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The digital euro: Implications for the European banking sector

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No. 729

Volker Brühl

The digital euro – implications for the European banking sector

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The digital euro – implications for the European banking sector

Volker Brühl*

Abstract:

The introduction of central bank digital currencies (CBDCs) in general, and of a digital euro in particular, has attracted growing interest from academic research, central banks and political decision-makers. Most of the existing literature is focused on the impact of a digital euro on monetary policy issues, financial stability – especially the potentially enhanced risk of bank runs – and related questions concerning the design options of a digital euro. However, a digital euro could negatively affect the profitability of the European banking sector. Fees from payment transaction services could decline and refinancing costs could increase, as comparatively cheap financing from retail deposits would have to be replaced in part by more expensive financing instruments such as bonds or open market operations with the ECB. This paper deals with these aspects by estimating the potential impact of a digital euro in a simulation model based on current market data. The analysis demonstrates that the annual fee losses could be in the range of €2.1 billion to €4.2 billion. The associated refinancing need due to replacements of deposits by digital euro holdings could be in the range of €324 billion to €650 billion, translating into additional refinancing costs of around €6.5 billion to €19.5 billion p.a.. Therefore, a fair compensation model for banks and payment service providers is needed to avoid adverse consequences for the profitability and resilience of the European financial sector. The paper also discusses the general need for a retail digital euro in light of the expected benefits and risks as well as implications for design options to mitigate inherent risks.

JEL: E42, E51, G21

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The digital euro – implications for the European banking sector

Volker Brühl

1. Introduction

Advances in distributed ledger technology (DLT) have led to a growing decentralisation of financial services (“decentralised finance”) (e.g. Lavayssière and Zhang, 2024; Brühl, 2021; Schär, 2021). An important driver of this development is the tokenisation of assets, rights and payment instruments, which enables the digital encryption of financial instruments (“crypto assets”) (e.g. Arslanian, 2022; Gryglewicz et al., 2021; Sunyaev, 2021; Lo et al., 2020; Kim et al., 2018; Lipton, 2018). These include payment tokens (cryptocurrencies), which are primarily used to process payments in a decentralised peer-to-peer network. The tokenisation of assets has also enabled the generation of utility tokens, which represent a digital claim to future services or products, and security tokens, which are essentially digital equivalents of traditional securities. Tokens can also contain smart contracts that are automatically executed when certain events occur (e.g. Khan et al., 2021; Cong et al., 2019; Corrales et al., 2019). Additionally, so-called “stablecoins” have been introduced. Their market value is linked to an external reference such a fiat currency like the U.S. dollar, a commodity such as gold, or other crypto assets. The entity behind the stablecoin maintains a reserve of the assets backing the stablecoin (e.g. Hoang et al., 2021; Lennart et al., 2021; BIS, 2019). In an increasingly digitised financial system, a central bank digital currency (CBDC) is another development option that has been discussed for several years, including the introduction of a digital euro. There is a common understanding that a CBDC should complement, but not replace, physical cash (e.g. ECB, 2020; BIS, 2019; Sveriges Riksbank, 2017).

The introduction of a CBDC in general, and of a digital euro in particular, has attracted growing interest from academic research, central banks and political decision-makers. Most of the existing literature is focused on the impact of a digital euro on monetary policy and financial stability (e.g. Kosse and Mattei, 2022; Minesso et al., 2022; Kumhof et al., 2021; Carapella et al., 2020; Brunnermeier et al., 2019a; Brunnermeier et al., 2019b). There is also some research on the interdependencies between an interest-bearing CBDC and bank lending activities (e.g. Chiu et al., 2020; Andolfatto, 2018). But the potential implications of a digital euro on the profitability and resilience of the European banking sector have hardly been discussed so far. Nevertheless, fees from payment transaction services could decline to the extent that existing digital payment instruments are replaced by a digital euro. In addition, refinancing costs could increase if comparatively cheap financing from retail deposits has to be replaced by other, more expensive, financing instruments.

This paper quantifies the potential impact on fees from payment services, refinancing volumes and refinancing costs of European banks in different scenarios. The underlying simulation model uses current market data on retail payment behaviour such as payment volumes per instrument, corresponding fees and funding spreads. The results underscore the need for a compensation model for banks and other payment service providers that avoids negative effects on sector profitability and incentivises broad adoption of a digital euro. First, the paper gives a brief overview of the economic foundations of a CBDC and the current status of a potentially forthcoming digital euro.

2. Foundations of central bank digital currencies (CBDCs)

Money acts as a means of payment, a unit of account and a store of value for a currency area. Central bank money (CBM) so far consists of physical cash (notes and coins, NAC) and reserves held by banks and other qualifying financial institutions as central bank deposits. In addition, central banks facilitate the usage of private money, i.e. electronic commercial bank deposits, by allowing commercial banks to settle interbank payments using central bank money and enabling convertibility between commercial and central bank money through the provision of NAC (e.g. BIS, 2003).

A CBDC would be a new type of central bank money (BIS, 2020) representing a digital alternative to NAC issued directly by the central bank. A CBDC would be denominated in the national unit of account, making it a direct liability of the central bank (BIS, 2018). Depending on the scope, a CBDC could either be used by the general public (“retail CBDC”) or alternatively for interbank payments and securities transactions (“wholesale CBDC”) (e.g. BIS, 2018; ECB, 2020). As the current discussion about a digital euro refers to a broadly available, general purpose CBDC that could be used for everyday payments, the concept of a wholesale CBDC will not be discussed in this paper.

It should be noted that a CBDC has to be distinguished from “synthetic CBDCs”, which would be issued by private sector payment service providers (PSPs), matched by funds held at the central bank (e.g. Adrian and Griffoli, 2019; BIS, 2020; Kahn et al, 2018). In such a case, PSPs would act as intermediaries between the central bank and the end users. However, these liabilities would not be a CBDC, as the end user would not hold a claim against the central bank.

2.1 Objectives of a CBDC

Efficient, secure and stable payment systems are crucial both for the effective transmission of monetary policy decisions and the stability of the economy as a whole. Therefore, payment systems are considered as critical financial market infrastructures that are regulated and supervised by competent authorities (e.g. BIS-IOSCO, 2012). Due to the ongoing digitisation both of the financial and the “real” sector, changes in payment behaviour including declining cash usage in day-to-day payments, and technological innovation (e.g. Artificial Intelligence (AI) and Blockchain applications), many central banks are analysing the potential benefits and risks of a CBDC.

The various central banks working on a CBDC mention the following objectives, with different priorities (e.g. Bank of Canada, 2020; Bank of England, 2020; Bank of Japan; BIS, 2020; Boar et al., 2020; ECB, 2020; Federal Reserve, 2023; Sveriges Riksbank, 2017):

- Boost the efficiency of payment systems by offering a digital alternative to physical cash
- Lower transaction costs, especially for retail customers
- Facilitate cross-border payments
- Provide a platform for more innovation in the field of payments
- Improve financial inclusion, especially in developing countries
- Enhance protection against money laundering, tax fraud and terrorist financing
- Create access to central bank money independent of physical cash (“digital notes”)
- Improve operational resilience in cases of natural disasters or cyber-attacks leading to a breakdown of digital networks
- Protect monetary sovereignty by offering a digital form of legal tender

The main focus of existing CBDC projects is on improving efficiency and facilitating innovation of national and cross-border payment systems in the digital age. Moreover, a CBDC could foster broad access to banking services and therefore support financial inclusion in emerging economies (Lannquist and Tan, 2023). On the other hand, a lack of digital literacy or trust in modern technologies could create a digital divide, e.g. between younger and older generations (BIS, 2020; BIS-World Bank, 2020).

2.2 Monetary policy aspects

There is also a common understanding that the introduction of a new form of money supplied by the central bank, like a CBDC, should not negatively impact the central bank’s ability to secure monetary and financial stability. Depending on the characteristics of a CBDC, the transmission of monetary policy measures could be affected. An important aspect relates to the question of whether or not a CBDC should bear interest (e.g. BIS, 2020; BIS, 2018; Davoodalhosseini, 2020; ECB, 2020). If the primary objective is to offer a digital alternative to NAC, the answer should be negative. On the other

hand, an interest-bearing CBDC could pass on policy rate changes immediately to CBDC holders, which could also generate incentives for commercial banks to adjust their rates more quickly. To be effective, However, this would require market-based rates to be offered on a CBDC and a significant volume to be held by the general public. Other aspects of a CBDC include the technical possibility to allow for a “programmable monetary policy” (e.g. money transfers that have an “expiration date” or are conditional on being spent on certain goods) (BIS, 2020; Narula et al., 2023). Besides, a CBDC would reduce the risk that alternative units of account, such as stable coins, negatively affect central banks’ control over monetary policy matters (e.g. Brunnermeier et al., 2019a).

Issuing a “deposit-like” CBDC could intensify the disintermediation of banks and other deposit takers, which could negatively affect the role of these market participants in the payment industry. Consequently, the risk of bank runs could increase, which in turn could trigger or reinforce financial crises.

