EUROPEAN CENTRAL BANK

EUROSYSTEM

Report on a digital euro

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Foreword

A key part of the Eurosystem's mission is to provide citizens with riskless money for their payments; the Eurosystem has been providing euro banknotes for nearly two decades. While cash is still the dominant means of payment, new technologies and the increasing demand for immediacy from consumers are changing the way European citizens pay. This is evident in the expanding role of fast electronic payments.

To ensure that consumers continue to have unfettered access to central bank money in a way that meets their needs in the digital age, the ECB's Governing Council decided to advance work on the possible issuance of a digital euro – an electronic form of central bank money accessible to all citizens and firms. A digital euro would be introduced alongside cash, it would not replace it.

A digital euro would create synergies with private payment solutions and contribute to a more innovative, competitive and resilient European payment system. By serving as a unifying force in Europe's digital economies, a digital euro would also be an emblem of the ongoing process of European integration.

It is too early to commit to a specific design of a digital euro. But it is clear that any type of design must fulfil a number of principles and requirements identified in this report – including accessibility, robustness, safety, efficiency and privacy – while complying with relevant legislation.

Issuing a digital euro would be relevant for nearly everything the Eurosystem does and it would have pervasive effects on society as a whole. This report will therefore form the basis for a dialogue with citizens and other external stakeholders. It will serve as a starting point for a public consultation in which we encourage everyone to participate. And together with the European Parliament and other European institutions and authorities, we will discuss the operational and legislative framework that would be necessary to introduce a digital euro. At the same time, experiments on the practical aspects of a digital euro are necessary to examine the strengths and weaknesses of different options.

Looking ahead, we need to be ready to introduce a digital euro, shall the need arise. For now we maintain the options open as to whether and when this should happen.

Our role is to secure trust in money. This means making sure the euro is fit for the digital age.

Christine Lagarde
ECB President

Fabio Panetta
ECB Executive Board Member and Chair of the Eurosystem High-Level Task Force on Central Bank Digital Currency (HLTF-CBDC)

Executive summary

This report examines the issuance of a central bank digital currency (CBDC) – the digital euro – from the perspective of the Eurosystem. Such a digital euro would be a central bank liability offered in digital form for use by citizens and businesses for their retail payments. It would complement the current offering of cash and wholesale central bank deposits.

The possible advantages of a digital euro and the rapid changes in the retail payment landscape imply that the Eurosystem needs to be equipped to issue it in the future. A digital euro could support the Eurosystem's objectives by providing citizens with access to a safe form of money in the fast-changing digital world. This would support Europe's drive towards continued innovation. It would also contribute to its strategic autonomy by providing an alternative to foreign payment providers for fast and efficient payments in Europe and beyond.

A digital euro may even become essential in a number of possible scenarios. For example, if the use of cash were to decline significantly, other electronic payment methods were to become unavailable owing to extreme events, or foreign digital money were to largely displace existing means of payment.

In the absence of a digital euro, the Eurosystem would need to identify alternative tools to respond to the possible materialisation of one or more of these scenarios. For example, a decline in the use of cash as a means of payment could exacerbate financial exclusion for the "unbanked" and for vulnerable groups in our society, forcing the central bank to intervene. The introduction of a digital euro could address multiple scenarios at once, but it would have profound implications for key areas of central banking, for the broader economic and financial system, and, ultimately, for the life of European citizens.

A digital euro would also support other strategic objectives of the Eurosystem. It could provide state-of-the-art payment services that reflect people's changing needs and actively promote innovation in the field of retail payments, complementing private payment solutions. It could increase choice, competition and accessibility with regard to digital payments, supporting financial inclusion.

A possible role for the digital euro as a tool to strengthen monetary policy is not identified in this report, but could emerge in the future on the basis of further analysis or owing to developments in the international financial system. Finally, the digital euro could represent an option for reducing the overall costs and ecological footprint of the monetary and payment systems.

The Eurosystem would design the digital euro in such a way as to avoid possible undesirable implications for the fulfilment of its mandate, for the financial industry and for the broader economy. Some digital euro design options could affect the intermediation function of banks and their funding costs, especially in situations of stress. Furthermore, some potential configurations of a digital euro could lead to an

expansion of the size of the Eurosystem's balance sheet and increase its exposure to shocks and could give rise to challenges in international financial markets related to larger capital flows. However, the analysis in this report indicates that by following appropriate strategies in the design of the digital euro the Eurosystem can address these challenges.

The Eurosystem is conducting further analysis to fully understand the challenges and benefits that could emerge as a result of the introduction of a digital euro. In particular, we are examining the advantages and weaknesses of specific types of digital euro and how they would meet the needs and expectations of European citizens, businesses and financial intermediaries. A digital euro could be designed to replicate some key features of cash that are useful in the digital economy, such as the ability to make offline payments. However, it should also provide online payment capabilities that could support the fulfilment of the mandate of the Eurosystem in other areas.

This report deliberately does not advocate a specific type of digital euro and does not reach conclusions on issues such as the setting-up, running costs or cost recovery of a digital euro. Any potential solution must satisfy a number of principles and requirements that are identified in this report – including robustness, safety, efficiency and protection of privacy – while complying with relevant legislation, including legislation on money laundering and the financing of terrorism.

Our analysis suggests that most of the desirable features of a digital euro derived from our analysis are mutually compatible and can be combined to meet the requirements of the Eurosystem and of users. The report follows a pragmatic, policy-oriented approach to identify the essential elements of an effective digital euro. First, we derive its core principles, which must fully comply with the Eurosystem's mandate, policies and principles. We then determine its scenario-driven requirements, which would make the introduction of a digital euro consistent with the fulfilment of the Eurosystem's objectives and the needs of potential users. Finally, we identify the broader set of general requirements needed in all foreseeable scenarios to protect the European economy, the European financial system and the Eurosystem from unwarranted implications arising from the issuance of a digital euro.

A digital euro could also support the general economic policies of the European Union (EU). It could satisfy the emerging payment needs of a modern economy by offering, alongside cash, a safe digital asset with advanced functionalities. The public sector may prove to be best placed to provide the safety, scale, level of convenience and accessibility needed to allow citizens, businesses and financial institutions to participate in the digital payment market.

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.

The technical implementation of a digital euro needs to be thoroughly tested and legal considerations carefully examined before any decision is taken on issuance.

Implementation requires a new infrastructure, perhaps building on the existing Eurosystem infrastructure and incorporating new technology. Practical experimentation is necessary to test functional designs and to explore the technical feasibility of different options, as well as their ability to satisfy the needs of prospective users. Experimental work should aim at identifying and developing a “minimum viable product” with the characteristics identified in the report.

The High-Level Task Force on CBDC will coordinate this experimentation, so that the resources of the Eurosystem are leveraged efficiently. To ensure that meaningful answers are obtained to the open questions raised in this report, towards mid-2021 the Eurosystem will decide whether to launch a digital euro project, which would start with an investigation phase.

The Eurosystem must address a number of important legal considerations related to a digital euro, including the legal basis for issuance, the legal implications of different design features and the applicability of EU legislation to the Eurosystem as the issuer. A close dialogue with other European authorities and institutions is necessary at an early stage in order to analyse the legislative changes that would be needed to issue a digital euro.

Feedback from future end users and potential intermediaries is also necessary. Hence, the Eurosystem will solicit the views of other public authorities, financial institutions and society at large to assess the need, feasibility and actual business cases for a digital euro, without pre-empting a decision on issuance.

1 Introduction

The Eurosystem provides safe money and reliable means of payments to households, businesses and the broader financial system in the euro area. By pursuing its tasks of maintaining monetary and financial stability and the smooth operation of payment systems, it ensures that money and payments serve European society. We have always been committed to maintaining confidence in our currency, which has meant adapting the form of money and payment services we provide to the changing ways in which people spend, save and invest.[1]

The speed of innovation is accelerating and citizens show an increasing preference for digital payments. This is changing the payment landscape, raising questions that go to the very heart of our core functions. Against this background, the Governing Council of the European Central Bank (ECB) established a High-Level Task Force in January 2020 in order to advance work on central bank digital currencies (CBDC) in the euro area. This report presents the main findings of the Task Force, which analysed the possible benefits and challenges as well as the legal, functional and technical issues associated with the introduction of a CBDC in the euro area – i.e. a digital euro.

In this report, the term digital euro denotes a liability of the Eurosystem recorded in digital form as a complement to cash and central bank deposits. The analysis focuses on the design of a digital euro for use in retail transactions available to the general public – that is, including citizens and non-bank firms – rather than only being available to traditional participants (typically banks) in the large-value payment system managed by the central bank.

The analysis covers the key dimensions of a digital euro, such as the scenarios in which it could help to achieve the objectives of the Eurosystem;[2] the identification of viable designs and their assessment, with particular reference to the applicable legal framework and the implications for monetary policy, financial stability and the payment system; and possible options for the underlying infrastructure and the practical testing of such an infrastructure by the Eurosystem.

The digitalisation of the economy and technological innovations are influencing consumer perceptions of payment services and fuelling interest in the possible issuance of a digital euro. Central banks are the natural candidates for issuing a digital currency. Even leaving aside legal considerations (for example, the legal tender status

1 For instance, the Eurosystem responded to technological change and increasing demand for much faster payments by enhancing its infrastructure and creating the TARGET Instant Payment Settlement (TIPS) service to enable instant and cost-efficient payments throughout Europe.

2 This report is intended to assess whether the introduction of a digital euro could fulfil relevant objectives in any of the scenarios under consideration, but it does not assess whether this would be the optimal solution in comparison with other available options.

of central bank liabilities) citizens place the most confidence in digital money issued by their domestic monetary authority.[3]

Moreover, the current status and fast evolution of the payments ecosystem need to be borne in mind. First, the public perception of cash relative to electronic payments is changing. Cash remains the dominant means of payment in the euro area as a whole, but its use is declining in some countries,[4] and preferences might change rapidly and unexpectedly. For instance, the COVID-19 crisis induced a shift in payment habits towards contactless payments and e-commerce.[5] Second, according to recent ECB surveys, young Europeans make extensive use of cash but have a preference for electronic payments and expect the related infrastructure to guarantee safety and speed.[6] Other key issues are those of confidentiality, including enhanced privacy for users, and concerns related to potential money laundering and terrorist financing.

As regards confidentiality, the issuance of a digital euro would require the central bank to have the capacity to innovate, without compromising security aspects. Some concerns have been raised that, by introducing their own digital currency, central banks could acquire sensitive information on users; however, in the case of privately issued payment instruments (such as "stablecoins"), the risk associated with the issuers acquiring sensitive information would be even more pronounced.

Most users and investors are also concerned that emerging private payment solutions (especially if unregulated) could entail cyber risks. In the case of a digital euro, such risks might be mitigated by the involvement of the central bank. Finally, the issuance of a digital euro could stimulate the supply of new payment services and functionalities and create business opportunities, although it could also generate new sources of risk.

Some core guiding principles for the design of a digital euro can be identified on the basis of current Eurosystem policies. First, a digital euro would be just another way to supply euro, not a parallel currency. It should therefore be convertible at par with other forms of the euro, such as banknotes, central bank reserves and commercial bank deposits. Second, a digital euro would be a liability of the Eurosystem and therefore by definition risk-free central bank money (see Annex 2 for a discussion of how the digital

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3 This finding is based on the evaluation of the euro information campaigns, on reporting on CBDC since November 2019, and on the latest reports on global public confidence in monetary, financial and payment institutions. A global opinion poll on public trust in monetary institutions, payment characteristics and digital currency, conducted in the last quarter of 2019 by Ipsos MORI, shows the importance of trust in the underlying systems. For details, see "Digital currencies: A question of trust", the Official Monetary and Financial Institutions Forum, 2020.

4 While some 79% of all euro area payments at points of sale are still cash transactions and these transactions account for more than half of the total value of such payments, the share of cash transactions declined from 41% to 32% in the Netherlands between 2017 and 2019 (according to De Nederlandsche Bank estimates).

