with the political and monetary authorities of the countries concerned in order to preserve financial stability and to accomplish the tasks entrusted to the digital euro in the best possible way.

Finally, it should be emphasised that the availability of an off-line use of the digital euro would de facto make possible the international circulation of the digital euro (within the limits of the chosen design). In fact, as there could be no need for any kind of connection in order to use them, the value-based devices containing the digital euros may be used outside the eurozone, just as cash today. Thus, it will be the rules of use of this offline version that will allow a more or less extensive international circulation in volume and time of the digital currency in its offline version. For example, these devices can be programmed to allow the use of the currency only for a specific period of time before it is recredited to the original account or simply destroyed (Kahn et al., 2021). Users would only be able to use it for small transactions or up to a certain volume of exchange. All of these features would either promote or limit the international circulation that will be de facto enabled by an off-line version of the European CBDC.

C. Alternative cross-border payment solutions

Bindseil and Pantelopoulos (2022) characterise and compare the different solutions to the establishment of international transactions that would be "immediate, cheap, universal in terms of reach, and be settled in a secure settlement medium such as central bank money." The provision of such a service would address the objective of enabling retail transactions between the Eurozone and the surrounding world. The researchers reviewed six different solutions, two of which emerge as being the most likely to accomplish these missions: on the one hand, the interconnection of instantaneous central payment systems with currency conversion and, on the other hand, the linking of a network of CBDCs, also with conversion operations. The other solutions are: the creation of an international stablecoin, the use of a non-collateralized crypto asset (Bitcoin type), the reliance on fintech infrastructures and finally the improvement of the current system of bank correspondence.

The analysis of all the technical possibilities is beyond the scope of this section: we will focus on the two solutions put forward by these authors in order to compare them to a potential internationalisation of the digital euro.

1. Interconnection of instant payment systems

The interconnection of instant payment systems would consist of providing an infrastructure that links the account books of the various central banks in which the balances of national commercial banks are recorded. It is an interface between two currency areas that coordinates the movement of funds between the accounts of the two settlement systems (e.g., the ECB's TIPS and the Riksbank's RIX) through the creation of a standardised communication network, exchange mechanisms and a transaction settlement model (see Renzetti et al. (2022) for technical details).

This institutionalisation of international transactions (which does not exist today) would allow for the instantaneous settlement of retail transactions from one currency zone to another. Thanks to the presence of a conversion module that prevents the holding of a domestic currency by a non-resident actor, the control of the central bank of origin over the circulation of its currency remains preserved. This technical infrastructure would also meet the requirements of speed, security, affordability and universality. Many projects of this type currently exist around the world and this model has been identified by the Financial Stability Board as being able to participate in the reduction of transaction costs on an international scale (Financial Stability Board, 2021).

2. A network of CBDCs

Closer to the digital euro project is the possibility of creating a network of CBDCs with or without exchange modules. The solution involving a foreign exchange operation would guarantee that one of the currencies accessible via the platform would not supplant the other currencies in international or domestic use. Without foreign exchange, i.e. in cases where non-residents could directly hold an account on the balance sheet of a foreign central bank, one currency could replace others in both international and domestic transactions.

So far, the possibility of linking CBDCs to each other has been mentioned as a solution for international wholesale transactions, and the Bank for International Settlements has been the most productive institution on the subject (see especially BIS (2021)). International CBDC projects are multiplying and could be at the heart of international monetary rivalries in the coming years. However, there is no reason why an international CBDC network cannot be used to facilitate international retail payments, and the digital euro could be part of this effort. Nevertheless, this alternative has the disadvantage of not relying on existing infrastructures, which on the one hand is an opportunity since starting from scratch allows to address all of the shortcomings of the current system, but on the other hand requires an enormous amount of research, consultation and experimentation.

Thus, different options are available to allow quick and inexpensive transactions between individuals in the eurozone and non-resident agents. Their advantages and disadvantages must be weighed against those that would be involved in the international circulation of the digital euro. Indeed, it seems to us that the main drawback of the latter solution would be that it would not be based on a conversion procedure at the borders of the euro area and that it could therefore, in economically unstable countries, lead to undesirable currency substitution effects from the point of view of financial stability. These risks could be mitigated by allowing the circulation of the digital euro only in countries with stable currencies and sharing the

banking standards of the Eurozone. This circulation would make payments more fluid, especially for the several hundred thousand cross-border workers (European Commission, 2022), without, however, imposing the euro on the domestic currency.