2.3 Financial stability – potential disintermediation of banks

The two-stage banking system, consisting of a central bank as lender of last resort and commercial banks providing liquidity to the public, is widely regarded as the preferred monetary architecture. At the same time, bank runs due to a loss of trust in individual financial institutions or the entire system must be avoided, as such incidents could lead to a collapse of the financial system. It is argued that a digital euro could increase the risk of bank runs and that managing such a systemic risk scenario could become more complicated if retail customers could easily switch to a safe asset like a CBDC, especially if the CBDC offers a positive remuneration, unlike physical cash (e.g. Ahnert et al., 2022; BIS, 2020; Vives, 2019).

Without a CBDC, bank runs may unfold by retail customers, in the main, massively withdrawing money from their bank accounts in exchange for cash. Consequently, in serious economic crises banks could become insolvent, triggering additional financial distress of financial institutions that have significant credit relationships with the banks affected. Public or sometimes private bail-outs are needed to preserve the stability of the banking system. Prominent examples include Northern Rock (2008) during the subprime crisis, several Greek banks (NBG, Alpha Bank, Piraeus Bank) during the sovereign debt crisis (mainly between 2010 and 2015 in Greece), or more recently Silicon Valley Bank and a few other regional banks in the United States in 2023. Other prominent bank failures like Lehman Brothers (2008) or the emergency takeover of Bear Sterns (2008) during the global financial crisis were not accompanied by bank runs, as these were investment banks and therefore did not rely on deposit-based funding.

Whether or not a CBDC would increase the risk of bank runs is one of the most critical questions raised. Depending on the exact features and the quantitative availability, a CBDC could facilitate the switch from bank deposits into central bank money and thus increase the speed and scale of these flows. Such developments could exacerbate threats to financial stability, including a restricted credit supply (BIS, 2018). Nevertheless, these risks could be mitigated, e.g. by imposing quantitative limits on individual CBDC deposits and designing the CBDC as a more “cash-like” and less “deposit-like” payment instrument. Other options include introducing a tiered remuneration of CBDC deposits, e.g. by lowering or eliminating interests rates beyond a certain threshold (e.g. Ahnert et al., 2024; Bindseil, 2020; Panetta, 2018).

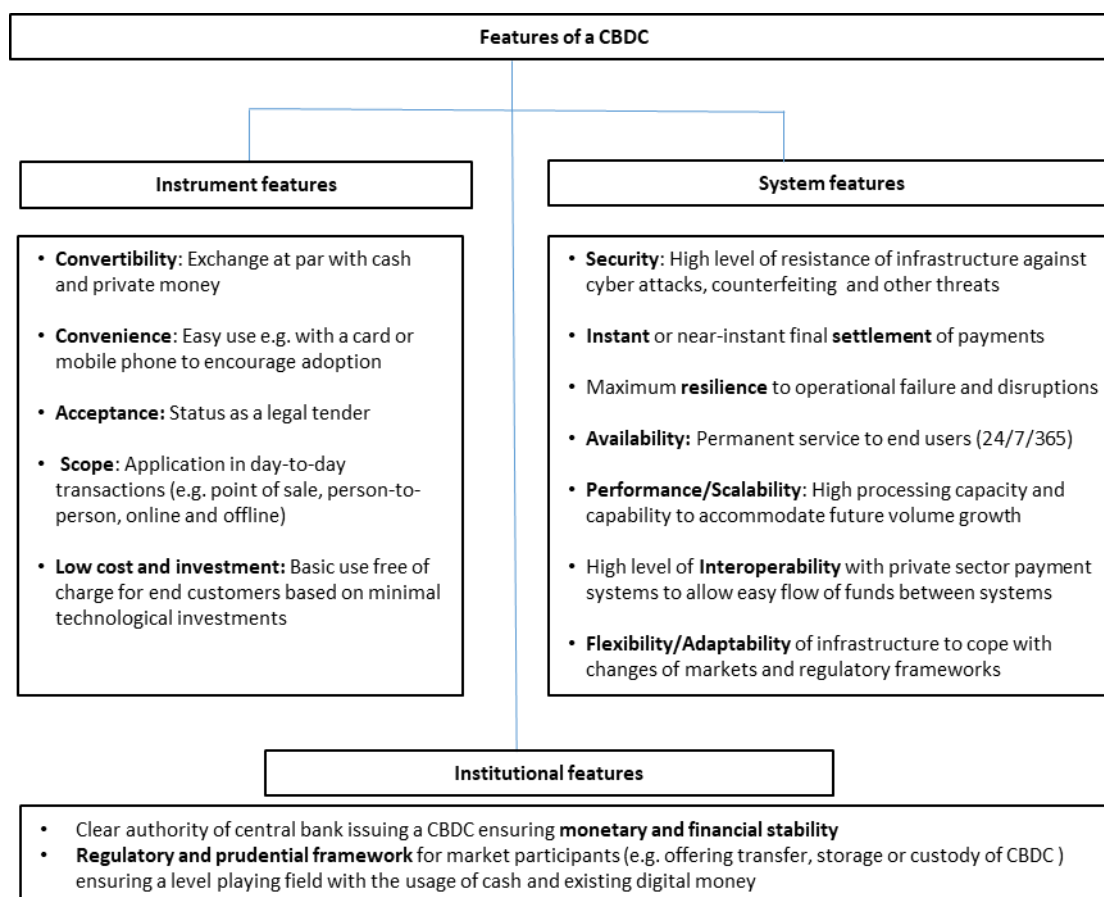
3. Features and design options of a CBDC

There is a broad consensus that a CBDC should foster efficiency and innovation in payments while at the same time preventing negative effects on monetary and financial stability. Therefore, a number of essential requirements for a CBDC can be defined. On this basis, alternative design options are conceivable.

3.1 Essential requirements of a CBDC

Table 1 gives a brief overview of important requirements a CBDC should meet, distinguishing between instrument features, system features and institutional features (BIS, 2020). In order to achieve a high level of acceptance, a CBDC should be convenient to use in day-to-day payment transactions, including point of sale and person-to-person payments, both online and offline. The basic services of a CBDC should be free of charge for end users and require only minimal investment in technology. The underlying infrastructure and systems should be resistant to cyber risks and counterfeiting and should be highly resilient against operational failures and disruptions. Payments with a CBDC should be settled instantly and available on a 24/7 basis. Furthermore, the system architecture must be able to perform a large number of transactions and must be scalable to accommodate fast-growing volumes in the future. A high level of technical interoperability between different CBDCs will be crucial for efficient execution of cross-border payments (Auer et al., 2021; BIS, 2020). Various bilateral experiments of central banks have demonstrated the feasibility of using CBDCs for cross-border payments (e.g. ECB and BoJ, 2019; BoC and MAS, 2019; BoT and HKMA, 2020). Finally, a CBDC system needs the flexibility to adapt to changing market or regulatory environments.

Figure 1: Important features of a CBDC



Source: Own illustration based on BIS (2020)

3.2 Design options of a CBDC

Based on the core features of a CBDC, alternative options are available that differ e.g. in terms of underlying technology, interest-bearing characteristics, integration into the existing payment infrastructure and privacy (figure 2). A key design option concerns the question of whether or not a CBDC should bear interest and, if so, how exactly interest levels should be determined in line with monetary policy and financial stability objectives. From a technological perspective, the decision on the underlying payment infrastructure is crucial to ensuring safe, efficient and trustworthy execution

of transactions in central bank money (Auer and Böhme, 2020; Auer et al., 2020; Bank of Canada, 2020; Bank of England, 2020; BIS, 2020; BIS, 2018; ECB, 2020; Sveriges Riksbank, 2017).

Figure 2: Design options for a CBDC

Design Options for a CBDC	
Instrument design	<ul style="list-style-type: none"> • CBDC “deposits” Interest bearing or not • Level of interest rate versus other central bank rates • Holding limits
Distribution channel	<ul style="list-style-type: none"> • Direct distribution by central banks • Distribution through banks (like cash) • Role of third party payment service providers (PSP)
Scope of applications	<ul style="list-style-type: none"> • Online/offline features • B2C, C2C, B2B
Technical platform (ledger design)	<ul style="list-style-type: none"> • Ledger technology (centralised, DLT, hybrid) • Account based
Devices	<ul style="list-style-type: none"> • Cards, wallets (HW/SW), smartphones, wearables
Privacy	<ul style="list-style-type: none"> • Complete anonymity (like physical cash) • Selected access to transaction data due to KYC/AML issues
Compensation model	<ul style="list-style-type: none"> • Cost allocation (users, PSP, merchants, banks etc) • Free of charge to promote adoption, innovation, inclusiveness
Integration into private electronic payment systems	<ul style="list-style-type: none"> • None • Full interoperability (e.g. ATM, non-cash transactions) • Cross border payments (e.g. SWIFT, money transmitters)

Source: Own illustration based on BIS (2020)

In general, the ledger on which the payments are recorded could be centralised (e.g. operated by the respective central bank or a cooperation between them) or decentralised using distributed ledger technologies (DLT) such as a Blockchain solution. A hybrid approach is also conceivable. Possible advantages of a centralised ledger approach include the easier technical integration in existing payment infrastructures that are traditionally based on centralised ledgers, lower investments to adapt existing payment architectures, and more effective prevention of money laundering and fraud due to the central availability of transaction data. On the other hand, thorough governance of access, usage and monitoring rights would be needed to fulfil privacy requirements and maintain public trust in data protection. Otherwise, broad adoption of a CBDC would be unrealistic. A more decentralised approach could support the introduction of more sophisticated, innovative payment functions like smart contracts. Possible disadvantages include a lack of transparency with regard to anti-financial crime initiatives and more technological barriers for integrating a CBDC in the existing payment systems. Furthermore, a decentralised ledger could potentially make peer-to-peer and offline payments easier, but would probably be more costly to implement due to the higher level of complexity. Other technical design aspects concern the payment authentication approach (multifactor), the underlying data structure of a CBDC system and the integration with other systems (e.g. know your customer (KYC), anti-money-laundering (AML), counter-terrorism financing (CTF)).