5 This shift towards contactless payments occurred even though banknotes do not represent a particularly significant risk of coronavirus infection compared with other kinds of surface that people come into contact with in daily life. See for example "Beyond monetary policy – protecting the continuity and safety of payments during the coronavirus crisis", a blog post by Fabio Panetta, 28 April 2020; and the article entitled "Coronavirus accelerates shift away from cash", in the "Financial Times" on 27 May 2020. In March 2020 the European Banking Authority issued a statement encouraging payment service providers to increase contactless transaction limits to €50 where possible. Some central banks are promoting the use of contactless payments and favour increasing the limit to €50. In South Korea, banknotes were taken out of circulation for two weeks and in China potentially infected cash was "deep cleaned".

6 See in particular "Young people's view of the economy, finance, the ECB and their communication channels preferences", Kantar research commissioned by the ECB, 2019.

euro would differ from other assets, particularly crypto-assets and stablecoins). The issuance and circulation of a digital euro should not create undue financial risks to the Eurosystem. This implies that the amount of central bank money issued in the form of digital euro should always be under the full control of the Eurosystem.[7] Third, the digital euro should be widely accessible on equal terms to prospective users in all euro area countries, and supervised private intermediaries should have the opportunity to use their expertise and participate in the provision of payment services. Fourth, the prospect of central bank initiatives to issue a digital euro should neither discourage nor crowd out private solutions for efficient digital retail payments in the euro area. Fifth, a digital euro must be trusted, just like any other form of the euro, and measures would need to be taken in order to ensure that it was trusted from its inception and that this trust was maintained over time (this would entail an adequate design but also appropriate communication, just as at the time of the introduction of the euro).

The report is structured as follows. Section 2 describes the main grounds that might justify the issuance of a digital euro under a set of plausible scenarios and derives scenario-specific requirements that would allow a digital euro to fulfil the stated objectives.[8] Section 3 highlights the potential effects of the issuance of a digital euro on central bank tasks and functions and derives some general requirements for a digital euro.[9] Section 4 addresses the main legal issues and considerations regarding a digital euro. Section 5 describes possible functionalities of a digital euro and assesses a set of feasible designs against the core principles and requirements identified in the first part of the report. Section 6 presents stylised approaches to the infrastructure underlying issuance of the digital euro and how it would be accessed by end users. Finally, Section 7 highlights potential follow-up work on a digital euro.

The report also analyses a number of technical, economic, financial and legal issues. These include the impact of a digital euro on monetary policy, financial stability, banks' business models, international monetary spillovers and the oversight of services related to the digital euro.

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7 Against this background, it is important to stress that forms of money that consist in a claim on any private entity are not CBDCs, even if they are intended to be fully backed by reserves held with the Eurosystem, to the extent that the private entity would remain responsible for any users' claim originating from a lack of synchronisation between the value held in reserve accounts and the value held by the users within the private system.

8 The requirements derived in Sections 2 and 3 are theoretical in nature. The assessment of whether a digital euro could successfully meet them in practice is made in Section 5.

9 Annex 1 summarises the core principles, scenario-specific requirements and general requirements that a digital euro should satisfy on the basis of the analysis in this report.

2 Reasons to issue a digital euro – possible scenarios and implied requirements

This section describes scenarios which could induce the Eurosystem to issue a digital euro[10] and derives requirements that the new form of money should satisfy in order to address each specific scenario. These scenario-specific requirements, together with the core principles cited in the introduction and the general requirements covered in Section 3 (which are applicable in all scenarios), will be used to assess the feasibility and convenience of different possible configurations of digital euro.

Key messages:

- In a range of future scenarios, a digital euro could be a viable option for the Eurosystem in order to achieve the objectives related to core central bank functions (Section 2.1) and the general economic policies of the EU (Section 2.2), provided that its design meets scenario-specific requirements.
- A digital euro could be issued (i) to support the digitalisation of the European economy and the strategic independence of the European Union; (ii) in response to a significant decline in the role of cash as a means of payment, (iii) if there is significant potential for foreign CBDCs or private digital payments to become widely used in the euro area, (iii) as a new monetary policy transmission channel, (iv)) to mitigate risks to the normal provision of payment services, (v) to foster the international role of the euro, and (vi) to support improvements in the overall costs and ecological footprint of the monetary and payment systems.
- The materialisation of a specific scenario does not necessarily warrant issuance of a digital euro to the extent that alternative solutions are available.

2.1 Scenarios related to core central bank functions

Scenario 1: the digitalisation and independence of the European economy can benefit from a digital form of central bank money available to citizens.

The issuance of a digital euro may be a way to foster the digitalisation of the economy, supporting the development of innovative European solutions in all kinds of industries. To the extent that it would fill gaps in the provision of digital payment solutions and

[10] The scenarios under which the ECB could consider CBDC issuance are specified in the note by the ECB for the Economic and Financial Affairs Council of December 2019, which is the key public statement by the ECB on the subject of CBDC so far.

functionalities, a digital euro available to the general public would support the digitalisation of the financial sector and, hence, of the broader economy. It could also reduce costs for payment service providers by making their business processes more efficient and supportive of new business models.[11] For instance, a digital euro could be issued to facilitate the development by supervised intermediaries of a full range of pan-European end-user solutions accessible to consumers. These end-users solutions could be used for the distribution of both commercial money and central bank money. In such a scenario, the issuance of a digital euro would help to preserve European autonomy in such a strategic sector as retail payments; it could then represent a building block for a European solution for point-of-sale and online payments. The architecture of the system underlying the digital euro should be flexible and easy to expand, with standardised open interfaces between system components, so as to support possible future payment needs and easy integration of new types of device over time.

Requirement 1 (R1): enhanced digital efficiency. *The digital euro should keep pace with state-of-the-art technology at all times in order to best address the needs of the market as regards, among other attributes, usability, convenience, speed, cost efficiency and programmability. It should be made available through standard interoperable front-end solutions throughout the entire euro area and should be interoperable with private payment solutions.*

Scenario 2: the role of cash as a means of payment declines significantly.

A decline in the use of cash in the economy would imply increasing dependence on private forms of money and private payment solutions in the euro area. Beyond a certain point, such a trend could endanger the sustainability of the cash infrastructure and hamper the provision of adequate cash services.[12] European citizens would thus encounter difficulties in accessing the only means of payment that is provided by the public sector and that takes account of their needs, regardless of any commercial perspective.

In response to a decline in the use of cash, the Eurosystem could introduce a digital euro as an additional form of public money and means of payment. In order to satisfy the needs of users, the digital euro should be cheap to use (generating very low costs for users, like physical cash), secure (providing the highest levels of fraud prevention and offering consumer protection), risk-free (its holders should not be subject to any market risk or issuer default risk), easy to use (even for unskilled consumers and merchants) and efficient (permitting fast payments).

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11 This could include, for example, the digitalisation of information exchanges such as e-invoices and e-receipts as well as the acceptance of national eID and eSignature solutions that comply with the European Regulation on electronic identification, authentication and trust services.

12 Although this trend is currently not observed in the euro area as a whole, it is emerging in some EU Member States and could spread further and be accelerated by extreme events, such as the outbreak of COVID-19, which cause a shift in payment habits (see Scenario 5). If other countries follow suit, the maintenance costs of the cash infrastructure relative to the number of cash transactions might increase beyond acceptable limits and could accelerate the decline in the availability and acceptance of cash.

The preliminary results of the Eurosystem payment study conducted in 2019 indicate that the share of electronic payments in total payments is increasing. At the same time, for the euro area as a whole, cash is still used for the majority of payments at the POS. Differences across countries in the use of cash for payments remain pronounced.[13] Although no clear conclusions can yet be drawn on the impact of the COVID-19 crisis on the use of cash, it might accelerate changes in payment habits and increase the use of electronic payments; a similar trend will likely emerge from the rapid development of e-commerce.

Cash has distinct intrinsic features – its physical nature, the capacity to ensure privacy in payment transactions and the possibility to be used without any technical infrastructure – that are not (fully) matched by electronic payment solutions but are required by many citizens (such as population groups who are less "tech-savvy", face barriers to access or want to ensure their privacy). Ideally, a digital euro should allow citizens to continue to make their payments much as they do today with cash.[14] Moreover, the issuance of a digital euro should ensure that the euro maintains strong support from citizens and is seen as a symbol of European unity, addressing the risk that the symbolic value of physical euro banknotes and coins could diminish with the dwindling use of cash.

Requirement 2 (R2): cash-like features. *To match the key distinctive features of cash, a digital euro aiming to tackle a decline in the acceptance of cash should permit offline payments. Moreover, a digital euro should be easy for vulnerable groups to use, free of charge for basic use by payers and should protect privacy. It should have a strong European branding.*

Scenario 3: a form of money other than euro-denominated (i) central bank money, (ii) commercial bank deposits or (iii) electronic money becomes a credible alternative as a medium of exchange and, potentially, as a store of value in the euro area.

This scenario could materialise in different ways. First, many foreign central banks are assessing the possibility of issuing their own CBDC, which could potentially also be made available to European citizens. This could cause currency substitution as well as an increase in foreign exchange risk in the euro area economy. Second, private actors – possibly outside the supervision of European financial authorities – including large technology firms, are developing payment solutions not denominated in euro (such as global "stablecoins") that could achieve a global footprint and become widely used for European retail payments. Such developments would foster innovation but could also

[13] The ECB and the national central banks of the euro area have recently conducted a Study on the payment attitudes of consumers in the euro area (SPACE), forthcoming, November 2020. In addition to purchases at the POS and peer-to-peer (P2P) payments, the scope of the study includes non-automated payments made remotely (i.e. online shopping, telephone and mail orders, and bill payments), unlike the previous Study on the use of cash by households in the euro area, published in 2017.

[14] A digital euro should not aim to replace cash, but should be only a complementary form of payment. It would be up to European citizens to decide whether to use digital euro instead of cash payments. The Eurosystem stance is that the availability of cash should be ensured and measures should be taken to this end.

threaten European financial, economic and, ultimately, political sovereignty.[15] It is worth noting that recently some global "stablecoin" initiatives have suggested that CBDCs could also be made available via their (private) infrastructures.[16]

Wide acceptance of a means of payment or store of value not denominated in euro could weaken or even impair the transmission of monetary policy in the euro area. It would also have unclear implications for financial intermediation and cross-border capital mobility, which could ultimately affect financial stability. In such circumstances, issuance of a digital euro could support European sovereignty and stability, in particular in the monetary and financial dimensions.[17]

The provision of electronic payments by foreign central banks or private service providers located outside the euro area would likely pose additional challenges for the Eurosystem regarding the safety and efficiency of European payments. The Eurosystem could therefore consider issuing a digital euro in order to ensure that payments in the euro area meet the highest standards and are conducted under its direct control. Moreover, by providing digital payments the Eurosystem could ensure that European citizens have access to payments at the technological frontier. This would preserve the global reputation of the euro, not least if other major foreign central banks press ahead with issuing CBDC.

Requirement 3 (R3): competitive features. *The digital euro should have features which are at the technological frontier. It should offer the basis for providing functionalities that are at least as attractive as those of the payment solutions available in foreign currencies or through unregulated entities.*

Scenario 4: if the Eurosystem were to conclude in the future that the issuance of a digital euro is necessary or beneficial from a monetary policy perspective.

For example, the introduction of a CBDC might reinforce the transmission of monetary policy by allowing the central bank to set the remuneration rate on the digital euro in order to directly influence the consumption and investment choices of the non-financial sector, although the strength of this mechanism is not clear cut[18] (the effect of the digital euro on monetary policy is examined in more depth in Section 3).

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15 See "Investigating the impact of global stablecoins", G7 Working Group on Stablecoins, 2019.