D. Conclusions on the international aspects of a digital euro

The creation of new payment infrastructures through the use of CBDC promises improvements in the realisation of transactions of all kinds on a domestic and international scale. However, it is important to keep in mind that these projects tend to cover multiple realities, and future payment system reforms could likely result in a variety of payment architectures operating together. It would therefore be more appropriate to see these future projects as the implementation of a payment ecosystem, with a retail CBDC being the current most visible part of the iceberg.

Thus, in view of the current contours of the digital euro project, it does not seem that its main mission is directly related to international use (ECB, 2022d). Although a circulation outside the eurozone could favour the international use of the currency and though the off-line option authorises de facto the use of the currency outside of the European borders, it appears that the regulatory and operational barriers with the majority of countries are more important than the probable benefits. However, it is certain that people living in cross-border life situations would benefit from a tool that enables them to live and operate simultaneously in two currency areas, without having to continuously pay exchange fees. This possibility would also contribute to the economic integration of the eurozone with its neighbouring countries.

Finally, a reform of the payment system that would see the creation of a version of the digital wholesale euro for international settlement purposes would be appropriate in the medium term. This version of the digital euro could be the European branch of the projects implemented to link the different currency zones of the world, which are now called multi-CBDC infrastructures. These would be responsible for linking national wholesale CBDCs whose architecture will have been designed around these functionalities. In any case, these developments imply a sustained consultation of the world's regulators to ensure that these monetary transformations bring about the harmonious developments that are expected of them while preserving the monetary sovereignty of their players.

To sum-up, the digital euro could accomplish three different international missions:

- Enable transactions between the euro area and the rest of the world, especially with countries to which the euro area payment systems are not yet sufficiently integrated;
- Facilitate transfers between non-eurozone countries;
- Participate in the economic integration of the eurozone with its neighbouring countries, notably by facilitating cross-border life situations.

However, it must avoid certain pitfalls:

- Its uncontrolled circulation in certain countries that are not financially stable could worsen their economic situation in times of financial crisis;

- An effective supervisory framework must ensure compliance with anti-money laundering regulations and prevent the financing of terrorism.

In the medium term, other solutions could ensure the same missions:

- By linking up the instant payment systems of neighbouring countries with the Target Instant Payment Settlement system of the Eurozone (Renzetti et al., 2022);
- Or by establishing a multi-CBDC network that will likely rely on a wholesale digital euro (Auer, Haene, et al., 2021).

General conclusion

Experimenting and implementing central bank digital currencies is a global trend, and the investigation launched by the ECB comes at the right moment. We therefore welcome and support the reflection the ECB has been leading on the topic for some two years now; launching a European CBDC is indeed necessary “to ensure the euro remains fit for the digital era” (Lagarde, 2020).

In this study, we highlighted crucial design and policy choices that decision-makers will have to face at some point in the process, and discussed what they mean for the future digital euro. But we might also take a step back and ask what will happen if the ECB chooses not to develop the digital euro after all? As stated by the ECB itself, “the counterfactual to a digital euro is not the status quo but a financial system in which private payment assets may dominate in future” (ECB, 2022h). This is not a desirable future for the monetary system nor for our economy.

Our general conclusion is that a CBDC is a truly disruptive innovation that could radically improve our monetary system: as such, it will naturally encounter resistance from banking and financial industries who currently dominate the payment system. This resistance concerns first and foremost the “public option” we recommend in this study, and which could in our opinion restore the lost balance between public and private money within the monetary system.

We have also challenged, on various grounds, the approach currently followed by the ECB as part of the investigation phase of the digital euro project. Our assessment is that more ambition needs to be given to the digital euro, otherwise it runs the risk of being seen as irrelevant by its prospective users if it does not bring clear innovation and added-value. The prospect of a digital euro entails various opportunities that need to be embraced for it to be a success, that is to be widely adopted and used.

In any event, we believe the current debate should focus much more on the objectives we want to assign to the digital euro, and that technical choices make sense once the objectives have been determined. This study puts forward various recommendations in regards to the design and the implementation of a digital euro. But it showed that choices here are always at least as much political as they are technical. Our recommendations are therefore not formulated as definitive answers, but as landmarks to guide policy discussions. There are competing views and projects about what a digital euro should be and various interest groups are pushing their own, including conservative ones that risk undermining the project. This reinforces the need for a broad political appropriation of the topic, beyond ECB experts and the industry representatives they mobilise³³.