The introduction of a CBDC would require substantial capital expenditures by the respective central banks and market participants such as banks, PSPs and merchants. In addition, there will be running costs for handling a CBDC, e.g. maintenance of the IT systems needed to handle CBDC transactions and corresponding costs for regulatory compliance. Therefore, market participants would have to charge fees for CBDC services to recover their costs and establish a viable business model. Depending on the market conditions, fees could be borne by merchants, users or both. However, transaction fees could hamper rapid adoption of a CBDC. In addition, this would contradict the

general purpose of offering a digital equivalent to physical cash. The design of the compensation model will obviously have implications for the efficiency, innovation and inclusiveness of the ecosystem creating the CBDC. If no charges on CBDC transactions are permitted, banks and other service providers would have to include the corresponding costs for using a CBDC in a blended product calculation for their other service offerings. The specific design of a CBDC system would require a rulebook formalising the roles and responsibilities of the operator(s), participants and potentially other service providers and stakeholders.

Besides, the digital nature of a CBDC would technically allow individual transactions to be tracked, thus gaining insights into consumption behaviour and even private social activities. Hence, the protection of data privacy and the guarantee of anonymity equivalent to physical cash transactions are widely considered important features of a CBDC. However, the prospects of the latter feature may depend on the democratic status of a country and could also provoke controversial debate if criminal investigations come into conflict with individual data protection rights (e.g. BIS, 2020; Bech and Garratt, 2017).

3.3 Central bank digital currencies (CBDCs) – international developments

Many central banks have been investigating the potential benefits and risks of a CBDC. Technical and economic design options have been analysed and tested in a limited experimental setting and pilot projects. Wallets can take “soft” forms (e.g. mobile apps) or “hard” forms (e.g. memory sticks, cards, wearables). China has been working for more than ten years on a digital renminbi (“digital RMB” or “e-CNY”). Since 2021 the e-CNY, issued by the People’s Bank of China (PBOC), has been tested in a growing number of large cities and regions. It has the status of legal tender and is primarily intended as a digital alternative to physical NAC, enhancing speed, security and efficiency of payments. It is also designed to facilitate international payments and offline P2P transactions. In addition, the PBOC aims to reduce money laundering, gambling, corruption and terror financing. It is an open question to what extent an e-CNY will limit individual privacy of financial transactions (Bhattacharya, 2022; Broby, 2024).

The Bahamas introduced the first fully operational CBDC in 2020, the so-called “Sand Dollar” (Branch et al., 2023). The primary objective was to improve financial inclusion, as many people had no or only limited access to banking services. Other objectives included offering a secure and efficient payment instrument and reducing money laundering and terrorist financing. Sand Dollars are usually used via digital wallets such as smartphone apps or physical payment cards. The establishment of a digital pound is being extensively evaluated by the Bank of England (Bank of England, 2023; Bank of England, 2020). Similar projects are being carried out in other countries: a digital US dollar in the United States (Federal Reserve, 2023), a digital yen (Bank of Japan, 2024; Bank of Japan, 2020), a digital Canadian dollar (Bank of Canada, 2024), an e-krona in Sweden (Sveriges Riksbank, 2024; Sveriges Riksbank, 2017), along with emerging economies like Nigeria, which became the first African country to introduce a CBDC (eNaira) (Ree, 2023). Furthermore, international cooperations between central banks are emerging to cover aspects of international payments and cross-border interoperability. These include the mCBDC Bridge, with the participation of Hong Kong, Thailand, China and the VAE (BIS Innovation Hub, 2021).

4. The current status of a digital euro

Like most of the other CBDCs currently in the preparation phase, a digital euro intends to offer a secure, efficient and trustworthy digital payment alternative in the digital age. Moreover, the digital euro should enhance the digital autonomy of the European single payment area (SEPA) from global payment service providers and foster innovation in the payment industry. The introduction of a digital euro has gained momentum since the idea of a CBDC for the eurozone was publicly presented in 2020 (ECB, 2021; ECB, 2020). In October 2021 the ECB launched an investigation phase by analysing the feasibility of a digital euro, including core design features, technical and legal aspects

(e.g. ECB, 2022a; ECB, 2022b). This process was accompanied by extensive discussions with market participants and feedback on prototyping exercises from potential users and technical service providers (e.g. ECB, 2023a, ECB, 2023c, ECB, 2023d; ECB, 2023e). The work of the investigation phase also covered the digital euro compensation model for banks and other PSPs, considerations on digital financial inclusion, and the envisaged rollout approach (ECB, 2023b; ECB, 2023f). At the end of the investigation phase, the results were documented in a draft regulation for the introduction of a digital euro (European Commission, 2023a; European Commission, 2023b, European Commission, 2023c). The ECB has been working on a rulebook for a digital euro, which will provide a single set of rules, standards and procedures for usage of a digital euro. Major components of the rulebook include (ECB, 2024a; ECB, 2024d):

- functional and operational model of a digital euro (e.g. end-to-end flows, core requirements for supervised intermediaries, minimum user experience standards)
- adherence model of the digital euro scheme (e.g. scheme eligibility criteria, participant obligations)
- technical scheme requirements (e.g. IT infrastructure, application programming interface implementation, technical standards)
- risk management requirements
- digital euro scheme management rules (e.g. scheme governance, change management processes)

4.1 Scope and core features of a digital euro

The digital euro issued by the ECB is intended to become a digital form of central bank money available to the general public as an alternative to NAC. As such, the digital euro would also have the status of legal tender. Hence, the digital euro shall not replace the use of cash but add to the current spectrum of payment instruments. A digital euro shall be used from person to person, at the point of sale, in e-commerce and in government transactions. It should allow users to settle payments instantly in central bank money. Users could access digital euro services via their payment service provider's proprietary app and online interface, or via a digital euro app provided by the Eurosystem. In order to protect monetary and financial stability, the current proposal on the design of a digital euro stipulates that holdings of individuals would not be remunerated and would be subject to holding limits. A digital euro should be designed to support financial inclusion. Therefore, the digital euro has to be easily accessible by people with low digital and financial skills such as elderly or disabled people. A digital euro payment card should be made available so that payments with the digital euro would be feasible without using a smartphone app. People without access to a bank account or digital devices would also be able to pay with a digital euro, for example by using a card provided by a public authority such as a social security office. Users would also be able to exchange digital euros for cash or vice versa at cash machines (ECB, 2023c; ECB, 2023f). Based on the current design, it should be noted that the digital euro would not be programmable but would allow for conditional payments (ECB, 2023a).

4.2 User privacy and data protection

The privacy and data protection of digital euro users shall be ensured in line with the "privacy by design" concept. This approach makes data protection an essential component of the respective core functionality embedded in IT systems and business practices, e.g. by using cryptographic technologies. For online payments with a digital euro, the issuer and payment infrastructure provider would not be able to directly link transactions to specific individuals. The data exchanged between PSPs and the Eurosystem would be segregated. As a result, the Eurosystem would not be able to directly identify end users or link any of the data it processes to an identified end user. The design of the digital euro includes an offline functionality that would offer users a cash-like level of privacy, both for person-to-person payments and payments in physical shops. Using the digital euro for offline payments would not involve sharing personal transaction data with PSPs, the Eurosystem or any potential providers of supporting services. Only the payer and the payee would know the details of offline digital euro payments. All parties involved in the digital euro scheme have to comply with the

standards of the European Union Data Protection Regulation (EUDPR) and the General Data Protection Regulation (GDPR) (ECB, 2024c).

4.3 AML and fraud detection

Although data protection is named as a key priority, the Eurosystem has to make sure that market participants comply with EU law and that end-users are protected from fraudulent activities. Therefore, the technical design of a digital euro should improve capabilities to counteract financial crime like tax evasion, terrorist financing and money laundering. Effective fraud detection and prevention is essential to maintain trust in a digital euro as an attractive and safe payment method. Therefore, the system architecture has to carefully balance the individual rights of privacy and data protection with the collective interest to prevent illegal activities (ECB, 2023b). Methods and tools of AI could help to find suitable technological solutions in situations where these interests come into conflict. This is an important field that needs to be covered in a final rulebook for a digital euro.