16 "Moreover, our hope is that as central banks develop central bank digital currencies (CBDCs), these CBDCs could be directly integrated with the Libra network, removing the need for Libra Networks to manage the associated Reserves, thus reducing credit and custody risk. As an example, if a central bank develops a digital representation of the US dollar, euro, or British pound, the Association could replace the applicable single-currency stablecoin with the CBDC" from Libra White Paper 2.0, Libra Association Members, April 2020.

17 See Ferrari, M., Mehl, A. and Stracca, L., "Central bank digital currency in the open economy", ECB, mimeo, 2020.

18 A CBDC could help to eliminate the effective lower bound on policy rates, and thereby widen the policy options available in crisis situations, if cash were to disappear. This may be considered particularly important in view of the decline in the neutral real rate. However, to the extent that cash remains available in the economy, this objective becomes less relevant. See Lalouette, L. and Esselink, H., "Trends and developments in the use of euro cash over the past ten years", *Economic Bulletin*, Issue 6, ECB, 2018.

The increasing role of non-banks in the financial system could also contribute to strengthening this direct transmission channel of monetary policy.

A possible role for the digital euro as a tool to strengthen monetary policy is not identified in this report, but could materialise in the future on the basis of further analysis or owing to developments in the international financial system.

Requirement 4 (R4): monetary policy option. *If considered to be a tool for improving the transmission of monetary policy, the digital euro should be remunerated at interest rate(s) that the central bank can modify over time.*[19]

Scenario 5: there is a need to mitigate the probability that a cyber incident, natural disaster, pandemic or other extreme events could hinder the provision of payment services.

Financial institutions and infrastructures are threatened by a wide array of tail risks. Cybersecurity risks[20] are ever-present, with the likelihood of cyberattacks growing in parallel with the increase in the proportion of payment services that are digitalised.[21] The payment infrastructure could be similarly hindered by the materialisation of other tail risks, such as natural disasters. As a result, outages of private card payment schemes, online banking and cash withdrawals from automated teller machines (ATMs) could significantly affect retail payments and erode trust in the financial system in general. Under these scenarios, a digital euro, together with cash, could constitute a possible contingency mechanism for electronic retail payments that could remain in use even when private solutions are not available.[22]

A pandemic may also be considered to fall under this scenario, for example because social distancing might modify consumers' payment habits. Consumers may even perceive cash to be a vector of infection, in spite of the lack of evidence of any specific risks of infection associated with the use of banknotes.[23] They might therefore become less willing to use cash and more inclined to use contactless and online payments.

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19 There may be other reasons to remunerate the digital euro at a variable rate, namely financial stability reasons and to prevent the central bank becoming a large-scale financial intermediary if the digital euro becomes a large-scale store of value.

20 In the report on systemic cyber risks of February 2020, the European Systemic Risk Board has identified cyber risk as one of the sources of systemic risk to the financial system which could have serious negative consequences for the real economy.

21 See "Protecting the European financial sector: the Cyber Information and Intelligence Sharing Initiative", a speech by Fabio Panetta, Member of the Executive Board of the ECB, 27 February 2020. For more details on cyber risk, see Section 3.

22 While cash remains the safest contingency solution for payments at the POS in the event of cyber incidents and other extreme events, the digital euro, as an alternative electronic means of payment, could be used in physical shops also, if cash were to become less widely available as considered under Scenario 2.

23 Possible concerns about the use of cash include: i) social distancing measures, which could become the new norm supported, for instance, by the implementation of social protection measures by governments, through government-to-person (G2P) payments; ii) difficulties in relationship banking and limited access to other financial services; iii) increased preference for online shopping and contactless payments, driven by the fear of infection.

Requirement 5 (R5): back-up system. *In order to improve the overall resilience of the payment system, the digital euro should be widely available and transacted via resilient channels that are separate from those of other payment services and can withstand extreme events.*

2.2 Scenarios related to the broader objectives of the EU

As laid down in Article 127 of the Treaty on the Functioning of the European Union (TFEU), the Eurosystem, without prejudice to the objective of price stability, shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union. For this reason, ways in which a digital euro could contribute to achieving the objectives of the Union are explored below.

Scenario 6: the international role of the euro gains relevance as a Eurosystem objective.

Euro area leaders recently stressed that a strong international role of the euro is an important factor in reinforcing European economic autonomy.

The issuance of CBDCs by major foreign central banks could enhance the status of other international currencies at the expense of the euro. In such a situation, the Eurosystem might consider issuing a digital euro in part to support the international role of the euro, stimulating demand for the euro among foreign investors.[24] A cooperative approach to interoperable designs of CBDCs across currencies could contribute to strengthening the international role of the euro and to improving cross-currency payments also without having to grant non-euro area residents access to the digital euro.[25] Moreover, a digital euro could help to fill gaps or correct inefficiencies in existing cross-currency payment infrastructures, notably those for transfers of remittances,[26] through improved interoperability among payment systems dealing in different currencies.

Requirement 6 (R6): international use. *The digital euro should be potentially accessible outside the euro area in a way that is consistent with the objectives of the Eurosystem and convenient to non-euro area residents.*[27]

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[24] It is estimated that around 30% of euro cash (€341 billion out of the total in circulation of roughly €1,100 billion) was held outside the euro area as at the end of 2016, especially in neighbouring countries. See "The international role of the euro", ECB, 2017.

[25] As an example, currently most cross-border payments are ultimately cleared in US dollars by US-based correspondent banks. A multilateral CBDC system, in which a CBDC is held only by residents of the respective currency area but is used for cross-border payments between participating central banks, could foster the international role of the euro.

[26] See "Enhancing Cross-border Payments – Stage 1 report to the Group of 20", Financial Stability Board, 2020; and "Cross-border retail payments", Committee on Payments and Market Infrastructures, 2018.

[27] If the digital euro could not be held outside the euro area, euro cash would continue to be preferred abroad, or, in the absence of cash, foreign users would hold other currencies or assets instead of euro banknotes, thereby weakening – or at least not strengthening – the international role of the euro.

Scenario 7: the Eurosystem decides to proactively support improvements in the overall costs and ecological footprint of the monetary and payment systems.

The production of payment instruments and infrastructures may not always be energy-efficient.[28] A well-designed digital euro may thus help to reduce the overall costs[29] and ecological footprint of euro area payment systems.[30] In this context, the Eurosystem would play a catalyst role and lead by example,[31] creating incentives and putting pressure on providers of payment services to reduce their costs and ecological footprint. This would be achieved by highlighting the cost and energy efficiency of the digital euro, compared with other payment solutions, when promoting its use.

Requirement 7a (R7a): cost saving. *The design of the digital euro should achieve a reduction in the cost of the current payments ecosystem.*

Requirement 7b (R7b): environmentally friendly. *The design of the digital euro should be based on technological solutions that minimise its ecological footprint and improve that of the current payments ecosystem.*

28 See "Environment, health and safety" for an ECB assessment of the environmental impact of banknotes; and "Hanegraaf, R., Larçin, A., Jonker, N., Mandley, S. and Miedema, J., "Life cycle assessment of cash payments in the Netherlands", *International Journal of Life Cycle Assessment*, Vol. 25, pp. 120-40, 2019.

29 See "Attacking the cost of cash", McKinsey & Company, 2018.

30 The cost of the digital euro infrastructure and related services should be estimated and compared with the expected benefits (taking account of alternative solutions).

31 See "Climate change and the financial sector", speech by Christine Lagarde, President of the ECB, 27 February 2020.

3 Potential effects of a digital euro and implied requirements

This section examines the consequences of the issuance of a digital euro for the balance sheet and the core tasks and functions of the Eurosystem, in order to derive requirements that the digital euro should meet irrespective of which specific future scenario materialises.

Key messages:

- The digital euro should be designed so as to avoid potential undesirable consequences of its issuance, thereby limiting any adverse effects on monetary policy and financial stability, and on the provision of services by the banking sector, as well as mitigating possible risks.
- The excessive use of the digital euro as a form of investment and the associated risk of sudden large shifts from bank deposits to the digital euro should be avoided. The digital euro should be available via supervised intermediaries, while IT project risks (for example, project delays or unexpected costs) should be minimised. The Eurosystem should aim at complying with regulatory standards even when exempted, unless it is clearly in the public interest not to do so.
- The digital euro should be an efficient way to achieve the Eurosystem's goals in comparison with alternatives. Conditions should be established for using it outside the euro area. Digital euro services will need to be highly resilient to cyber threats.

Effects on the banking sector, monetary policy and financial stability

The introduction of a digital euro could affect the transmission of monetary policy and have a negative impact on financial stability, for example by challenging banks' intermediation capacity and by affecting risk-free interest rates. Depending on its characteristics as a form of investment, it might induce depositors to transform their commercial bank deposits into central bank liabilities. This might increase the funding costs of banks and, as a consequence, interest rates on bank loans, potentially curtailing the volume of bank credit to the economy.

Banks could react to this trend in different ways. One possibility would be to try to stabilise deposits by increasing their remuneration or by bundling them with additional services (for example, payment services, mortgages, etc.). Second – unless the central bank increases its outright holdings of securities, thus increasing the supply of liquidity on a permanent basis – banks could replace lost deposit funding with central bank borrowing, provided that they have adequate collateral (in terms of both quality and quantity). This would imply an increase in demand for collateral, which might ultimately have an impact on market interest rates for safe assets; moreover, the

central bank would expand its role in the economy and its risk exposure. Finally, to the extent that the central bank increases its outright holdings of securities, banks could still try to substitute deposit funding with more expensive capital market-based funding.

Substantial demand for digital euro may also have a negative impact on financial stability, given the key role of the banking sector in financial intermediation. Were this demand to increase their funding costs, banks might have to deleverage and decrease the supply of credit, thus preventing an optimal level of aggregate investment and consumption. If this process ultimately implies higher costs for borrowers, economic activity could be hampered. Moreover, if their traditional business model is compromised, banks may decide to take on greater risks in an attempt to earn higher (nominal) returns and to offset the reduction in profitability.[32] Additionally, if banks decrease their role in deposit-taking and intervene less in the routing of payment instructions, they might have less information about clients, which, in turn, would harm their risk assessment capacity. This may increase the riskiness of banks' balance sheets, with negative effects on financial stability. Furthermore, investors may substitute safe assets (for example, sovereign bonds) with the digital euro, which would directly affect risk-free interest rates and indirectly affect other risk classes.[33]

In crisis situations, when savers have less confidence in the whole banking sector, liquid assets might be shifted very rapidly from commercial bank deposits to the digital euro if the operational obstacles to withdrawing money in the form of digital euro are lower than for withdrawing cash. This could increase the likelihood and severity of bank runs, weakening financial stability.

These examples highlight that the design of the digital euro needs to be carefully assessed, taking into account its implications for such important issues as monetary policy transmission and financial stability. Consideration should be given, inter alia, to whether a digital euro should be accessible by households and firms directly or indirectly through intermediaries, whether it would be remunerated, and whether digital euro holdings of individual users should be limited or unlimited. For instance, the central bank might mitigate potential effects on the banking sector, financial stability and the transmission of monetary policy by remunerating digital euro holdings at a variable rate over time,[34] possibly using a tiered remuneration system, or by limiting the quantity of digital euro that users can hold and/or transact.

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32 From a central bank perspective, the issue related to higher funding costs for the banking sector is not one of lower profits for individual banks but rather one of potential instability of the financial system as a whole.

33 Another implication for the conduct of monetary policy might be that demand for the digital euro could change rapidly on a daily basis and if the digital euro is classified as an autonomous factor it would increase the overall volatility of autonomous factors, making it more difficult to predict liquidity demand and, in turn, steer money market rates. This is less of a concern, however, if a floor system is established.

34 A non-interest-bearing or positive interest-bearing digital euro is more likely to induce large-scale substitution away from deposits in a negative interest rate environment. While banknotes already offer a non-interest-bearing alternative to deposits, storage and insurance costs mean that deposit rates can be below zero without triggering large-scale substitution into cash. Holding digital euro would likely entail lower costs than holding banknotes, implying that large-scale substitution into non-interest-bearing or positive interest-bearing digital euro would be more likely – at any given negative rate on deposits – compared with substitution into banknotes.