So this debate needs to be more transparent and open to the public and the civil society, starting now, from the investigation phase. This may even be inescapable if the digital euro is to be adopted by the Europeans. An increasing number of them express their reserve or even their hostility towards the project, as shown by the consultation recently organised by the

³³ Following the announcement of the digital euro “Market Advisory Group”, a call for broader implication of society was signed by more than 100 scholars and NGOs (Dissaux et al., 2022).

European Commission: almost 20.000 feedback were sent, mostly by EU citizens opposing the project in quite strong words³⁴. On 23 November 2022, the Dutch parliament held a debate on the digital euro. So many people came to attend that the building had to be closed down and the crowd was ultimately dispersed by the police. These examples show that the digital euro project is far from being only about a new way to pay: the digital euro opens a new chapter in the relation between Europeans and their single currency.

³⁴ See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13392-A-digital-euro-for-the-EU_en

References

- Archer D and Moser-Boehm P (2013) Central Bank Finances. *BIS Papers* (71).
- Association of German Banks (2019) *Following the debate on Facebook's "Libra" currency, German banks say: The economy needs a programmable digital euro!* 30 October. Berlin.
- Auer R and Böhme R (2020) The technology of retail central bank digital currency. *BIS Quarterly Review*: 85–100.
- Auer R and Böhme R (2021) Central bank digital currency: the quest for minimally invasive technology. *BIS Working Papers* (948).
- Auer R, Frost J, Gambacorta L, et al. (2021) Central bank digital currencies: motives, economic implications and the research frontier. *BIS Working Papers* (976).
- Auer R, Haene P and Holden H (2021) Multi-CBDC arrangements and the future of cross-border payments. *BIS Papers* (115). Monetary and Economic Department: 23.
- Bank of Canada, European Central Bank, Bank of Japan, et al. (2020) *Central Bank Digital Currencies: Foundational Principles and Core Features*. Report no 1 in a series of collaborations from a group of central banks. Bank for International Settlements.
- Bank of England (2020) Central Bank Digital Currency: Opportunities, challenges and design. *Bank of England Discussion paper*.
- Barrdear J and Kumhof M (2016) The Macroeconomics of Central Bank Issued Digital Currencies. *Bank of England Staff Working Paper* (605).
- Bech M and Garratt R (2017) Central bank cryptocurrencies. *BIS Quarterly Review*.
- Beckmann M (2022) Will the digital euro respect citizens' privacy? In: *Positive Money Europe blog*.
- Beermann J (2022) Cash of the Future. In: *The Banknote & Currency Conference 2022*, Washington, D.C., 24 February 2022.
- Bergman M (2020) Competitive aspects of an e-krona. In: Nessén M and Söderström U (eds) *Sveriges Riksbank Economic Review Second Special Issue on the E-Krona*. Stockholm: Sveriges Riksbank.
- Bindseil U (2020) Tiered CBDC and the Financial System. *ECB Working Paper Series* (2351).
- Bindseil U and Pantelopoulos G (2022) Towards the holy grail of cross-border payments. *ECB Working Paper Series* (2693).
- Bindseil U, Panetta F and Terol I (2021) Central Bank Digital Currency: functional scope, pricing and controls. *ECB Occasional Paper Series* (286).
- BIS (2021a) CBDCs: an opportunity for the monetary system. In: *BIS Annual Economic Report 2021*.
- BIS (2021b) *Central bank digital currencies: executive summary*. September.
- BIS (2022) The future monetary system. In: *BIS Annual Economic Report 2022*. Bank for International Settlements.
- BIS, World Bank, International Monetary Fund, et al. (2021) *Central Bank Digital Currencies for Cross-Border Payments: A Review of Current Experiments and Ideas*. World Bank.
- BIS, People's Bank of China, Hong-Kong Monetary Authority, et al. (2022) Project mBridge : Connecting economies through CBDC.
- Brunton F (2019) *Digital Cash: The Unknown History of the Anarchists, Utopians, and Technologists Who Created Cryptocurrency*. Princeton: Princeton University Press.
- Buetzer S (2022) Advancing the Monetary Policy Toolkit through Outright Transfers. *IMF Working Paper* (WP/22/87).
- Buiter WH (2014) The Simple Analytics of Helicopter Money: Why It Works — Always. *Economics* 8.
- Carstens A (2019) The future of money and the payment system: what role for central banks? In: *Lecture at the Princeton University*, Princeton, New Jersey, 5 December 2019.
- Chaudhuri RR (2014) The Free Banking Era. In: Chaudhuri RR (ed.) *The Changing Face of American Banking: Deregulation, Reregulation, and the Global Financial System*. New