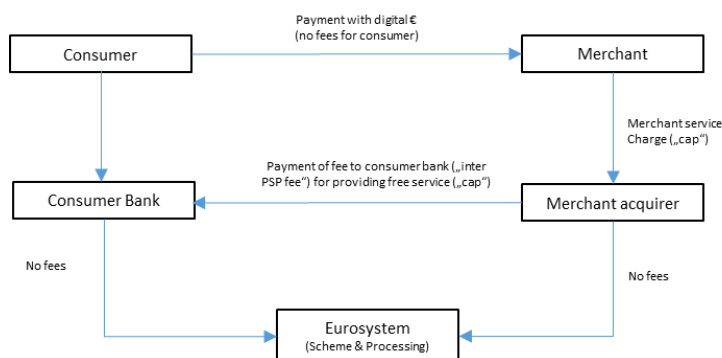
4.4 Cost allocation and compensation model

The Eurosystem has proposed that it would bear its own costs, reflecting the status of a digital euro as a public good and following the same logic that currently applies to cash. PSPs would bear their own costs linked to the adoption of the digital euro services they provide, but they would not be charged Eurosystem costs related to scheme management and settlement processing. There is a political agreement that private users should be able to pay with a digital euro and use basic services without any additional charges, as is the case with physical cash. These basic services offered by banks and other PSPs for using the digital euro could include: (i) opening/holding/closing of a digital euro payment account, (ii) non-automated and automated funding and defunding from a non-digital euro payment account, (iii) waterfall/reverse waterfall services, (iv) provision of a basic payment instrument, and (v) initiating and receiving payment transactions (European Commission, 2023b, Annex 2).

At the same time, PSPs (such as banks and payment card companies) need to have sufficient economic incentives to distribute the digital euro to their customers and to provide acquiring services to merchants. In order to generate network effects among users, wide and rapid adoption of a digital euro is essential. Therefore, PSPs distributing the digital euro to private individuals should have a similar level of economic incentive to do so as for other comparable electronic payments. Although basic functionalities of digital euro services should be free of charge, PSPs could charge customers for providing additional value-added services that build on digital euro functionalities. Against this background, the ECB has agreed upon the basic elements of a compensation model (figure 3) that needs further elaboration (ECB, 2024c; ECB, 2023b). However, the revenue potential for PSPs distributing the digital euro to customers would be lower than that of PSPs charging merchants for digital euro acquiring services. Therefore, PSPs charging fees to merchants should compensate the PSPs offering free services to customers by paying an inter-PSP fee. The respective fees should be market based but will most likely be subject to regulatory limits, as is the case in the card business. Calibrating these fees is an essential task for the preparation phase. It should balance the commercial incentives for market participants with consumer protection interests.

In order to establish fair competition in the market for digital euro services, the easy transfer of digital euro holdings from an individual's personal wallet held with one intermediary to another is important. Hence, intermediaries would be expected, at the user's request, to enable the user to port their digital euro access as well as their transaction history and recurring payments to a new intermediary. The latter would be able to acquire the necessary data directly from the previous intermediary, without the involvement of the central bank.

Figure 3: Basic structure of the compensation model for a digital Euro



Source: Own illustration based on ECB (2024c)

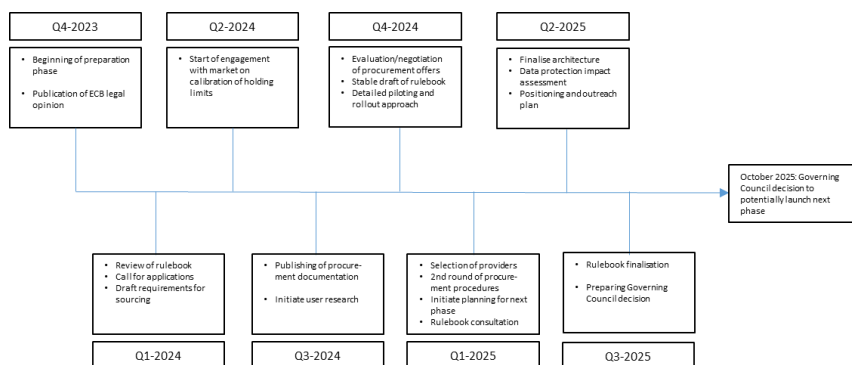
4.5 The rollout of a digital euro

The introduction of a new payment instrument is a highly complex undertaking, due to the large number of intermediaries, different systems and the need for new hardware solutions, e.g. for POS transactions. Therefore, a rollout in two phases is currently envisaged. A first product release would include person-to-person and e-commerce payments (online and offline). A second product release would include point-of-sale payments, which would require suitable physical infrastructure across Europe such as payment terminals and physical devices. The prototyping exercise and market research on a digital euro confirmed that a digital euro could be smoothly integrated into multiple use cases within the existing European payments landscape. Furthermore, it revealed that a sufficiently large pool of European providers are able to develop digital euro solutions based on different architectures and technologies (ECB, 2023b; ECB, 2023d; ECB, 2023e).

5. Start of the preparation phase for a digital euro

On 18 October 2023, the Governing Council of the ECB announced it is entering the next phase of the digital euro project – the preparation phase, which started on 1 November 2023 and is scheduled for two years (ECB, 2023g, figure 4). It will involve finalising the design and features of a digital euro, based on further testing and experimentation to ensure that key requirements and objectives will be met. Another focus will be the further development of the technical platform, the selection of potential service providers and the finalisation of the digital euro rulebook (ECB, 2024a). An important workstream concerns the methodology of calibrating the individual holding limit. However, such a limit will be set closer to a potential launch date to reflect the economic conditions at that time (ECB, 2024b). Finally, the Governing Council will decide whether or not to move to the next stage, i.e. the possible future issuance and rollout of a digital euro.

Figure 4: The preparation phase for the digital euro



Source: Own illustration based on ECB (2023g)

6. Is there a need for a digital euro?

When looking at the communicated objectives of a digital euro, the question arises as to whether or not the expected benefits outweigh the costs of developing and running a digital euro and the potential financial risks associated with its introduction.

6.1 Efficiency of payments

A secure, cost efficient and fast transfer of money is a key element of a modern financial system. In a currency union like the eurozone, digital money transfer has been the dominant type of payment for many years. Cash transactions have gradually declined in importance in the eurozone as a whole and in individual countries (e.g. ECB, 2024e; ECB, 2024f; ECB, 2022). In non-cash transactions, money is transferred between bank accounts, which are the end-to-end nodes for payments between private customers (C2C), businesses and private customers (B2C), or between businesses (B2B). Even today, bank accounts are essentially digital wallets representing the monetary value and recording changes due to incoming and outgoing payments in virtual T-accounts. Online and mobile banking apps grant customers real-time access to their bank accounts and facilitate all types of standard bank transactions (e.g. bank transfers, standing orders, direct debit authorisations, credit card transactions), including the buying and selling of securities. Since 2012, in the eurozone, money transfers between bank accounts have to be executed within 24 hours at the latest (“t+1”).

However, instant payments, i.e. payments settled in real time, will become the “new normal” in the European payment industry after the Instant Payments Regulation (IPR, Regulation (EU) 2024/886) entered into force on 8 April 2024. It requires EU payment service providers and e-money institutions that offer regular SEPA credit transfers to offer instant euro payments within 10 seconds, every day of the year, via all initiation channels. The charges that apply must not be higher than those for standard credit transfers. In light of these recent technological and regulatory developments, there seems to be little need to introduce a digital euro, especially as customers already have access to multiple electronic payment instruments allowing for near-time or real-time payments at no or very low, incremental costs.

6.2 Safety and privacy – regulation of payments in the EU (PSD2, PSD3, PSR)

The most important regulatory framework for payments and payment service providers in the EU is the revised Payment Services Directive (PSD2), which entered into force on 12 January 2016 (Directive (EU) 2015/2366). The PSD2 is amended by three delegated acts, developed by the EBA and implemented by respective RTS, which were published in the Official Journal of the European Union on 13 March 2018 and apply as of 14 September 2019. To take into account the changes in the payment services industry in recent years and keep pace with its ongoing digitisation, the European Commission has initiated further regulatory changes. Against this background, the European Commission proposed, on 28 June 2023, a modernisation of the current Payment Services Directive (PSD2), which will become PSD3, and the establishment of a Payment Services Regulation (PSR). Both legislative initiatives are still to be finalised.

The main objectives of PSD2 included (i) to promote a more integrated and efficient European payments market; (ii) to further level the playing field for payment service providers; (iii) to make payments safer and more secure; and (iv) to enhance protection for European consumers and businesses. Major changes involved the introduction of strong customer authentication solutions to enhance process security and the provision of a standardised and reliable access interface to payment accounts (i.e. an application programming interface, API), which makes it possible to securely identify third-party payment service providers. The ongoing initiatives PSD3 and PSR intend to better combat payment fraud and improve customer rights as well as the functioning of open banking. As a result, payment rules will be further harmonised and barriers to competition reduced to foster innovation in the European payment sector.