Given the risks for monetary policy transmission and financial stability, it is not desirable for the digital euro to attract very large investment inflows. However, if individual holdings of digital euro were too low, either because of rigid constraints or because of disincentives applied above a relatively low threshold, then the digital euro would be less attractive as a means of payment and less competitive than alternative instruments.[35] To address the aforementioned risks, the central bank should design the digital euro in line with the following requirement:

Requirement 8 (R8): ability to control the amount of digital euro in circulation. *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.*

Impact of a digital euro on the profitability and risk-taking of the central bank

The issuance of a digital euro would change the composition and most likely the size of the Eurosystem's balance sheet, and would therefore affect its profitability and risk exposure. Issuing money is normally profitable and generates seigniorage income because of the difference between the remuneration of central bank assets and the interest rate applied to central bank liabilities (the rate is zero for banknotes). In the case of a digital euro, several factors need to be considered: (i) a digital euro may to some extent substitute banknotes therefore it would not necessarily increase the size of and risks to the Eurosystem's balance sheet to any great extent; at the same time, a considerable increase could occur if, for instance, non-euro area residents shifted a non-negligible part of their portfolios into digital euro. In such a situation, the size of and risks to the Eurosystem's balance sheet could increase significantly; (ii) to the extent that it increases the size of the balance sheet, the Eurosystem would need to acquire assets (loans or securities) to be held against digital euro; (iii) unlike cash, a digital euro could be remunerated, which would affect seigniorage income; (iv) in the same way as for cash, the provision of a digital euro is not free of cost; (v) the central bank might need to offer long-term lending via longer-term refinancing operations (LTROs) to banks that lose deposits (in order to avoid bank disintermediation), consequently the differential between the remuneration of the digital euro and the interest rate applied in the LTROs would be critical to determining central bank profitability.

In addition to the risks related to its balance sheet size and composition, the Eurosystem might also be exposed to financial liabilities as an operator of a retail payment system. For example, malfunctioning of the IT infrastructure underlying the digital euro could cause loss and damage to individual users, raising questions about the responsibility of the central bank. Moreover, unauthorised payment transactions conducted in digital euro could cause inconvenience to users; in such cases, if the

[35] Moreover, limiting the use of a digital euro risks affecting the convertibility at par with other forms of the euro, either because of changes in interest rates or owing to informal markets where the digital euro can be treated as if it was a parallel currency, which would pose a threat to the use of the euro in its different forms as a means of account in the economy.

payer has not acted fraudulently or with gross negligence, they should be reimbursed by the payment service provider. If the payment service provider is acting on behalf of the central bank, it cannot be ruled out that the central bank could, again, be drawn in.[36]

Other central banks are guided by a cost recovery principle for CBDC issuance.[37] Although that is one possibility, central banks generally recover the costs of issuing their monetary liabilities through seigniorage income and end users are likely to expect the digital euro to be free of charge, like banknotes. Moreover, it is unclear whether the Eurosystem would be willing or able to impose fees on third-party providers involved, for example, in the provision of front-end services. At this stage, it cannot be ruled out that the Eurosystem might even have to subsidise the services offered by these providers in order to ensure that the holders of digital euro do not have to bear any costs, by analogy, again, with the distribution of banknotes.

Although the central bank would not aim at expanding its intermediation role, this possibility cannot be ruled out. In this case it could be forced to invest more in illiquid assets, ultimately taking on more credit and market risk. As profitability is not, per se, a policy objective of the Eurosystem, these considerations would have no immediate implications for the design of a digital euro. A central bank issuing a CBDC should nonetheless strengthen its risk management.

Reputational and other risks

The issuance of a digital euro and its functionality would affect the image of the central bank. For example, the central bank should not be perceived as having embarked on a costly project without clear benefits. A loss of reputation could also occur if the implementation of the digital euro is delayed beyond a publicly announced implementation date, if the IT infrastructure underlying the digital euro proves to be unstable (including in the event of cyberattacks), or if digital euro services are without good reason provided outside the regulatory framework applied to private payment instruments and possibly used for criminal activities (for example, money laundering or the financing of terrorism).[38] In the Eurosystem context, reputational issues could arise if the accessibility of the digital euro were not the same across euro area countries. Legal risks could also arise if there was uncertainty about the legal basis for issuing the digital euro.

To address these risks, the central bank should design the digital euro in line with the following requirements:

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36 In general, the entity responsible for handling unauthorised transactions should be the entity to which consent for the transactions was given. In principle, this would therefore be the entity responsible for the user authentication – i.e. either the central bank or intermediaries acting on its behalf.

37 See for example "Central Bank Digital Currency: opportunities, challenges and design", Bank of England, March 2020, which raises the possibility of charging small transaction fees to intermediaries as a way for the central bank to recover costs incurred in building and running the core CBDC system.

38 Applying the AML/CFT framework to the digital euro should send a clear message that illicit money will not flow unchecked in the digital euro network, and is extremely important to ensure the integrity, stability and reputation of the digital euro, its issuing central banks and, ultimately, the euro.

Requirement 9 (R9): cooperation with market participants. *A project to introduce a digital euro should be carried out in line with best practices in IT project management. The digital euro should then be made available on an equal basis in all euro countries through supervised intermediaries, which could leverage their existing customer-facing services and avoid the costly duplication of processes.*

Requirement 10 (R10): compliance with the regulatory framework. *Although central bank liabilities are not subject to regulation and oversight, in issuing the digital euro the Eurosystem should still aim at complying with regulatory standards, including in the area of payments.*

Effects on the safety and efficiency of retail payments

A retail digital euro would inevitably have implications for the functioning of the payment system. It should therefore be designed in such a way that it does not hamper, but rather improves, the smooth operation of the payment system and its role in maintaining confidence in the euro and promoting an efficient market economy.

The issuance of a digital euro would affect in particular the activity and role of issuers of commercial bank money and providers of related payment services.[39] The Eurosystem should be mindful of any proven alternatives aiming to achieve the same stated results and should avoid hampering them. Its role should not go beyond what is needed to ensure the effectiveness of a digital euro (for example, controlling the monetary base; guaranteeing certainty of settlement and security of the infrastructure; and ensuring that providers of related services are adequately overseen and supervised) as well as its efficiency and usability (for example as regards IT services, customer support, customisation and technological innovation).

The provision of additional services should be left to supervised intermediaries. The Eurosystem would still be responsible for ensuring that the services provided to end users are in line with public interests. It should therefore ensure that the payment facilities offered to citizens serve the needs of all segments of the population in a non-discriminatory way. While attention to citizens' needs and information campaigns would greatly support the Eurosystem in the area of retail electronic payments, euro banknotes and coins should remain in circulation to avoid generating financial exclusion.

The issuance of a digital euro would not inevitably lead to the introduction of yet another end-user solution in the already heterogeneous European landscape of retail payments. On the contrary, in line with the retail payments strategy of the Eurosystem, the digital euro could make use of – and thereby strengthen – existing pan-European payment solutions for consumers and merchants across Europe.[40] The progress made towards a safe, efficient and integrated European payments market with the introduction of pan-European back-end schemes – such as those related to the Single

[39] The credible announcement or leaking of information on the issuance of a digital euro would also have a similar effect.

[40] See "Innovation and its impact on the European retail payment landscape", a note by the ECB for the Economic and Financial Affairs Council (ECOFIN), 2019.

Euro Payments Area (SEPA) – should translate into similar progress at the "front end", with a standard interoperable European solution for citizens' online payments that would complement the use of cash in the case of POS payments. Such a solution would ideally be developed by the payment industry and would already be in place when the digital euro were issued.

To address these risks, the Eurosystem should design the digital euro in line with the following requirements:

Requirement 11 (R11): safety and efficiency in the fulfilment of the Eurosystem's goals. *The digital euro should be designed in a safe and efficient way. Its project and operating costs should be estimated and compared with the expected benefits, considering alternative solutions in any future scenario.*[41] *The provision of non-core services should be left to supervised private entities.*

Requirement 12 (R12): easy accessibility throughout the euro area. *The digital euro should be made available through standardised front-end solutions throughout the entire euro area and should be interoperable with private payment solutions. It should be easily accessible by anyone, including citizens who currently do not participate in the financial system (for example those who do not have an account at a commercial bank), and should be easy to use. The digital euro would need to co-exist with cash.*

Effects on the cross-border use of the euro

There are several risks related to the cross-border use of a digital euro. In general, wide circulation of a digital euro outside the euro area could have implications for capital flows and the exchange rate of the euro, with potential knock-on effects on the Eurosystem's monetary policy stance and transmission. Such effects would depend on the characteristics of the digital euro, including its interfacing with non-euro payment systems, its remuneration and the limits on holdings (especially for transactions by non-euro area residents).[42]

If non-euro area residents were to rebalance their portfolios significantly towards digital euro, the size of and risks to the Eurosystem's balance sheet would increase. Another related risk is that such substantial shifts of global portfolios into the digital euro could strengthen the euro exchange rate and harm the competitiveness of euro area firms.

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41 Whereas Requirement 7a applies to the possibility of the digital euro being issued as a way to lower the cost of payment infrastructures, Requirement 11 emphasises that, when addressing any future scenario by issuing a digital euro, this solution should be provided in a cost-efficient way and compared beforehand with alternative tools that the central bank could use to achieve the same objective.

42 In order for digital euro system operators to enforce the technical limitations on where the currency can be used (for example outside the euro area), information should be acquired and verified before confirming the payment. In any case, ceilings on the amounts or values for cross-border flows would be limited to digital euro and therefore not prevent non-euro area citizens from using other forms of the currency. This is consistent with the fundamental freedom of movement of capital, which is embedded as core principle of the euro area.

Larger international spillovers and spillbacks are also potential challenges. Indeed, ECB staff analyses indicate that a digital euro could amplify the real and financial cross-border spillovers of domestic monetary policy shocks by creating a new channel for their propagation.[43]

Yet another risk is that the cross-border circulation of a digital euro might facilitate international criminal activities, if not properly controlled. Depending on its design, an internationally traded digital euro could constitute an attractive instrument for terrorist financing, money laundering and other cross-border criminal activities (by both residents and non-residents of the euro area).

Finally, the availability of a digital euro could lead to currency substitution in third countries, in particular those with weak currencies and fragile economic fundamentals. It might facilitate digital "euroisation", especially in such countries, leading to the full or partial replacement of their currencies with the digital euro for local payments, as a savings vehicle and, ultimately, as the unit of account. This would significantly impair monetary policy sovereignty in affected economies.[44] In general, the threat that a digital euro poses to monetary sovereignty in non-euro area countries entails political risks, as the possibility of (digital) "euroisation" could foster resentment abroad and political tensions. In this context, the possibility of cross-currency transactions through a multilateral CBDC system used for cross-border payments between participating central banks could be explored.

To address these risks, the central bank should design a digital euro in line with the following requirement:

Requirement 13 (R13): conditional use by non-euro area residents. *The design of the digital euro should include specific conditions for access and use by non-euro area residents, to ensure that it does not contribute to excessively volatile capital flows or exchange rates. Such conditions could take the form, for instance, of limits on or adequate remuneration policies for the holdings of digital euro of non-euro area residents.*

Cyber risk

A digital euro may attract cyberattacks with potential financial and business implications for several dimensions (including monetary policy, financial stability, financial risk, and the safety and efficiency of the payment system). Cyberattack could be perpetrated in order to profit from fraud, extortion or data exfiltration. They could hamper or even prevent the use of the digital euro. They could also have an impact on

[43] According to Ferrari, M., Mehl, A. and Stracca, L., "Central bank digital currency in the open economy", ECB mimeo, 2020, a CBDC with fixed (positive) remuneration and limited restrictions on foreign transactions would increase the international spillovers of a monetary policy shock, thereby increasing international linkages.