- York: Palgrave Macmillan US, pp. 7–19.
- Chaum D and Moser T (2022) *eCash 2.0: Inalienably private and quantum-resistant to counterfeiting*.
- Chaum D, Grothoff C and Moser T (2021) How to issue a central bank digital currency. *SNB Working Papers* (3/2021).
- Chiu J, Davoodalhosseini M, Jiang J, et al. (2019) Bank Market Power and Central Bank Digital Currency: Theory and Quantitative Assessment. *Bank of Canada Staff Working Paper* (2019–20).
- CNIL (2022) *When Trust Pays Off: Today's and Tomorrow's Means of Payment Facing the Challenge of Data Protection*. 2, White Paper Collection, 23 February. Paris: Commission Nationale Informatique & Libertés.
- Coupey-Soubeyran J (2020) “Helicopter money” to combat economic depression in the wake of the Covid-19 crisis. *Veblen Institute Notes & Studies*.
- Coupey-Soubeyran J and Delandre P (2022) Comment monnayer la transition écologique ? *AOC media - Analyse Opinion Critique*.
- Coupey-Soubeyran J, Carré E, Lebrun T, et al. (2020) “Drone money” to put monetary policy back to the people. *Veblen Institute Notes & Studies*.
- CPMI and Markets Committee (2018) *Central bank digital currencies*. March. Bank for International Settlements.
- CPSS (2003) *The role of central bank money in payment systems*. August. Basel: Committee on Payment and Settlement Systems, Bank for International Settlements.
- Dalinghaus U (2019) *Virtually Irreplaceable: Cash as Public Infrastructure*. Cash Matters White Paper. Irvine: Cash Matters / ICA / IMTFI.
- Demirgüç-Kunt A, Klapper L, Singer D, et al. (2022) *The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19*. Washington, DC: World Bank Group.
- Digital euro project team (2022) Foundational design options for a digital euro. Presentation at Euro Retail Payments Board technical session on digital euro.
- Dissaux T, Coupey-Soubeyran J and Kalinowski W (2022) The digital euro concerns the whole society, not only finance. *Euractiv*, 14 February.
- EBF (2021) *EBF contribution to the ongoing debate on a Central Bank Digital Euro #2: Impact on bank funding*. 26 May. Brussels: European Banking Federation.
- EC (2022) Targeted consultation on a digital euro. European Commission.
- ECB (2019) Exploring anonymity in central bank digital currencies. *European Central Bank In Focus* (4).
- ECB (2020a) Denmark to join Eurosystem’s TARGET services.
- ECB (2020b) ECB intensifies its work on a digital euro. *Press release*.
- ECB (2020c) *Report on a digital euro*. October. Frankfurt am Main: European Central Bank.
- ECB (2020d) *Study on the payment attitudes of consumers in the euro area (SPACE)*. December. Frankfurt am Main: European Central Bank.
- ECB (2021a) ECB announces digital euro Programme Manager. *MIP News*.
- ECB (2021b) ECB announces members of Digital Euro Market Advisory Group. *Press release*.
- ECB (2021c) ECB digital euro consultation ends with record level of public feedback. *Press Release*.
- ECB (2021d) ERPB engagement in the digital euro investigation phase. *ERPB Secretariat*.
- ECB (2021e) Eurosystem launches digital euro project. *Press release*.
- ECB (2021f) *Eurosystem report on the public consultation on a digital euro*. April. Frankfurt am Main: European Central Bank.
- ECB (2021g) Mandate of the Digital Euro Market Advisory Group (MAG).
- ECB (2022a) *3rd ERPB technical session on digital euro*. 1 September.
- ECB (2022b) *5th Digital Euro MAG meeting*. 6 July.
- ECB (2022c) *6th Digital Euro MAG meeting*. 16 September.
- ECB (2022d) *7th Digital Euro MAG meeting*. 9 November.
- ECB (2022e) Call for interest: technical talks on programmable digital euro payments. *MIP News*.