6.3 Innovation

The ECB also argues that a digital euro would support innovations in the payment industry. In fact, the payment sector has been among the most innovative fields in financial services over the last decade, as the ongoing digitisation of the economy requires fast, secure and flexible electronic payments. Moreover, the growing digitisation of assets through tokenisation and advances in distributed ledger technologies has paved the way for innovative payment solutions. Another key enabler of innovations in the sector was PSD2, which facilitated open banking in Europe.

Open banking allows for financial data to be shared between banks and third-party service providers through the use of application programming interfaces (APIs). APIs form the technical backbone of open banking. They enable standardised and secure data exchange between financial institutions and third-party providers (TPPs). Account information services (AIS) and payment initiation services (PIS) are important examples of new services based on APIs. Other use cases include identity verification (e.g. in e-commerce), credit scoring, peer-to-peer transfers or financial planning tools for private households. New payment instruments like contactless payments using NFC technologies, digital wallets (e.g. Apple Pay, Google Pay), request-to-pay (RtP) solutions, buy now pay later (BNPL) or instant payments are only a few of those already introduced independently of a CBDC. A digital euro would not broaden the innovation potential in the payment sector per se, especially if the digital euro is not programmable, as the current status of the design features indicates.

6.4 Direct access to central bank money

Some promoters of a CBDC maintain that citizens will no longer have access to central bank money if demand for NAC continues to fall and becomes marginalised in the future. In such a scenario, trust in the currency would entirely depend on trust in financial intermediaries issuing commercial money (e.g. Barontini and Holden, 2019; Sveriges Riksbank, 2018).

Trust in the monetary and financial stability of a currency area depends very much on the credibility of the respective central bank's monetary policy. This credibility rests on the effectiveness of the central bank's monetary policy instruments, in conjunction with the macro- and microprudential supervisory policies for financial institutions. Therefore, especially when responding to crisis situations, the central bank must have control over the money supply, regardless of the type of central bank money individuals are using, i.e. physical NAC or a CBDC. Clearly, it is hard to challenge this argument as long as a CBDC is nothing more than a digital alternative to NAC. Even in a nearly fully digitised financial system, the public could then continue to have access to central bank money. Besides, a digital euro could at least partially provide a secure and efficient payment system, even when – in serious crises – private payment systems may fail.

7. Potential impact on the banking sector

A key area of concern relates to the potential impact of a CBDC on the stability and profitability of the banking sector. Although concerns over a greater risk of bank runs are not the subject of this paper, it has been noted that individual holding limits and/or tiered interest rates on digital euro deposits could mitigate such a risk.

In addition, a digital euro could affect the profitability of commercial banks in three ways:

- (i) The introduction of a digital euro will require significant investments in digital payment infrastructure. Both central banks and commercial banks will have to adapt their IT architecture to integrate a CBDC into their existing systems as an alternative means of payment. As long as the design and underlying architecture has not been finalised, it would be very speculative to estimate the size of one-time investments and additional operating costs required to integrate a digital euro into existing payment processes. Therefore, they are outside the scope

of this paper, yet they need to be taken into account when deciding on the level and structure of fees within the compensation model described above.

- (ii) The loss of revenues from payment transactions could negatively affect banks and other PSPs such as payment card companies to the extent that digital euro use replaces other means of electronic payment.
- (iii) As deposits are an important refinancing source for retail and universal banks, refinancing costs of banks could increase if customer deposits are partly withdrawn due to a change of payment behaviour in favour of a digital euro. The resulting funding gap would have to be closed by other, usually more expensive, financing instruments such as the issuance of bonds or refinancing through ECB facilities. In the following, we try to estimate the potential losses of transaction fees and increased refinancing costs of the banking sector and other PSPs in different scenarios. The resulting estimated figures give an indication for a compensation model that would be neutral in terms of banking sector profitability.

7.1 Methodology

The introduction of a digital euro will have an impact on the volume of monetary aggregates and the distribution of their components. The monetary aggregate M1 is defined as the sum of currency in circulation (NAC) and overnight deposits (D). Central bank money (CBM) consists of NAC and central bank deposits of commercial banks (central bank reserves, CBR). A CBDC, being a digital form of NAC and therefore another form of legal tender, would amend both the definition of M1 (equation 1) and central bank money (equation 2).

$$(1) M1 = NAC + D + CBDC$$

$$(2) CBM = NAC + CBR + CBDC$$

Hence, the introduction of a CBDC would trigger substitutions between those different monetary components if a CBDC is considered a safe, convenient and fast payment instrument. The basic substitutional relationships between those components are summarised in table 1.

Table 1: Impact of a CBDC on monetary aggregates and PSPs

transaction type	Impact of transaction type							
	ΔNAC	$\Delta CBDC$	ΔCBR	ΔD	$\Delta M1$	ΔCBM	$\Delta \text{trx_income}$	$\Delta \text{ref_costs}$
NAC/CBDC substitution	↓	↑	→	→	→	→	→	→
D/CBDC substitution	→	↑	↓	↓	→	→	↓	↑
P2P	→	→	→	→	→	→	→	→
POS	→	↑	→	↓	→	→	↓	↑

Source: Own analysis

Table 1 distinguishes four types of basic transactions that may be observed upon the introduction of a CBDC. Firstly, a CBDC could partially replace NAC in day-to-day payment behaviour, which itself would be neutral for the monetary aggregates M1 and CBM. It would also have no immediate impact on the profitability or refinancing costs for banks. Secondly, a CBDC could replace deposits, i.e. commercial money, for non-cash transfers of value. As this would require withdrawals from deposits to CBDC wallets, deposit volumes and reserves of banks at the central bank would decrease, presuming that the holders of CBDC have a direct claim on the central bank. Consequently, fees from electronic payments executed by banks would drop and bank refinancing costs could increase if the refinancing gap created by declining retail deposits had to be closed by other, usually more

expensive, funding instruments (e.g. open market transactions with the central bank). Furthermore, table 1 shows that P2P transactions using a CBDC would be neutral on the parameters mentioned above. However, if a CBDC is used for online payments or at physical stores, transactions fees for banks and PSPs could be negatively affected, e.g. when replacing direct debit or direct credit payments. In addition, this could also trigger higher refinancing costs.

7.2 Market data and estimated fee pool

In order to estimate potential fee losses and increased financing costs for the banking sector, one needs to identify the key parameters of these cost items. The starting point of our analysis marks the existing payment structure in the eurozone. The ECB regularly publishes the payment statistics for the eurozone, which include the development of transaction numbers and transaction values per payment instrument. Table 2 summarises the respective figures for the year 2023. Table 3 shows the relevant macroeconomic data, notably the total consumption of private households, the average disposable income per capita, and the corresponding savings rate. These data are important for estimating total payment volumes and numbers per payment instrument as well as the corresponding transaction fees.

Table 2: Payment statistics (2023) and selected ratios

Payment statistics (2023)							
Payment instrument	no trx (bn)	no trx (%) ex cash	value of trx (tn €)	value of trx (%) ex cash	ø ticket size (€)	no trx (%) incl cash	value of trx (%) incl cash
Card Payments	76.0	54.9%	3.0	1.4%	39.9	28.4%	1.3%
Credit Transfer	29.8	21.5%	206.7	92.8%	6947.9	11.1%	91.7%
Direct Debit	21.5	15.5%	10.0	4.5%	467.0	8.0%	4.5%
E-Money	8.9	6.4%	0.5	0.2%	56.2	3.3%	0.2%
Other	2.2	1.6%	2.5	1.1%	1113.6	0.8%	1.1%
Total (ex cash tx)	138.4	100.0%	222.7	100.0%	1609.8	51.7%	98.8%
Cash trx	129.4		2.8		21.6	48.3%	1.2%
Total (incl. cash trx)	267.8		225.5		842.2	100.0%	100.0%

Source: ECB, own analysis

Table 2 differentiates non-cash payments using cards, credit transfers, direct debit, e-money and others. In 2023 the total value of non-cash payment transactions was around €223 trillion, based on approximately 138.4 billion transactions. Since the ECB does not regularly report the corresponding figures for cash transactions, we have estimated these figures based on previous studies of retail payment habits (ECB, 2022). The number of more than 129 billion cash transactions underscores the important role that NAC continue to play in day-to-day payment behaviour in the eurozone. However, there are significant differences between countries.

Table 3: Selected macroeconomic data (2023)

Economic region	GDP (m €)	private consumption (m €)	private consumption (% GDP)	population (m)	no households (m)	ø people per household	ø consumption per household (€)	ø consumption per capita (€)	ø savings rate	ø implied disposable income (€)
Eurozone (2023)	14,499,937	7,721,177	53%	349	158	2.2	48,868	22,124	14%	25,725

Source: ECB, Eurostat, own analysis

In a next step, we estimate the fee pool based on the underlying payment structure and the average fees charged by financial institutions executing the payment process of the respective instrument. As the use of payments and the corresponding fees vary between retail and corporate customers, we estimate the split of payment volumes and values between these groups (table 4). In the

corporate segment, it will be mainly small and medium-sized enterprises (SMEs) using a digital euro. It should be noted that the figures for corporates do not include intra-company payments, which are often consolidated internally by using cash management and treasury solutions and are therefore not subject to fees for individual payments. In addition, a meaningful separation between payments within the eurozone and cross-border payments between the eurozone and third-party countries is not feasible as the required data is not systematically collected. To estimate the number and value of transactions per payment instrument, we use the macroeconomic consumption data as of 2023 and a typical payment structure of private households. The number and average ticket size per payment instrument and household are in line with statistical data from various sources (Deutsche Bundesbank, 2024; Capgemini, 2023; ECB, 2022) and are partly based on own assumptions.