[44] While formal cases of currency substitution – where the local currency is fully replaced with a foreign currency– remain limited, informal cases – where the foreign currency is used alongside the local currency for certain functions of money – are more common. In particular, a large share of bank deposits and loans in central, eastern and south-eastern Europe is denominated in euro, while euro banknote circulation is also widespread in the region, albeit with significant heterogeneity across countries. See "The international role of the euro", ECB, 2019, for more detailed evidence.

the integrity of the data and/or the value of the currency (by weakening citizens' trust in it), including by violating the confidentiality of the information on end users or on the underlying financial transactions. To address these risks, the digital euro ecosystem will have to remain available under the broadest range of circumstances and will have to adequately protect the integrity and confidentiality of the information that is processed. The central bank should design the digital euro in line with the following requirement:

Requirement 14 (R14): cyber resilience. *Digital euro services will need to be highly resilient to cyber threats and capable of providing a high level of protection to the financial ecosystem from cyberattacks. In the event of successful attacks, the recovery time should be short and the integrity of the data protected.*

4 Legal considerations regarding a digital euro

Key messages:

- The concrete design choices for the digital euro would determine the legal basis for its issuance.
- EU primary law does not exclude the possibility of issuing digital euro as legal tender, which would consequently require payees to accept it for payments.
- Certain practical arrangements regarding the distribution of and access to a digital euro could in principle be outsourced, but would need to be subject to strict Eurosystem supervision.

Legal basis for the issuance by the Eurosystem of a digital euro

The choice of primary Union law to be used as the basis for issuance will depend on the design of the digital euro and the purpose for which it is issued. Thus, if the digital euro were to be issued as an instrument of monetary policy, akin to central bank reserves, and only accessible to central bank counterparties, then the Eurosystem could invoke, as the legal basis, Article 127(2) of the TFEU in conjunction with the first sentence of Article 20 of the Statute of the European System of Central Banks (ESCB). If instead the digital euro were to be made available to households and other private entities through accounts held with the Eurosystem, the Eurosystem could invoke, as the legal basis, Article 127(2) of the TFEU, in conjunction with Article 17 of the Statute of the ESCB (which, however, cannot serve as the sole legal basis). If the digital euro were to be issued as a settlement medium for specific types of payment, processed by a dedicated payment infrastructure only accessible to eligible participants, then the most expedient legal basis for its issuance would be Article 127(2) of the TFEU in conjunction with Article 22 of the Statute of the ESCB. Finally, if the digital euro were to be issued as an instrument equivalent to a banknote, then the most expedient legal basis for its issuance would be Article 128 of the TFEU in conjunction with the first sentence of Article 16 of the Statute of the ESCB.

Overall, invoking Article 128(1) of the TFEU in conjunction with Article 16 of the Statute of the ESCB would afford the Eurosystem the amplest margin of discretion for the issuance of a digital euro with the status of legal tender. Reliance on Article 127(2) of the TFEU in conjunction with Articles 17, 20 or 22 of the Statute of the ESCB would be more consistent with the issuance of digital euro variants for limited uses, devoid of general legal tender status.

A secondary law act, adopted on the basis of Article 133 of the TFEU, could be drawn up to regulate the conditions for the issuance of a digital euro with the status of legal tender by the Eurosystem.

Eurosystem competence to issue a digital euro with the status of legal tender

Primary law introduces the concept of legal tender, without elaborating on its scope and legal effects. Although it follows from EU primary law that euro banknotes issued by the Eurosystem shall be the only “notes” to enjoy legal tender status, neither the TFEU nor the Statute of the ESCB explicitly exclude the issuance by the Eurosystem of assets or obligations other than euro banknotes (for example ECB debt certificates) that might enjoy legal tender status. Moreover, the right to issue “euro banknotes” could be understood to encompass the right to determine the format or medium of “euro banknotes”. If the digital euro were to be treated as a banknote, then the Eurosystem’s exclusive competence under Article 128(1) of the TFEU to “authorise the issue of euro banknotes within the Union”, could be invoked to enable the issuance of a digital euro with the status of legal tender.

Legal implications of different digital euro access options

In a scenario in which end users have direct access to the digital euro, the Eurosystem would become the sole provider of payment services for digital euro, whereas in a scenario in which end users have intermediated access, the Eurosystem would rely on third parties for the distribution of the digital euro.

Retail access to the digital euro entails considerable legal novelty, while non-retail access (meaning that access to a digital euro is only granted to entities which currently have access to central bank money, be it as monetary policy counterparties in accordance with the ECB General Documentation or as participants in TARGET2) would be more straightforward, as it would be more similar to present practices. A retail account-based digital euro could be implemented by opening accounts directly with the Eurosystem or through supervised intermediaries, while distribution of a bearer digital euro (also referred to as “token-based” or “value-based” digital euro) would likely require the involvement of supervised intermediaries.

Overall, contrary to the elements of the design and issuance of a digital euro (features such as remuneration, anonymity, infrastructure, issuance model, etc.), which cannot be outsourced, practical arrangements with no impact on the central bank’s balance sheet (for example storage of units, handling of payments on behalf of the public, etc.) could, in principle, be outsourced, subject to strict Eurosystem supervision.

Private law issues relevant to the digital euro

Depending on the design of the digital euro and on the purpose for which it is issued by the Eurosystem, different private law issues would arise. For instance, in an account-based model, the digital euro would constitute a claim on or a representation of a claim on the relevant national central bank (NCB) or the ECB for convertibility at par with another representation of the sovereign currency. Accordingly, the private law rules governing bank deposits would apply, with digital euro transfers achieved by a reduction in the debt owed by the payer’s NCB to the payer and an increase in the debt owed by the receiver’s NCB to the receiver.

5 Digital euro functional design possibilities

In this section, the principles and requirements discussed previously are used to identify the necessary features of possible types of a digital euro.[45]

Key messages:

- The potential features of a digital euro can be designed to meet the core principles of the Eurosystem and the requirements derived in the report.
- Based on the possible features of a digital euro, two broad types have been identified that would satisfy the desired characteristics: offline and online. These types are compatible with each other and could be offered simultaneously to the extent that they both satisfy the core principles and meet the general requirements identified.

5.1 Key dimensions of functional specifications

In previous sections, we identified the core principles (Section 1), scenario-specific requirements (Section 2) and general requirements (Section 3) of a potential digital euro under the Eurosystem framework.

Annex 1 summarises the ideal characteristics identified in the report, recalling all the core principles and requirements. The main features of a digital euro that can be customised to meet the required characteristics are described in the following paragraphs, and the interaction of these characteristics is highlighted when applicable.

5.1.1 Access model

Users could access the digital euro either directly or through supervised intermediaries. If users have direct access, the central bank would need to provide end user-facing services, such as customer identification and support. This would not be necessary if users access the digital euro indirectly, i.e. through intermediaries responsible for the provision of such services.

An intermediated access model is preferable as identified in Requirement 9. However, the central bank should ensure that the actions of supervised intermediaries do not affect the quality and accessibility of the services provided in the name of the central bank (Requirement 12). All actors and procedures outside the central bank should foster end users' trust in the digital euro payment solution (Principle 5). In particular,

[45] The technical infrastructure needed to provide such types will be discussed in Section 6.

the underlying technical infrastructure and its interface with end users provided by intermediaries should be designed in such a way as to preserve the nature of the digital euro as a central bank liability (Principle 2) and prevent any creation of additional digital euro units as a consequence of an error or misconduct by an intermediary (Principle 2).

5.1.2 Privacy requirements

Users' privacy can be protected to various degrees, depending on the preferred balance between individual rights and public interest. Means of payments in current use already provide varying degrees of privacy, ranging from anonymous cash transactions to transactions requiring documentary verification or monitoring via bank accounts.[46] If the legal identity of digital euro users were not verified when they access services, any ensuing transaction would be essentially anonymous.[47] While that is currently the case for banknotes and coins, regulations do not allow anonymity in electronic payments and the digital euro must in principle comply with such regulations (Requirement 10). Anonymity may have to be ruled out, not only because of legal obligations related to money laundering and terrorist financing, but also in order to limit the scope of users of the digital euro when necessary – for example to exclude some non-euro area users and prevent excessive capital flows (Requirement 13) or to avoid excessive use of the digital euro as a form of investment (Requirement 8).

If users are identified when they first access digital euro services, different degrees of privacy can still be granted by both the issuer (the Eurosystem) and the providers of intermediary services. Full privacy would be typical of offline digital euro payments, in line with Scenario 2 (a decline in the use of cash), even when users have been identified by the provider(s) of digital euro services beforehand. Indeed, the absence of a data connection with a third party implies that sharing transaction data is not necessary for payment settlement.

The approach to privacy could be selective, i.e. the system operator could permit only certain types of transaction to be executed without registering the identity of payer and payee. This would still be in line with the requirement of Scenario 2. Some types of transaction, for example large-value transactions, could be subject to identification of the users involved as mandated by the regulations (Requirement 10). Users' trust in the privacy model of the underlying digital euro system could be reinforced through auditing by independent third parties. Finally, digital euro transactions could be fully transparent to the operator of the infrastructure who should nevertheless guarantee data protection, as is typically the case with electronic payments currently.

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46 It should be noted that the differing degrees of privacy for cash and electronic payments do not pose any hindrance to the convertibility at par with the different forms of money.

47 Transactions could still be linked to users' identities as a result of ex post investigations, typically by the judicial authorities. Electronic payments leave traces whenever an internet connection is needed for execution. Additional techniques could be used to provide additional confidentiality if necessary. See for example "Balancing confidentiality and auditability in a distributed ledger environment", ECB and Bank of Japan, February 2020.

5.1.3 Limiting or disincentivising the large-scale use of a digital euro as an investment

As already mentioned, the Eurosystem might consider introducing tools to limit the use of a digital euro, in line with Requirements 8 and 13, and to prevent excessive shifts of commercial bank money into digital euro.[48] The amount of digital euro that individual users could hold would be kept within a range such that the overall value of the digital euro in circulation would remain below an aggregate threshold deemed reasonable. This would require every digital euro user to be identified at least during onboarding: anonymity would not be possible in order to avoid the circumvention of restrictions by impersonating multiple users.

One option to be investigated would be to allow users to hold digital euro only up to an individual threshold at any given time. To ensure that a user can always receive a payment in digital euro and no information is disclosed on current individual holdings, a "waterfall" approach would be possible whereby any incoming digital euro in excess of the holding limit would be shifted automatically to the payee's account in private money. However, this would require all payees to hold such an account.[49]

Demand for a digital euro could also be controlled through incentive schemes under which less attractive interest rates or service fees are applied when individual holdings exceed the aforementioned threshold. This would have the advantage of allowing users to decide how much digital euro they want to hold normally, while ensuring that holding amounts above the threshold would be less competitive than other forms of investment.[50] Incentive schemes based on tiered (and variable) remuneration of holdings would make it more challenging to allow offline payments as required by Scenario 2. Similar to limits, tiered remuneration would require appropriate thresholds to be determined for the amount of digital euro that residents, non-residents and corporate entities would be able to hold at no additional cost.

It does not seem feasible, under current circumstances, to offer unlimited holdings of digital euro to corporate entities at zero interest rates. In line with the current monetary policy stance of the ECB, the nominal remuneration rate of risk-free euro investments (for example AAA-rated government bonds with a short residual maturity) achievable by corporate entities and domestic and international investors is currently below -0.5%. Unconstrained access of these entities to a digital euro could not be offered currently at more attractive rates without disrupting financial flows and the monetary policy stance. Tiered interest rates are an option that would enable the following two objectives to be combined: (i) providing euro area citizens access to digital euro in large (but not necessarily unlimited) amounts at conditions not worse than banknotes, i.e. interest rates not below 0%; and (ii) granting others access to digital euro without quantity constraints and without restricting digital euro holders to domestic citizens.

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48 As a first step, it would be necessary to quantify the threshold value above which digital euro in circulation should be considered excessive.

49 Besides this "waterfall" functionality that utilises private money, differing needs of households and corporations could also be taken into account to introduce different allowances depending on user type.