ECB (2022f) Digital euro: Privacy options. Presentation to the Eurogroup.

ECB (2022g) ECB selects external companies for joint prototyping of user interfaces for a digital euro. *MIP News*.

ECB (2022h) Potential impact of a digital euro on the financial system and the use of cash. Presentation to the Eurogroup.

ECB (2022i) *Progress on the investigation phase of a digital euro*. 29 September.

ECB (2022j) The case for a digital euro: key objectives and design considerations.

ECB and Bank of Japan (2020) *Balancing confidentiality and auditability in a distributed ledger environment*. February.

EDPB (2022) *Statement on the design choices for a digital euro from the privacy and data protection perspective*. 04/2022, 10 October. European Data Protection Board.

Engert W and Fung BSC (2017) Central Bank Digital Currency: Motivations and Implications. *Bank of Canada Staff Discussion Paper (2017–16)*: 30.

ERPB (2021) *Report of the ERPB Working Group on Access and Acceptance of Cash*. 25 November. Euro Retail Payments Board.

Eurogroup (2022) Eurogroup statement on the digital euro project.

European Banking Authority (2022) Guidelines on the use of Remote Customer Onboarding Solutions under Article 13(1) of Directive (EU) 2015/849.

European Commission (2018) *Towards a stronger international role of the euro - European Commission contribution to the European Council and the Euro Summit*.

European Commission (2022) *Annual report on intra-EU labour mobility 2021*.

European Parliament and European Council (2015) Directive 2014/92/EU of the European Parliament and of the Council of 23 July 2014 on the comparability of fees related to payment accounts, payment account switching and access to payment accounts with basic features.

Felt M-H, Hayashi F, Stavins J, et al. (2021) Distributional Effects of Payment Card Pricing and Merchant Cost Pass-through in Canada and the United States. *Bank of Canada Staff Working Paper (2021–8)*.

Ferrari MM, Mehl A and Stracca L (2020) Central bank digital currency in an open economy. *ECB Working Paper Series (2488)*.

Financial Stability Board (2021) G20 Roadmap for Enhancing Cross-border Payments: First consolidated progress report.

FinTechRat beim Bundesministerium der Finanzen (2020) *Der digitale, programmierbare Euro*. 01/2020, Stellungnahme.

FSUG (2021) *FSUG position paper on financial exclusion linked to broader accessibility issues*. May. Financial Services Users Group.

Gorelova A, Lands B and teNyenhuis M (2022) Resilience of bank liquidity ratios in the presence of a central bank digital currency. *Bank of Canada Staff Analytical Notes (2022–5)*. 2022–5. Bank of Canada.

Gross J, Sedlmeir J, Babel M, et al. (2021) Designing a Central Bank Digital Currency with Support for Cash-Like Privacy. *SSRN Scholarly Paper*.

Guo S, Kreitem J and Moser T (2022) DLT Options for CBDC. *SSRN Scholarly Paper*.

Infante S, Kim K, Orlik A, et al. (2022) The Macroeconomic Implications of CBDC: A Review of the Literature. *Federal Reserve Board Finance and Economics Discussion Series (2022–076)*.

Jakab Z and Kumhof M (2015) Banks are not intermediaries of loanable funds — and why this matters. *Bank of England Working Papers (529)*.

Jérusalmy O, Fox P, Hercelin N, et al. (2020) *Financial exclusion: Making the invisible visible, A study on societal groups encountering barriers to accessing financial services in the EU*. March. Brussels: Finance Watch.

Jourdan S (2017) Helicopter money and basic income: friends or foes? In: *Positive Money blog*.

Kahn CM, van Oordt MRC and Zhu Y (2021) Best Before? Expiring Central Bank Digital Currency and Loss Recovery. *Bank of Canada Staff Working Paper (2021–67)*.

Kaiser-Neubauer C (2022) Fully automatic – CashOnLedger.