Table 4: Estimated split of transactions between private households and corporates (SMEs)

Payment statistics (2023)	Payment structure private households								Payment structure Corporates (SME)			Total	
Payment instrument	Ø ticket size (€)	Ø no trx p.a. household	Ø no trx p.m. household	Ø trx value p.a. (€)	Ø trx value p.m. (€)	share of trx value	total trx value households (tn €)	no trx households (bn €)	no trx SME (bn)	value of trx SME (tn €)	Ø ticket size SME (€)	no trx (bn)	value of trx (tn €)
Card Payments	20.0	240.0	20.0	4,800	400	9.8%	0.8	37.9	38.1	2.3	59.7	76.0	3.0
Credit Transfer	500.0	24.0	2.0	12,000	1,000	24.6%	1.9	3.8	26.0	204.8	7,889.8	29.8	206.7
Direct Debit	350.0	60.0	5.0	21,000	1,750	43.0%	3.3	9.5	12.0	6.7	559.2	21.5	10.0
E-Money	20.0	48.0	4.0	960	80	2.0%	0.2	7.6	1.3	0.3	264.7	8.9	0.5
Other	0.0	0.0	0.0	0	0	0.0%	0.0	0.0	2.2	2.5	1,113.6	2.2	2.5
Total (excl cash tx)	104.2	372.0	31.0	38,760	3,230	79.3%	6.1	58.8	79.6	216.6	2,721.9	138.4	222.7
Cash trx	16.8	600.0	50.0	10,108	842	20.7%	1.6	94.8	34.6	1.2	34.7	129.4	2.8
Total (incl. cash trx)	50.3	972.0	81.0	48,868	4,072	100.0%	7.7	153.6	114.2	217.8	1,907.5	267.8	225.5

Source: Own analysis

Along with average transaction fees per payment instrument (table 5), we have estimated the fee potential per payment instrument and in total (table 6). The respective fee estimates are based on the officially published pricing tables of a sample of financial services providers in the respective field, i.e. major banks, payment service providers and credit card companies. With regard to the allocation of fees between private and SME customers, we first estimated the respective transaction numbers and values for an average private household, then allocated the remaining volumes to the SME segment.

Table 5: Assumptions on transaction fees

Ø fee per trx (€, %)	
Card-based trx ¹	1.00%
direct debit	0.25%
direct credit (€/tx) ²	0.5
cross-border	2%
paypal (other E-money)	2.50%
Other	1.00%
Cash	0
CBDC	0

¹ Card fees (credit, debit cards: interchange fee, scheme fee, acquiring fee)

² SEPA (retail trx free of charge)

Source: Own analysis, ECB (2022), World Payment Report (2023), various fee tables from private banks, savings banks, cooperative banks

Table 6: Estimated fee pool 2023

Transaction fees (m €)	Private households	Corporates (SME)	Total
Card Payments	7,584	22,716	30,300
Credit Transfer	18,960	12,979	31,939
Direct Debit	8,295	16,805	25,100
E-Money	3,792	8,708	12,500
Other	0	24,500	24,500
Total (ex cash tx)	38,631	85,708	124,339
Cash trx	0	0	0.000
Total (incl. cash trx)	38,631	85,708	124,339

Source Own analysis

With an estimated fee volume of about €124 billion, the payment services business is an important cornerstone for many financial institutions in the eurozone. According to the latest market research, the expected CAGR of the eurozone payment business is between 6% and 8% p.a. (Capgemini, 2023; OeNB/zeb, 2022). Major drivers include the ongoing shift from physical shopping to e-commerce and mobile commerce along with the ongoing adoption of smartphone-based payment solutions (e.g. Apple Pay, Google Pay) and other payment innovations like BNPL offerings, which are gradually replacing traditional cash payments. Cash payments are free of charge, except fees for withdrawals from or payments into accounts, e.g. in a physical bank branch or at an ATM. In line with the current proposal of a digital euro, we assume that basic functions are also free of charge for retail customers.

Whether and to what extent a digital euro will impact the fee pool of the payment services business basically depends on two factors. Firstly, the type of fee-bearing payment instruments the digital euro will replace. Secondly, the level and speed of digital euro adoption. That is to say, faster and higher acceptance of the digital euro, especially by private households and SME corporate customers, would cause a stronger negative impact on the payment fee pool.

Due to the lack of comparable data from introducing a CBDC in other jurisdictions, it is difficult to estimate plausible substitution rates and their development over time. For the purpose of our simulation, the substitution rate is defined as the percentage rate at which existing payment instruments will be replaced by a digital euro. In the following, we assume that a digital euro could partly replace cash transactions, card-based transactions, direct debit and e-money transactions. In addition, we assume that direct credit transactions, mainly used for larger transaction sizes, are not replaced by a digital euro. The potential substitution rates could differ per instrument and over time. Therefore, a range for a substitution rate underlying our simulations has to be defined. As a starting point, we looked into the current share of e-money payments (e.g. PayPal) and the development of their adoption rate over the last ten years, as e-money is among the most recently established electronic payment instruments. The current share of e-money in terms of number of transactions is about 6.4% (ECB, 2024e; ECB, 2024f). The average growth rate of the e-money stock over the last ten years has been about 20% p.a. in the eurozone, though starting from a low level.

In the following, we perform a simulation of the potential fee losses upon the introduction of a digital euro for a broad range of substitution rates, from 2.5% at the lower end to 20% at the upper end. The replacement rates per payment instrument shall be reached at the end of an adoption period of ten years. This means that a digital euro could replace, for example, 2.5% of card-based transactions, direct debit and e-money transactions after 10 years. We also implicitly assume a 2.5% replacement rate of cash transactions. By definition, however, this has no impact on the fee volume for financial institutions. Table 8 shows, by way of example, the possible impact of a 2.5% substitution rate on the yearly fee income, which amounts to approximately €1,059 million.

7.3 Deposit replacement and refinancing costs

The second economic impact for banks in the eurozone could be a change in refinancing costs when a digital euro is established. Traditional non-cash payment instruments like card payments, credit transfers, direct debits and e-money are usually linked to payment accounts, i.e. bank deposits, which constitute an important part of commercial bank refinancing. At the end of 2023, bank deposits amounted to approximately €8.8 trillion in the eurozone, of which around €5.1 trillion came from private households (ECB, 2024g). The household deposits to total funding-ratio for large banks subject to the single supervisory mechanism (SSM) has been around 33% over the last five years (ECB, 2024h). Funding based on retail deposits is particularly important for commercial banks with a substantial retail business. To the extent that customers replace not only cash but also deposit-based payments with digital euro transactions banks would have to replace the lost deposit volume with alternative funding instruments. These are usually more expensive than comparably low-interest deposits.

For our simulation we assume that banks would replace their reduced deposits either with an instrument of wholesale funding (e.g. bonds, medium-term notes, commercial papers), by expanding their refinancing operations with the ECB, or a combination of both. In either case, refinancing costs will be higher than the interest paid on deposits. Table 7 gives an overview of current spreads of wholesale funding (indicated by a 5y Investment Grade (IG) rated bond) and main refinancing operations (MRO) versus deposit financing. The respective spreads have been calculated as the average difference between the underlying funding rates over the period 10/2023 to 10/2024. Although the respective spreads appear to be relatively stable, even in the medium term, the corresponding increase in funding costs due to a reduction of cheap overnight retail deposits could vary, depending on an individual bank's rating and chosen refinancing mix. Therefore, we assume a broad range of increased financing costs from 200bp to 300bp p.a., with the lower bound reflecting favourable market conditions.

Table 7: Assumptions on funding spreads above retail overnight deposit rates

Ø spread wholesale funding vs. deposits (1d) ¹	2.90%
Ø spread MRO vs. deposits (1d) ¹	3.25%
Ø spread Euribor (12m) vs. deposits (1d) ¹	2.50%
ECB Rate (MRO)	3.65%
deposit rate (ECB)	3.50%
Long Term Bond (5y, IG-Rating ²)	3.30%
Euribor (12m)	2.90%
Ø retail deposit rate (1d)	0.40%

¹ spreads are calculated as average difference between funding rates (period 10/2023-10/2024)

² IG: Investment Grade, all data as of 16/10/2024

Source: ECB, S&P, own analysis

In order to get a first indication of the potential increase in financing costs, we apply the lower and higher end of the spreads to the 2.5% replacement scenario laid down in table 8. Based on those assumptions, the refinancing volume could reach around €162 billion, which would lead to increased refinancing costs in the approximate range of €3.2 billion to €4.9 billion p.a., depending on the refinancing cost spreads. Table 8 also displays the estimate of the overall cost for the financial sector

in the 2.5% replacement scenario, including reduced transaction fees. The average expected cost would be around €5.1 billion p.a.. We assume that this figure could be reached within a ten-year adoption period, in line with experience from introducing e-money transactions. If the acceptance of a digital euro accelerates faster, the associated fee loss would materialise earlier. It should be noted that these figures do not include the costs for the financial sector due to investments in setting up and operating new IT systems.