50 A tiered remuneration system is discussed in Panetta, F., "21st century cash: Central banking, technological innovation and digital currencies", *Suerf Policy Note*, No 40, August 2018. The remuneration could be set in terms of spreads against policy rates in line with Bindseil, U., "Tiered CBDC and the financial system", *Working Paper Series*, No 2351, ECB, January 2020.

This issue does not arise when risk-free nominal interest rates are clearly in positive territory. In this case, ample access of potential holders to digital euro remunerated at zero would become feasible.

5.1.4 Restrictions on access to digital euro services

The Eurosystem may want to restrict the scope of individuals/entities that can access digital euro services. The possibility of holding digital euro could be limited, for example, to residents in a certain jurisdiction (and possibly visitors for the time of their stay), or to retail users, etc.[51]

A digital euro without access restrictions would allow international use, in line with Requirement 6. However, given the serious risks that this would entail (see Section 3), a cooperative approach among central banks issuing CBDCs is preferable. A digital euro with restricted access could still be used internationally if specific groups of non-EU citizens are allowed to access it, for example when visiting euro area countries, and thereafter to use it.

While extensive use of the digital euro abroad could raise issues of currency substitution in foreign jurisdictions, at least two additional issues would need to be tackled in the case of a remunerated digital euro. First, under Scenario 4, the central bank should be able to apply different terms to the remuneration of the digital euro in different jurisdictions outside the euro area (if such use is allowed at all) depending on location, residence and/or citizenship (for example, to treat users in countries subject to international sanctions differently). Second, because the remuneration of different CBDCs could elicit capital flows and their size would depend on the limits imposed on digital euro holdings of individual users (Requirement 13), coordination among central banks issuing CBDCs would be necessary to ensure that the various CBDCs in circulation could not be used to create excessive capital flows, while not constraining the freedom to move euro-denominated capital via its other forms, or to shift from private money into a portfolio of CBDCs (Requirement 8). Without such coordination, a central bank offering unlimited investments in its CBDC could attract large amounts of capital that would otherwise have typically been stored as private money in other jurisdictions.

5.1.5 Transfer mechanism

A digital euro could be provided either through an account-based system or as a bearer instrument.[52] In an account-based system, users' holdings would be recorded by a third party that would determine, on behalf of the payer and payee, whether a

[51] As a result of the minimum harmonisation principle of the EU AML Directive and the risk-based approach, which is a key feature of the AML/CFT framework, ensuring harmonised and identical user-facing practices across the entire euro area would be a challenge. The technical requirements and limitations related to restricting access would be particularly difficult if the digital euro was a bearer instrument.

[52] Some sources use the term "token-based" synonymously with "distributed ledger technology (DLT)-based". However, i) not all DLT protocols are compatible with the provision of a bearer instrument and ii) we use the term tokens to mean representations of existing assets (as distinct from "native" assets recorded on a distributed ledger). A bearer digital euro would not have to use DLT.

transaction is valid and would update the respective balances accordingly. This is the approach that agents follow nowadays to transfer funds from the bank account of the payer to the account of the payee and is the approach adopted by major electronic payment solutions. It would allow the central bank issuing CBDC to control transaction flows (either directly or through supervised intermediaries). However, this method cannot be used in so far as users or the central third party are not online.

When using a bearer digital euro, the payer and payee would be responsible for verifying any transfer of value between them. This is how cash payments work, whereas applications to electronic payments are limited. A bearer digital euro would fall outside the direct control of the Eurosystem or its supervised intermediaries and would mean, among other things, that limits on holdings and on the value of international transactions (Requirements 8 and 13) as well as restrictions on the target group of users (Requirement 12) could only be enforced at the payment device level.

In the case of payments using bearer instruments, the central bank's requirement that only legally entitled users participate in a transaction would mean that all payment devices would require users to validate their identities. The device could, for instance, record information on physical attributes of the intended user (known as biometrics, e.g. fingerprint and iris recognition) and the user must provide matching elements when initiating a payment. If a bearer CBDC were stored locally on the payment device, loss or damage to the device may result in the loss of CBDC. Privacy and security of the information stored in the device should be ensured by means of the most advanced technical tools available.

5.1.6 Payment device

A digital euro could be provided as a web-based service and/or through dedicated physical devices such as smart cards. Whereas in the first case a broad range of devices could be used (for example, computers, mobile phones and wearable devices) and an internet connection would be necessary, the second case would require payer and payee to have specific compatible devices that could also enable offline use (Scenario 2). Of course, a digital euro could be provided through both a physical device and a web-based service (for instance for Scenario 1), to the extent that the two (or more) payment solutions are synchronised.

User-friendly devices to be used in offline digital euro payments would need to be certified and their developers highly trusted (Requirement 11 and Principle 5), as is the case with cash production, during which secret features are embedded in banknotes by private companies. However, achieving a similar level of security in a digital environment with multiple sources of cyber risk is much more complex and this risk is not yet fully understood (Requirement 14). It is important to note that the absence of a central third party that can block a specific user or counterfeit digital euro units substantially increases the impact of potential hacking with potentially disruptive consequences for the economy, including the possible unwarranted expansion of the monetary base (against Principle 2). The related counterfeiting and/or hacking risk would also need to be carefully mitigated.

5.1.7 Availability and usability offline

An electronic payment that is not confirmed online – either through the network of users or in a central register – can still be considered final by relying on "trusted hardware" modules. Offline functionality avoids the sharing of transaction details with parties other than the payer and payee, enabling the digital euro to become a complement to cash (Scenario 2) and providing a back-up payment solution that is available in extreme situations (Scenario 5).[53] These modules are increasingly available to potential digital euro users in the form of smart cards, mobile devices and payment terminals. The payment could be settled immediately as a transfer of pre-funded units between the devices of payer and payee.

Payment devices could be pre-funded with an amount of digital euro deducted from the balance that a user has online before they are used offline. The trusted device would contain the current balance and adjust it upon payment by the user. On the side of the payee, usually equipped with a terminal, the transfer would be recorded with the necessary information to prove that the transfer was indeed finalised.

If possible, on the basis of the legal classification of the digital euro and related anti-money laundering (AML) and countering the financing of terrorism (CFT) obligations, the possibility of offline private payments would be an attractive feature that the Eurosystem could provide, mirroring services that could be offered by some "stablecoin" issuers and wallet providers, but also by foreign central banks (Scenario 3). The Eurosystem would be best placed to win the trust of European citizens (Principle 5) in an offline payment tool, which is a logical continuation of its role as an issuer of banknotes.

Offline payments would require highly secure front-end standards to be drawn up to govern functionality on interoperable users' devices. This, in turn, would support the development of a common European end-user solution (or multiple interoperable solutions) at the POS and for P2P transactions, thereby supporting the digitalisation of the European economy. Users' devices could be activated when a payment is to be made, rather than always being connected and consuming energy as is the case with current payment terminals.

However, the remuneration applied to a digital euro stored offline could not be changed by the central bank over time since it would not be possible to communicate with the device (Scenario 4). Moreover, a digital euro that is only usable offline would be unlikely to support new advanced functionalities such as conditional payments (Scenario 1). An offline digital euro would need to exist online at some point, in order to allow users to load money onto the offline digital euro wallet through the broader

[53] An offline digital euro can act as a backup as long as the amount pre-funded by users in their devices is sufficient to satisfying their outgoing and incoming payment needs. While it would allow users with sufficient holdings to make and receive their day-by-day payments, such a solution could only be used with proximity payments and could not work over longer periods (similar to cash in the event of ATM outage and bank closure).

payment system; hence, any offline digital euro should also be linked to an online form of digital euro.[54]

5.1.8 Remuneration[55]

A digital euro may be remunerated for monetary policy reasons (Scenario 4), but also for financial stability and structural reasons, such as to lower demand for digital euro for investment purposes and to prevent the Eurosystem becoming a large investment intermediary (Requirement 8).[56] Remuneration could also be considered an attractive feature for users, which would preserve the role of the euro in retail payments in a digital environment with alternative digital currencies (Scenario 3), but this could be at odds with the monetary policy objective of the central bank. Moreover, when considering the features that would make the digital euro competitive relative to alternative digital payment instruments, its competitive advantages should be considered. A digital euro, as a Eurosystem liability, has less intrinsic risk compared with a deposit in a commercial bank. However, it is not the aim of the central bank to compete with commercial banks for financial stability reasons and given their important role in monetary policy transmission.

The remuneration of a digital euro could be fixed or variable and, in the latter case, could be linked to other central bank rates. A fixed remuneration would probably be zero, as for cash. With variable remuneration, the central bank could adjust the interest rate over time, in parallel with or independently of policy rate changes. One potential choice for a variable remuneration could be to set the interest rate on the digital euro as a spread over other central bank interest rates. Of course, as in the case of other spreads between central bank rates (for example the spread between rates on main refinancing operations (MROs) and rates on the standing facility), adjustments of the spread levels could sometimes be made for various technical reasons.

As already mentioned, remuneration could be tiered, with different interest rates applied in different cases. This would, for example, allow the Eurosystem to pay less attractive interest rates on large holdings of digital euro or on holdings by foreign investors in order to discourage excessive use of the digital euro as an investment or to mitigate the risk of attracting huge international investment flows.

It could be argued that the non-remuneration of banknotes creates unintended effects, as the opportunity cost of holding banknotes varies with central bank and market interest rates. From this perspective, it would seem natural to overcome this constraint once technology allows the central bank to remunerate its money. However, designing a digital euro that is available offline would face additional challenges if it was remunerated.

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54 For instance, the central bank could issue offline digital euro that is pre-funded by debiting the balance of digital euro accounts available online.

55 Remuneration could entail issues in relation to taxation that are not examined at this stage.

56 It should be noted that the use of remuneration would likely interfere with the transmission of monetary policy if used for any other purposes, including limiting digital euro holdings and competing with other digital currencies.

5.1.9 Legal tender

While Section 4 covers the legal analysis of whether and how a digital euro can be legal tender, this section focuses on the operational implications of a digital euro that would qualify as legal tender. Legal tender status would be a desirable feature of the digital euro. Without this status, the drivers of acceptance would be more similar to those of other electronic payment solutions: prospective payees would decide, on the basis of the features, whether or not to accept the digital euro as a means to discharge obligations, which may imply the need to complete possible onboarding requirements and to equip themselves with the payment device and/or other tools needed to accept an incoming payment.

The decision to assign legal tender status to the digital euro would in practice require that it be usable in any place and under all conditions, to allow the unconditional acceptance of payments. Legal tender status would require that users be able to receive incoming payments through means that are as user-friendly as banknotes, for example by using a simple physical device that can also be used offline or, if the legal tender status were applicable also to online payments, a digital wallet service that is available to everybody. A digital euro with the status of legal tender would be more easily accepted through a set of common (or interoperable) end-user solutions.

With the potential issuance of a digital euro, EU co-legislators could also consider extending the concept of legal tender to online transactions. This would update the legal environment in parallel with the issuance of a digital central bank liability, making the digital euro a very attractive payment solution that could avoid digital currency substitution (Scenario 3). However, the concept of legal tender is interpreted differently across Member States and take-up of a digital euro would certainly benefit from the strengthening and harmonising of national interpretations, potentially including by means of new provisions at the EU level.[57]

5.1.10 Parallel infrastructure

A digital euro based on infrastructures existing in parallel to those of other payment solutions could help to withstand extreme events such as cyber incidents and attacks, natural disasters, and pandemics (Scenario 5). Parallel infrastructures for private payment solutions could provide this but would be costly, given the nature of payment systems as a network industry, and less likely to be introduced by private profit-oriented entities. Having a parallel infrastructure for the digital euro seems especially costly and unlikely if supervised intermediaries are involved not only in the onboarding of users but also in the processing of their transactions. However, the

[57] See the "Report of the Euro Legal Tender Expert Group (ELTEG) on the definition, scope and effects of legal tender of euro banknotes and coins", 2010, which states that from the European Commission services' and the ECB services' perspective "the very concept of legal tender means that if a customer insists on paying in cash when concluding a contract, i.e. the retailer and the consumer do not agree on any other means of payment, then cash should not be refused, unless the retailer can bring forward restrictively defined objective reasons to do so". By contrast, ELTEG members from Germany, Finland, the Netherlands and Ireland affirmed that "the legal tender provisions refer to the fulfilment of an essential part of a contract already concluded and do not amount to an obligation to conclude a contract allowing for cash payments".

decision to bear such costs should be based on the likelihood and magnitude of the extreme events under consideration. A parallel infrastructure would also run counter to the aim of issuing a digital euro in order to improve the cost and environmental footprint of payments (Scenario 7).