- Katilmis S, Forster M, Sandner P, et al. (2022) Asset as a Service – CashOnLedger.
- Klein M, Gross J and Sandner P (2020) The Digital Euro and the Role of DLT for Central Bank Digital Currencies. *Frankfurt School Blockchain Center Working Paper*.
- Kosse A and Mattei I (2022) Gaining momentum – Results of the 2021 BIS survey on central bank digital currencies. *BIS Papers* (125).
- Lagarde C (2020) The future of money – innovating while retaining trust. *L'ENA hors les murs*.
- Lagarde C (2022a) 20th anniversary of the entry into circulation of euro banknotes and coins. In: *Plenary session of the European Parliament*, Strasbourg, 14 February 2022.
- Lagarde C (2022b) Interview conducted by Andreas Niesmann and Tim Szent-Ivany. *Redaktionsnetzwerk Deutschland*, 11 February.
- Lagarde C and Panetta F (2022) Key objectives of the digital euro. In: *The ECB Blog*.
- Lupo-Pasini F (2020) Is It a Wonderful Life? Cashless Societies and Monetary Exclusion. *Review of Banking and Financial Law* 40: 153.
- Mancini-Griffoli T, Martinez MS, Agur I, et al. (2018) Casting Light on Central Bank Digital Currency. *IMF Staff Discussion Note*: 39.
- Martin P, Monnet É and Ragot X (2021) What Else Can the European Central Bank Do? *French Council of Economic Analysis Notes* (65).
- McLeay M, Radia A and Thomas R (2014) Money creation in the modern economy. *Bank of England Quarterly Bulletin* 54(1): 14–27.
- Mersch Y (2020) An ECB digital currency – a flight of fancy? In: *Consensus 2020 virtual conference*, Online, 11 May 2020.
- Miedema J, Minwalla C, Warren M, et al. (2020) Designing a CBDC for universal access. *Bank of Canada Staff Analytical Notes* (2020–10).
- Muellbauer J (2014) Combatting Eurozone deflation: QE for the people. *VoxEU column*.
- Nessén M and Söderström U (eds) (2020) E-krona design models: pros, cons and trade-offs. In: *Sveriges Riksbank Economic Review Second Special Issue on the E-Krona*. Stockholm: Sveriges Riksbank.
- OMFIF (2020) *The Future of Payments*. Digital Money Institute.
- Panetta F (2020) From the payments revolution to the reinvention of money. In: *Deutsche Bundesbank conference on the "Future of Payments in Europe"*, Frankfurt am Main, 27 November 2020.
- Panetta F (2021a) Central bank digital currencies: a monetary anchor for digital innovation. In: *Speech at the Elcano Royal Institute*, Madrid, 5 November 2021.
- Panetta F (2021b) Designing a digital euro for the retail payments landscape of tomorrow. In: *ECON Committee of the European Parliament*, Brussels, 18 November 2021.
- Panetta F (2021c) Evolution or revolution? The impact of a digital euro on the financial system. In: *Speech at a Bruegel online seminar*, Frankfurt am Main, 10 February 2021.
- Panetta F (2021d) Interview conducted by Martin Arnold. *Financial Times*, 20 June.
- Panetta F (2021e) The ECB's case for central bank digital currencies. In: *The ECB Blog*.
- Panetta F (2021f) The present and future of money in the digital age. In: *Lecture for Federkasse (Federation of Italian Cooperative Credit Banks)*, Rome, 10 December 2021.
- Panetta F (2022a) A digital euro that serves the needs of the public: striking the right balance. In: *Committee on Economic and Monetary Affairs of the European Parliament*, Brussels, 30 March 2022.
- Panetta F (2022b) Bringing European payments to the next stage: a public-private endeavour. In: *Keynote speech at the European Payments Council's 20th anniversary conference*, Frankfurt am Main, 16 June 2022.
- Panetta F (2022c) Building on our strengths: the role of the public and private sectors in the digital euro ecosystem. In: *Introductory statement at the Committee on Economic and Monetary Affairs of the European Parliament*, Brussels, 29 September 2022.
- Panetta F (2022d) Central bank digital currencies: defining the problems, designing the solutions. In: *US Monetary Policy Forum*, New York, 18 February 2022.
- Panetta F (2022e) Demystifying wholesale central bank digital currency. In: *Symposium on "Payments and Securities Settlement in Europe – today and tomorrow" hosted by the*