Table 8: Exemplary scenario for fee losses and financing costs (@ 2.5% substitution rate)

Scenario	substitution rate	Δ no. trx (m)	Δ value trx (m €)	Δ fees (m €)	Δ refinancing need (m €)	Δ refinancing costs min (m €)	Δ refinancing costs max (m €)	ϕ Δ refinancing costs (m €)	total costs min (m €)	total costs max (m €)	ϕ total costs (m €)
Cash Payments	2.50%	3,235.1	69,923.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Card Payments	2.50%	1,900.0	75,750.0	757.5	75,750.0	1,515.0	2,272.5	1,893.8	2,272.5	3,030.0	2,651.3
Credit Transfer	0.00%	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Debit	2.50%	237.0	82,950.0	207.4	82,950.0	1,659.0	2,488.5	2,073.8	1,866.4	2,695.9	2,281.1
E-Money	2.50%	189.6	3,792.0	94.8	3,792.0	75.8	113.8	94.8	170.6	208.6	189.6
Total	2.08%	5,561.7	232,415.1	1,059.7	162,492.0	3,249.8	4,874.8	4,062.3	4,309.5	5,934.4	5,122.0

Source: own analysis

7.4 Simulations of transaction fee losses and increased refinancing costs

The above scenario represents a single estimate based on assumptions regarding the substitution rate, fee losses and financing spreads. As these figures are somewhat arbitrary, we conduct a simulation covering a range of substitution rates and a range of incremental financing spreads. The estimated impact can be summarised as follows (equation 3): The total costs of a digital euro (TC) is the sum of the estimated fee losses (FE) and the increased refinancing costs (FC). These, in turn, depend on the substitution rate for the respective payment instrument (r_i), the underlying payment volume in terms of transaction value (pay_i) or transaction numbers (trx_i), the respective fee rate in percentage points (α_i) and/or in € per unit (β_i) and the incremental refinancing costs in percentage points (c_i) (equation 4). Some financial institutions charge a fixed fee per transaction, which may or may not come on top of the volume-based fees.

Fees and replacement rates may vary per instrument i . As we consider five different instruments, index i will range from one to five in our model. Due to the limited availability of suitable data, simulations need to be based on a wide range and conclusions should be drawn with the utmost caution. In our simulation, we set a range R for the replacement rate between 2.5% and 20% that could be reached ten years after adoption.

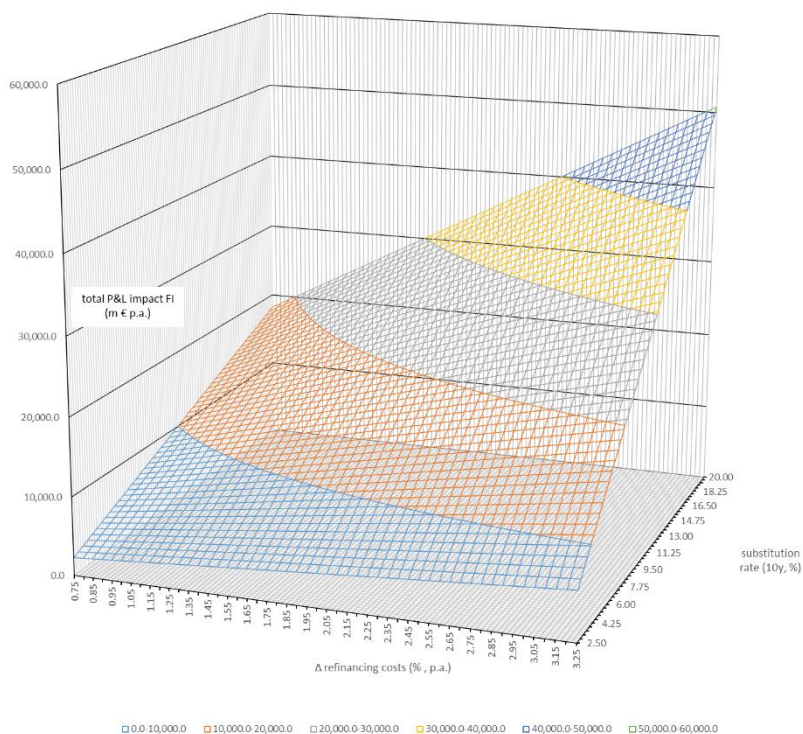
$$(3) \quad TC(r_i, c_j) = \Delta FE(r_i, \alpha_i) + \Delta FC(r_i, c_j)$$

$$(4) \quad TC(r_i, c_j) = \sum_{i=1}^n pay_i \cdot r_i \cdot \alpha_i + \sum_{i=1}^n trx_i \cdot r_i \cdot \beta_i + [\sum_{i=1}^n pay_i \cdot r_i] \cdot c_j$$

with $r_i \in R$ with $R := [0.025 ; 0.20]$ $c_j \in C$ with $C := [0.075 ; 3.25]$ $i \in [1 \dots 5]$

To estimate increased financing costs, we apply a range between 0.75% and 3.25% p.a., which is broader than the estimated range of funding spreads currently observable in financial markets (table 7). In order to narrow down the suggested ranges, extensive field experiments with potential users should be made to gain further insights into potential changes in payment behaviour and realistic adoption processes. Figure 5 illustrates the simulation of total costs of introducing a digital euro for different combinations of replacement rates and incremental financing costs, based on the defined ranges R and C . It is obvious that total costs (fee losses and increased financing costs) increase at a given replacement rate as financing costs rise, and at a given increase in financing costs as replacement rates rise. Table 9 extracts some data from figure 5 to illustrate the overall impact and composition in selected scenarios for the replacement rates 2.5%, 5%, 10% and 20%, combined with average increased financing costs for 100bp, 200bp and 300bp.

Figure 5: Simulation of total costs of a digital euro (€ million, ten years after adoption)



Source: own analysis

Table 9 shows the wide range of potential effects of introducing a digital euro on fees and refinancing costs. Depending on the assumptions, annual fee losses could be in the range of around €1.1 billion to €8.5 billion, while increased financing costs are potentially much more relevant, with a corresponding range of €1.6 billion to €39.0 billion p.a.. When assuming a replacement rate of 5% to 10% to be reached 10 years after adoption and an average credit spread over daily retail deposits in the range of 200bp to 300bp, overall costs would be in the range of €8.6 billion to €23.8 billion per year. In all scenarios, fee losses are far less important than increased financing costs. In relation to the overall fee pool in the payment industry, the estimated losses would be around 1.7% to 3.4% of the current market volume for payments in the eurozone (c. €124 billion in 2023).

Table 9: Selected scenarios for fee losses and increased financing costs

Scenario	replacement rate	100bp		200bp		300bp	
1	2.50%	2,685	100%	4,310	100%	5,934	100%
	Δ refinancing costs	1,625	61%	3,250	75%	4,875	82%
	fee loss	1,060	39%	1,060	25%	1,060	18%
2	5.00%	5,369	100%	8,619	100%	11,869	100%
	Δ refinancing costs	3,250	61%	6,500	75%	9,750	82%
	fee loss	2,119	39%	2,119	25%	2,119	18%
3	10.00%	10,738	100%	17,238	100%	23,738	100%
	Δ refinancing costs	6,500	61%	12,999	75%	19,499	82%
	fee loss	4,239	39%	4,239	25%	4,239	18%
4	20.00%	21,477	100%	34,476	100%	47,475	100%
	Δ refinancing costs	12,999	61%	25,999	75%	38,998	82%
	fee loss	8,477	39%	8,477	25%	8,477	18%

Source: own analysis

In terms of refinancing needs, the potential replacement rates of 5% and 10% respectively would translate into a refinancing volume of between €324 billion and €650 billion. This is an extrapolated estimate based on the data provided in table 8, indicating a refinancing need of around €162 billion in the 2.5% scenario. These figures would correspond to a range of €6.5 billion to €19.5 billion additional financing costs per year, assuming the spreads shown in table 7. Although the numbers appear high in absolute terms, in relation to approximately €5.1 trillion of private household deposits as of 31/12/2023, these would be equivalent to between 6.3% and 12.6% of the current deposit volume.