5.2 Possible coexistence of types of digital euro

Based on the description of the possible features of a digital euro, it seems possible to identify two types that would satisfy the characteristics derived in this report. These are mutually compatible and could be offered at the same time to the extent that they both satisfy the core principles, scenario-specific requirements and general requirements identified in this report.

The first type can be used offline. It could be used without third party intervention and should therefore be made available only by means of specific user devices, which could be distributed and/or funded through supervised intermediaries and should be secure against both hacking and use by unintended persons. Offline digital euro transactions would be anonymous in principle and could only be remunerated with a fixed and non-negative interest rate.[58] Moreover, limits on the use of the offline digital euro, including in relation to its potential anonymity feature, should be ensured by means of the appropriate technical constraints in the payment device.[59] The characteristics of an offline digital euro would be fully compatible with those needed to enjoy the status of legal tender (for example, lack of additional costs for the prospective user and universal availability – no need for an internet connection). Finally, the infrastructure of an offline digital euro would de facto be parallel to that of other electronic payment solutions.

The second type of digital euro can be used online and remunerated at a rate that varies over time. Remuneration would be a powerful tool for monetary policy applications and also to limit shifts from private money into the digital euro (although for this purpose it might interfere with monetary policy transmission). A digital euro that can be used online could feature advanced functionalities and provide opportunities for supervised private intermediaries to offer value-added services. Its use would not be tied to any specific device and access to all digital euro services could be controlled by the responsible parties (the central bank and supervised private intermediaries) at any time. However, this second type of digital euro would exclude the possibility of anonymity for users.

It should be noted that any digital euro for offline use would need to be managed online at some point in order to add funds to the device or /withdraw funds and the two types of digital euro can coexist.[60] Similarly to the current coexistence of (online)

[58] The interest rate could only potentially be changed when the user brings the device online in order to add/withdraw an amount of the digital euro.

[59] It should be noted that incoming offline payments in excess of a holding limit could not be routed to an account in private money and the associated transaction would be rejected by the payee. However, offline payments can only be initiated upon consent from the payee and therefore this limitation should not create issues of privacy regarding her/his holdings.

[60] If the digital euro that is available online were to pay variable interest rates that cannot be replicated in the case of offline digital euro, this could hamper substitutability between the two.

commercial bank deposits and (physical) cash that can be withdrawn from bank accounts via ATMs, the digital euro could be made available online and amounts loaded onto a physical device for offline use. This also implies the possible coexistence of account-based and bearer digital euro to cater to different needs.

6 Technical and organisational approaches to digital euro services

Key messages:

- The underlying back-end infrastructure for the provision of a digital euro can either be centralised, with all transactions recorded in the central bank's ledger, or feature some decentralisation of responsibilities to users and/or supervised intermediaries, thus also enabling the provision of a bearer digital euro. Regardless of the approach, the back-end infrastructure should be ultimately controlled by the central bank.
- The main difference between a direct and intermediated model is the role of the private sector. While in a direct model supervised intermediaries are mere gatekeepers, in an intermediated model they would play a more prominent role, including that of settlement agents. In both cases, the private sector would be able to build new businesses based on digital euro-related services.
- Solutions for end-user access to a digital euro infrastructure could either be hardware or software-based, or a combination thereof. In any case, front-end access solutions need strong customer authentication and identification.
- End-user solutions and any private systems involved in the provision of digital euro services should interface with the back-end infrastructure of the central bank in a way that ensures the highest protection against the risk of unwarranted creation of digital euro units without authorisation from the central bank.

This section describes selected design options for the technical implementation of a digital euro at the level of the back-end infrastructure (Section 6.1) and end-user access solutions (Section 6.2). These specific design options meet the core principles and general requirements derived in previous sections.[61]

6.1 Back-end infrastructure

Issuance of a digital euro should remain under the control of the Eurosystem. Supervised intermediaries should be involved at least for the identification and onboarding of entitled users and possibly for the routing of transactions to the central bank infrastructure; they could build new businesses on digital euro-related services.

Two approaches are considered for the back-end infrastructure: centralised and decentralised. In the first approach, digital euro transactions are recorded in the Eurosystem's ledger. In the decentralised approach, the Eurosystem sets rules and

[61] Design options in which private entities would act as custodians of digital euro holdings, thereby leaving users with a claim on the intermediary rather than on the Eurosystem, are excluded in line with the core principle that the digital euro should always be a claim on the Eurosystem. Approaches that exclude the intervention of intermediaries are also disregarded (Requirement 9).

requirements for the settlement of digital euro transactions that are then recorded by users and/or supervised intermediaries.

In both approaches, supervised intermediaries can operate either as mere gatekeepers or as settlement agents. Gatekeepers would authenticate end users and deal with activities such as Know Your Customer (KYC), AML and CFT[62] requirements; they may also provide the technical connectivity between users and the Eurosystem's infrastructure. The basic functions of gatekeepers are therefore similar to those of commercial banks in the primary provision of cash to the economy. Settlement agents, conversely, would in addition execute digital euro transactions on behalf of their customers and may provide storage facilities (akin to digital vaults) for digital euro holdings. These holdings shall, however, remain available to end users as a Eurosystem liability at any time.

6.1.1 Centralised infrastructure

End users could hold their accounts in a centralised digital euro infrastructure provided by the Eurosystem. Such accounts would allow users to deposit and withdraw digital euro by means of electronic transfers from/to other forms of money and to make payments in digital euro.[63]

The Eurosystem would face technical and organisational challenges. It would need to process a volume of payments that its current infrastructure is not designed to handle and ensure an appropriate level of security and adherence to AML/CTF requirements, even when delegated to supervised intermediaries. Two potential models are considered, which could possibly be combined:

(i) Payments are instructed by end users in the central bank infrastructure (direct access);

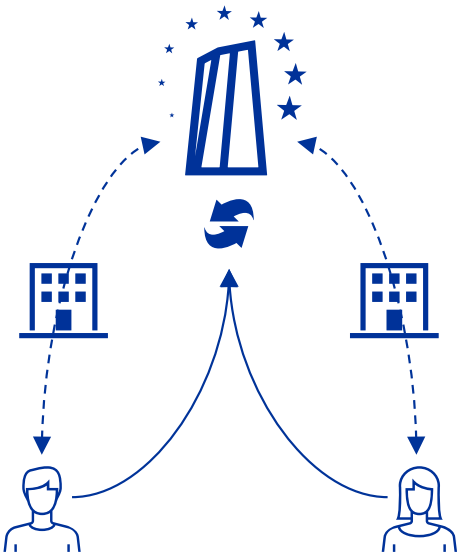
(ii) Payments are initiated by end users but instructed by their supervised intermediaries managing accounts with the central bank on their behalf (intermediated access).

62 Diverging national AML/CFT requirements, however, could result in limited scalability of technology used in the KYC process. For instance, not all EU jurisdictions support a remote-only video onboarding process.

63 For instance, TARGET instant payment settlement (TIPS) could serve as an environment for the provision of accounts directly to the general public, as opposed to the current restricted set of participants.

(i) Direct access by end users to central bank accounts

Figure 1
Direct access by end users to central bank accounts

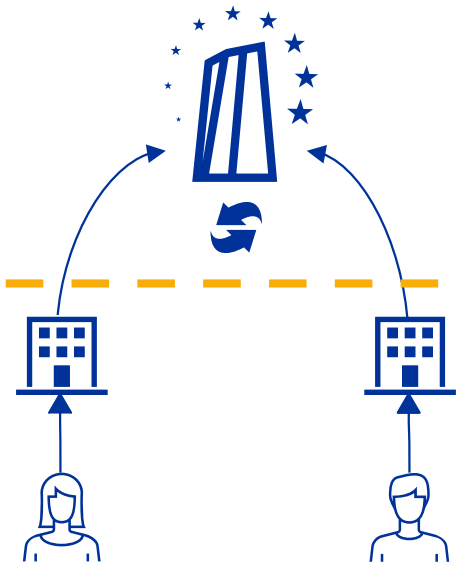


The Eurosystem, aided by gatekeepers, would grant end users the ability to directly access and operate accounts on its infrastructure. In this model, the Eurosystem would have full control over the digital euro life cycle as it would issue and redeem any unit of digital euro and would process transactions directly via its own infrastructure. Such solutions could be designed so that private keys, required to digitally sign transactions, would only be stored with end users, which would allow them to submit transactions directly to the central bank.

This model would be technologically challenging for the Eurosystem owing to the number of connections and independent accounts to be provided and for which the present central bank IT infrastructure is not designed. Moreover, direct access would imply a significant operational burden for the central bank, which could be required to ensure adherence to payment services regulations and requirements as a scheme operator.

(ii) Intermediated access by end users to central bank accounts

Figure 2
Intermediated access by end users to central bank accounts



The Eurosystem could continue interacting directly only with supervised intermediaries, which would act as settlement agents instructing transactions on behalf of their customers. Digital euro accounts would still belong to the end users and the Eurosystem would retain full control over the life cycle and processing of transactions in real time via its infrastructure. However, the number of connections to the system would in principle be limited to the number of participating intermediaries.

In this model, supervised intermediaries participating in the system would incorporate digital euro services into their businesses and could also take advantage of the innovative infrastructure to foster competition in the payments market.

6.1.2 Decentralised infrastructure

An infrastructure with some decentralisation could be used to provide a bearer digital euro, where either end users, or supervised intermediaries acting on their behalf, would verify any payment. This could be achieved through either of the following two models, which could also be combined:[64]

(i) Direct end-user access to the bearer digital euro;

(ii) Hybrid bearer digital euro (also allowing wholesale transactions) and account-based infrastructure.

[64] Direct end user access could be maintained alongside an intermediated access model to facilitate inclusion.

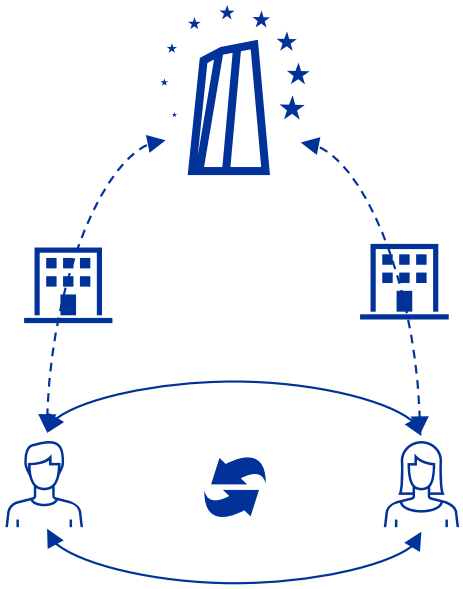
Digital euro holdings and transactions could only be managed in a decentralised way if it were possible to ensure that they were processed in line with central bank requirements at all times. The central bank would therefore need to set the standards (for example cryptography and validation methods) that would allow external parties to transfer central bank money in compliance with appropriate safety standards, even outside a central ledger.

The Eurosystem would need to develop a new decentralised infrastructure with adequate security and processing capacity, which would require significant resources and could pose various challenges as a result of the adoption of frontier technologies. However, the Eurosystem's operational burden could be potentially reduced by eliminating centralised processes.