- Deutsche Bundesbank*, Frankfurt am Main, 26 September 2022.
- Pincovski C (2022) The European Payments Initiative (EPI) – what is being achieved and what’s next. *The Paypers*, 27 June.
- Ponsot J-F (2019) Économie politique de la dollarisation: *Mondes en développement* n° 188(4): 51–68.
- Ramey VA (2019) Ten Years after the Financial Crisis: What Have We Learned from the Renaissance in Fiscal Research? *Journal of Economic Perspectives* 33(2): 89–114.
- Renault T and Savatier B (2021) What Impact Does Helicopter Money Have on Inflation? *Focus Conseil d’Analyse Economique* (063bis).
- Renzetti M, Dinacci F and Börestam A (2022) Cross-Currency Settlement of Instant Payments in a Multi-Currency Clearing and Settlement Mechanism. *Markets, Infrastructures, Payment Systems’ Research Paper series* 16. Banca d’Italia.
- Rice T, von Peter G and Boar C (2020) On the global retreat of correspondent banks. *BIS Quarterly Review* March 2020: 16.
- Ryan-Collins J, Greenham T and Werner R (2012) *Where Does Money Come From? A Guide to the UK Monetary & Banking System*. Edition : 2nd Revised edition. London: New Economics Foundation.
- Sahm C (2019) *Direct Stimulus Payments to Individuals*. Brookings.
- Sandner P (2020) Programmable Money and Programmable Payments. In: *Medium*.
- Sandner P (2022) The Digital, Programmable Euro: In: *Medium*.
- Sandner P and Gross J (2020) The Digital, Programmable Euro: Statement by the FinTech Council of the German Federal Ministry of Finance (Unofficial Translation). In: *Medium*.
- Sandner P, Gross J and Chung J-C (2021) *The Programmable Euro: Review and Outlook*. Study for the Finanzplatz München Initiative, 19 November. Munich: Frankfurt School Blockchain Center.
- Schuh SD, Shy O and Stavins J (2010) Who Gains and Who Loses from Credit Card Payments? Theory and Calibrations. *Federal Reserve Bank of Boston Public Policy Discussion Papers* (10–03).
- Scott B (2022) *Cloudmoney: Cash, Cards, Crypto and the War for Our Wallets*. Bodley Head.
- Seidemann W (2021) CBDC systems should focus on programmable payments. In: *OMFIF news*.
- Soderberg G, Bechara M, Bossu W, et al. (2022) Behind the Scenes of Central Bank Digital Currency: Emerging Trends, Insights, and Policy Lessons. *IMF Fintech Notes* (2022/004).
- SPF Economie (2019) *Le fonctionnement du marché des paiements électroniques en Belgique*. Bruxelles: SPF Economie, P.M.E., Classes moyennes et Energie, Direction générale des Analyses économiques et de l’Economie internationale.
- van Anholt R (2022) Future of Dutch cash infrastructure. In: *Cash Talks 1 - Access to Cash*, 10 February 2022.
- Werner RA (2016) A lost century in economics: Three theories of banking and the conclusive evidence. *International Review of Financial Analysis* 46: 361–379.
- WhisperCash (2021) *WhisperCash offline CBDC product brochure*. July.
- Wieladek T and Kumar A (2021) Central Bank Digital Currencies May Bring “Helicopter Money” Closer. *T. Rowe Price Insights on Economics*.
- Winkler A, Mazzaferro F, Nerlich C, et al. (2004) Official Dollarisation/Euroisation: Motives, Features and Policy Implications of Current Cases. *ECB Occasional Paper Series* (11).
- Witlox E (2022) Digital euro – our future money. Presentation at Sibos 2022. Amsterdam.
- Xu J (2022) Developments and Implications of Central Bank Digital Currency: The Case of China e-CNY. *Asian Economic Policy Review* 17(2): 235–250.
- Yue E (2020) A New Trend for Fintech - Cross-border Payment. In: *InSight of the Hong-Kong Monetary Authority*.
- Zamora-Pérez A (2022) Guaranteeing freedom of payment choice: access to cash in the euro area. *ECB Economic Bulletin* (5/2022).
- Zamora-Pérez A, Coschignano E and Barreiro L (2022) Ensuring adoption of central bank digital currencies – An easy task or a Gordian knot? *ECB Occasional Paper Series*

(307).

Zhabska K (2022) Keynote on the Ukrainian case for a CBDC. In: *Panel "Digital Money in Times of Crisis"*, 31 May 2022. Digital Euro Association.