Another important question concerns the adoption path of a digital euro and hence the speed at which the respective substitution rate will be reached. The more convenient and attractive the use of a digital euro is for retail customers, the faster the acceptance and diffusion of a digital euro will be. Based on the data for the acceptance of e-money, we assume an adoption period for a digital euro of ten years. Figure 6 simulates the possible development of costs for a digital euro for a ten-year period after its introduction. The cost simulations depend on the assumptions for the substitution rate, the incremental refinancing costs and the adoption period t (equations 5 and 6). The respective trajectory is derived from the implicit compound annual growth rate (CAGR) applicable to the assumed initial value of one percent in the first year of adoption to the expected end value after ten years (equations 7 and 8).

$$(5) TC(r_i, t, c) = \Delta FE(r_i, t, \alpha_i, r_{it} \cdot \beta_i) + \Delta FC(r_{it}, t, c_{it})$$

$$(6) TC(r_i, t, c_j) = \sum_{i=1}^n pay_i \cdot r_{it} \cdot \alpha_i + \sum_{i=1}^n trx_i \cdot r_{it} \cdot \beta_i + \sum_{i=1}^n pay_i \cdot r_{it} \cdot c_{it}$$

$$(7) CAGR_{i,n} = \sqrt[n]{\frac{r_{in}}{r_{i0}}}$$

$$(8) r_{i,t} = r_{i0} \cdot (1 + CAGR_{in})^t$$

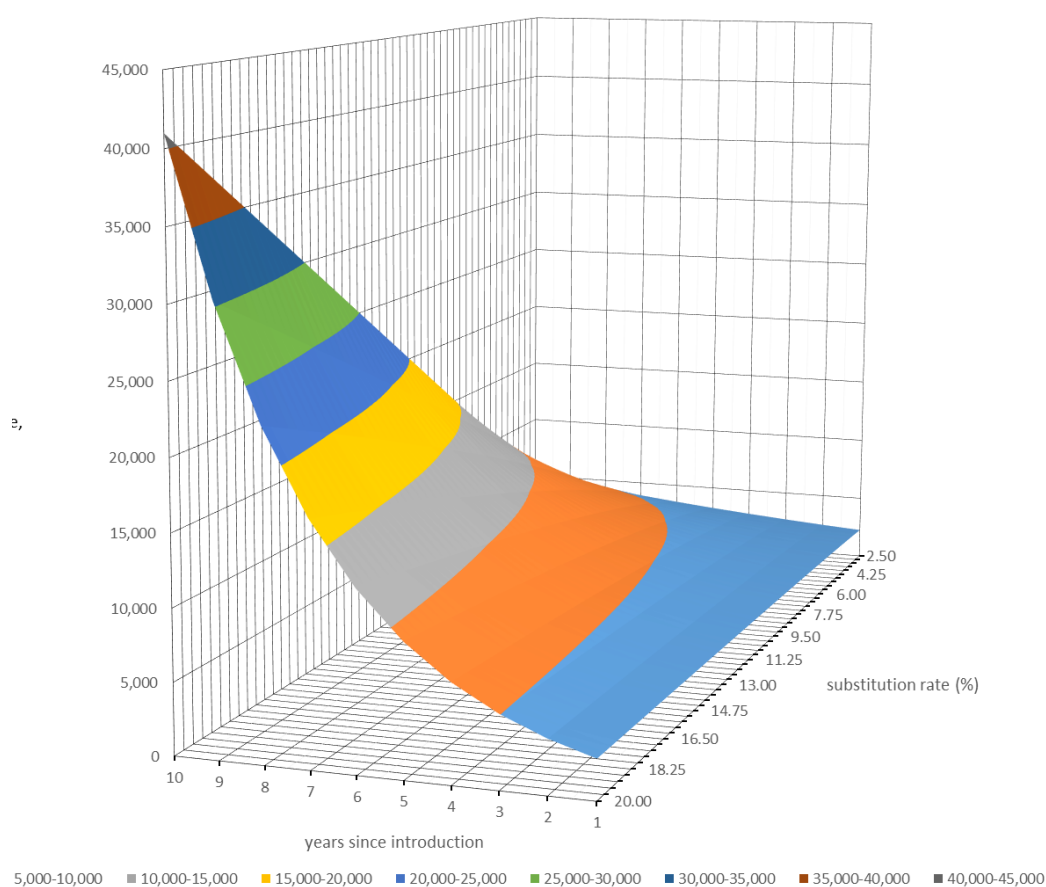
In our simplified simulation model, we assume that the refinancing costs are equivalent to the average refinancing spread for the whole period (equation 9).

$$(9) c_{i,t} = c_{i,o} = \left[\frac{c_{min} + c_{max}}{2} \right]$$

With $r_i \in [0.025 ; 0.20]$, $t \in [1 ; 10]$, $c_j \in [0.075 ; 3.25]$, $i \in [1 \dots 5]$, $r_{i,0} = 0.01 \forall i$, $n = 10$

And $c_{min} = 200bp$ and $c_{max} = 300bp$

Figure 6: Simulation of total costs of a digital euro over a ten-year development path (€ million p.a.)



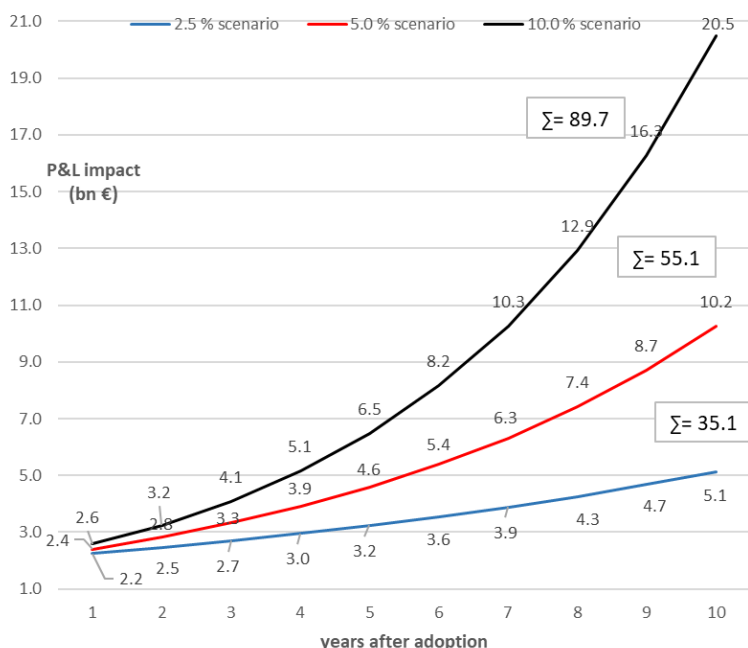
Source: own analysis

In figure 7 we extract three exemplary adoption paths from figure 6 for the underlying substitution rates 2.5%, 5.0% and 10.0%. Based on the numerical assumptions on fees, substitution rates and average incremental refinancing costs, the cumulative costs over the ten-year adoption period could range from €35 billion (2.5% scenario) to €90 billion (10% scenario).

It can be concluded that neither the individual components, i.e. the decreasing fee income and the increasing refinancing costs, nor their combined potential impact are of sufficient magnitude to justify serious concerns about introducing a digital euro. However, a reasonable and sustainable profitability of the European banking sector is crucial to financial stability in Europe and beyond. Therefore, the European authorities and the ECB should keep a close eye on a fair and balanced compensation model for banks and other PSPs when eventually introducing a digital euro. Such a model should provide appropriate incentives for marketing and distributing the digital euro to ensure broad use by retail customers. Moreover, when the compensation model is designed, it should be calibrated to ensure that the digital euro does not place any additional burden on the banking sector in Europe.

Furthermore, the individual holding limit for a digital euro should be in line with average balances of cash holdings in the eurozone, which need to be quantified closer to a potential launch date. The most recent ECB data showed that the average cash holding per day in the wallet of people in the eurozone was approximately €83 (ECB, 2022). Non-transactional demand for cash as a store of value has been on average around €1,270 per person (Zamora- Pérez, 2021).

Figure 7: Negative P&L impact on the European Banking sector in different development scenarios (€ billion p.a.)



Source: own analysis

8. Conclusions

Overall, there is no obvious need for a digital euro, given the efficiency, safety and innovation of existing electronic payment systems. Convincing use cases for a digital euro can hardly be found, except the preservation of access to central bank money in times of declining demand for physical NAC. Therefore, the digital euro appears to be primarily a political project, symbolising a further deepening of the European currency area. If, nevertheless, a digital euro is considered useful, its features should be strictly limited to functions performed today by NAC, in order to ensure financial and monetary stability. Therefore, a digital euro should be non-interest-bearing and subject to individual holding limits in line with average cash holdings in the eurozone close to a possible launch date. The disintermediation of banks must be avoided by excluding direct accounts of private users at the ECB. As the banking sector could face substantial fee losses in the payment business and increased refinancing costs, a fair compensation model for banking services associated with the adoption and use of a digital euro is crucial. The analysis presented in this paper shows that annual fee losses could be in the range of €2.1 billion to €4.2 billion. The associated refinancing need due to replacements of deposits by digital euro holdings could be in the range of €324 billion to €650 billion, translating into additional refinancing costs of around €6.5 billion to €19.5 billion p.a.. Hence, the impact of a digital euro on the financing costs of commercial banks is much greater than the potential loss of fees. How banks would respond to increased financing costs depends, among other things, on the macroeconomic situation on the credit markets and the monetary policy of the ECB. Banks could try to pass on their increased refinancing costs to their customers, they could increase the interest rates on their deposits to mitigate the use of the digital euro, or they could employ a combination of these measures. The ECB could also anticipate the impact of the digital euro in its policy, for instance by recalibrating its key interest rates. Nevertheless, it is very likely that a digital euro would, on balance, have a negative impact on the refinancing costs and thus the profitability of the European banking sector.

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