Supervised intermediaries would also face challenges to adapt their internal systems to the provision of digital euro services built on a decentralised infrastructure. Conversely, an infrastructure with such a decentralised control and information management could foster innovation in the type of service provided to end users.

(i) Direct end-user access to a bearer digital euro

Figure 3
Direct end-user access to a bearer digital euro



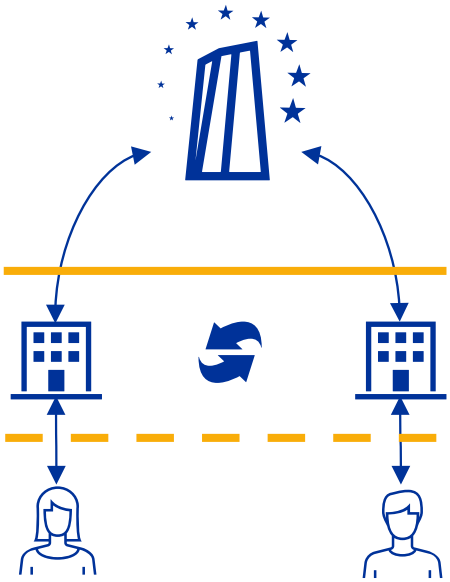
A decentralised infrastructure could allow end users to transfer holdings of the bearer digital euro among them with no need to mandate a third party to play any role in the transaction. This approach could be implemented in two ways: either via distributed ledger technology (DLT) protocols or by means of local storage (e.g. using prepaid cards and mobile phone functionality, including in offline payments). In both cases supervised intermediaries would still be required and involved as gatekeepers, including for the provision of physical devices and loading funds on to them. As

mentioned in the legal analysis, this solution presents challenges with regard to compliance with AML/CFT rules.

(ii) Hybrid bearer digital euro and account-based infrastructure (also allowing wholesale transactions)

Figure 4

Account-based and bearer infrastructure



A hybrid decentralised infrastructure could be implemented to enable the use of a bearer digital euro at the level of supervised intermediaries, who could act as settlement agents on behalf of their clients for retail transactions in digital euro and also use the same infrastructure for their wholesale payments (see Annex 3). In the provision of retail payment services in digital euro to end users, supervised intermediaries would leverage their account relationship but end users would still hold a direct claim on the Eurosystem and all transfers would be ultimately settled in the Eurosystem infrastructure.[65]

6.2 End-user access solutions

Access solutions link end users to the back-end infrastructure and therefore are heavily dependent on the infrastructure model chosen. The Eurosystem would need to ensure integration of different end-user access solutions to make digital euro services universally accessible and allow their interoperability with the financial market ecosystem. Were the Eurosystem to provide digital euro payment devices or applications, they should conform to industry standards to the extent possible, being

[65] For a similar infrastructure design, see "Exploring anonymity in central bank digital currencies", In Focus Series, No 4, ECB, Frankfurt am Main, December 2019.

interoperable with existing market solutions and facilitating inclusion and pan-European integration. Different options are possible depending on the type of access (direct or intermediated) and the use of hardware or software solutions.

Whenever the end user accessed digital euro services, authentication and authorisation should be conducted, applying the strong customer authentication requirements referred in the revised Payment Services Directive (PSD2). This means that, in order to grant access to digital euro holdings or payment initiation services, private payment service providers – and possibly the Eurosystem – should adopt technologies that guarantee safe end-user authentication and secure storage of personal data. Every end user should have hardware or software solutions in order to identify themselves and authorise digital euro payments.

PSD2 requires that a payment transaction be authorised only if the payer has given consent to execute it. In a scenario in which the Eurosystem issues a digital euro, a key question would be whether the consent is given to the central bank or to a supervised intermediary. The payment authorisation would need to be carefully implemented in digital euro transactions and would involve some degree of central bank responsibility, even if delegated to intermediaries. The Eurosystem would therefore need to develop specific know-how on the approaches and technologies used for strong customer authentication on a par with the market and in line with innovative trends.

6.2.1 Hardware solutions

Hardware solutions for using digital euro services include devices possessed by end users, merchants' acceptance devices and ATMs. These would be hardware elements in mobile phones, computers, smart cards, wearables or tokens that an end user can use as a gateway to access digital euro services via mobile and web-based banking applications and to initiate POS or P2P payments.

Customers could initiate digital euro payments with smart cards at merchants' POS terminals. Smart cards and payment terminals should follow the established industry standards, which could facilitate digital euro service integration, efficiency and possibly gain wider acceptance by merchants and ATMs.[66] Additional solutions could be considered to allow more flexible use by both merchants and customers, such as trusted mobile-POS machines enabling transactions to occur between cards and mobile phones rather than traditional POS terminals. For P2P payments, the initiation of mobile payments depends greatly on software solutions (applications) in combination with identification processes by the smartphone manufacturer. Digital euro mobile applications and web interfaces could make use of mobile proxy look-up

[66] Smart cards could also be a potential solution for offline transactions, since they have the required security features.

services (for example, identifying a payee via either phone number or email address) to ensure the smooth implementation of P2P payments.[67]

6.2.2 Software solutions

Software solutions for end-user access to payment services include applications, web interfaces, digital wallets and virtual cards. Mobile and web-based banking applications that use mobile and desktop devices for user identification are widely used in e-commerce and P2P payments. Downloadable mobile applications would be accessible to customers only after being allowlisted by trusted application stores. These stores have their own constraints on what types of application can be made available to users and with what security measures, which would place certain design and development limits on any Eurosystem application. An alternative way to access payment services is by using a web browser-based application for online banking, which could ensure the same accessibility and services.

Digital wallets could allow payments to be performed both online and at the POS (by adding card or account details in the app) while leveraging some security elements of the primary payment instrument to which they are linked (for example a card or mobile device). Additionally, a more dynamic solution could be to use virtual cards, whereby temporary virtual card details are generated to be used for online card payments, with additional features like a shorter expiration date and spending limits. Possible ceilings on the holdings of digital euro would not limit capital flows, since users could always resort to other forms of the currency.

At the POS, merchants would use their selected payment software and POS machines, therefore requiring minimal interoperability if the digital euro adhered to established industry specifications and was interoperable with existing proprietary solutions. A pan-European merchant application could be built that accepts card and mobile payments, and communicates with the back-end infrastructure for transaction processing.

End-user access solutions to a digital euro infrastructure could also be a combination of software and hardware.

6.3 Interfacing between digital euro users and the central bank infrastructure

In the case of intermediated access to the digital euro, a situation may occur in which the overall amount in circulation (i.e. recorded in the systems of intermediaries or end-user devices) does not match Eurosystem records. Such discrepancies – potentially triggered by an error or misconduct by an intermediary – could expose the

[67] In June 2015 the Euro Retail Payments Board, chaired by the ECB, issued a set of recommendations on P2P mobile payments that led the European Payments Council to launch the pan-European SEPA Proxy Lookup Scheme.

Eurosystem to reputational or balance sheet risk. Three possible approaches could be considered by the central bank to avoid discrepancies.

The most restrictive approach is to create a constrained operational framework in which the systems used by intermediaries and users are provided by the central bank, such that all processing that happens on their end is codified by the central bank. This could be done through the provision of licensed software and/or hardware to supervised intermediaries and end users (for example mobile applications or cards). With such a solution, intermediaries' systems would not be able to create or destroy units of digital euro. However, this solution would place a high operational burden on the Eurosystem and would limit flexibility for intermediaries.

Another approach is to enable real-time audits of all systems belonging to supervised intermediaries and end-user devices, which would require tight integration of all systems and automated checks operated by the central bank. Different technical solutions could be envisaged for implementing such a solution, in particular enabling the central bank to have administrator access through remote access capabilities to the digital euro systems operated by supervised intermediaries. More advanced techniques could be used whereby cryptographic proof is computed by the systems to prove to the central bank that the amounts recorded remain valid.

Finally, to ensure consistency of the amounts and avoid the abovementioned risks for end users, the latter could be given the possibility to automatically check, through their devices and applications, that their balances correspond to what is recorded in the system of the central bank. To ensure that no unintended transaction can be originated by an intermediary on behalf of a user, the end user could automatically send a request to the central bank upon initiation of a transaction (using a private signature not known to the intermediary) approving initiation of the transaction. The end user would then receive confirmation from the central bank system that the transaction had been processed.

7 Follow-up work

Key messages:

- A comprehensive and balanced policy-oriented assessment of the challenges of a digital euro and its potential relative to alternative options is necessary before issuance of the digital euro can be considered. The views of institutions, citizens and professionals will provide valuable input to this assessment, including through a public consultation.
- Practical experimentation is necessary to test functional design options and explore their technical feasibility, as well as their ability to satisfy the needs of prospective users. Experimental work should involve the private sector and prospective users to the extent necessary and should not pre-empt decisions or commit the Eurosystem to providing a digital euro.
- To ensure that meaningful answers are obtained to the open questions raised in this report, the Eurosystem will consider whether to start a digital euro project towards mid-2021, with the possible launch of an investigation phase aimed at developing a minimum viable product.
- In addition to conceptual analysis and practical experimentation by the Eurosystem, the involvement of European and international institutions, fora and standard-setters would be required to ensure that the digital euro could satisfy the expectations of all prospective stakeholders.

The analysis carried out so far has identified principles and requirements which represent the starting point of an assessment of digital euro issuance by the Eurosystem under the given scenario(s). The future issuance of a digital euro depends on the results of a comprehensive policy-oriented assessment of its challenges and potential relative to alternative options. Introducing a digital euro is a policy decision and not just a technical one.

Communication with prospective end users and with the supervised intermediaries that could be involved in the provision of services is crucial to assess the actual business case for issuance. This report will serve as a starting point for a public consultation. Hearing the views of the public is essential to ensure that any change to the form of money and payments that the Eurosystem provides remains firmly ensconced in citizens' trust. The extent to which supervised intermediaries and prospective users would favour a digital euro and under what conditions they would be willing to adopt it should also be evaluated.

7.1 Operational considerations

From an operational perspective, follow-up conceptual analysis and practical work would need to cover a wide range of aspects. A thorough exploration of the soundness

and technical feasibility of the concepts and models described in previous sections is essential to further develop the findings in this report. The main purpose would be to assess the soundness of different design options, within the current institutional and regulatory frameworks, and to gauge the possibilities and limitations of current technologies for developing features that are desirable from a policy perspective.

Experiments do not pre-empt decisions or commit the Eurosystem to providing a digital euro. Their aim is to enable the Eurosystem to address an initial set of fundamental design questions raised in the report. Some experiments may have to be conducted in conjunction with the financial industry. This would ensure that digital euro services are interoperable with other payment services and that solutions developed by private intermediaries can be integrated. The selection of the relevant association(s) and market actors will depend on a digital euro's key functionalities.

Towards mid-2021 the Governing Council of the ECB will consider whether to launch a digital euro project, which would start with an investigation phase. The investigation would aim at identifying at least one minimum viable product able to meet the requirements described in this report. It would cover the key dimensions of a digital euro and would address not only technical requirements but also consider user requirements, in order to inform the design of the digital euro and its front-end processes such that it can meet the needs of prospective users. The objective is to ensure that the Eurosystem will be prepared to issue a digital euro if it decides to do so in the future.

Before any decision can be taken on the issuance of a digital euro, the scope and cost of such a project should be quantified, in order to compare this solution with possible alternatives. The costs associated with issuing a digital euro are not only financial but also organisational, since the central bank would have to develop new competencies and processes and manage new risks.

7.2 Institutional framework

Follow-up work on a digital euro will involve European institutions, fora and standard-setters. Dialogue with other European institutions and authorities is required to discuss the operational and legislative framework that would be necessary to introduce a digital euro. Institutions involved in EU legislation – the European Parliament, the EU Council and the EU Commission – will have a fundamental role to play.

Interaction with other institutions tasked with micro- – and macroprudential supervision – such as the European Banking Authority, the European Securities and Markets Authority, and the European Systemic Risk Board – is also needed in order to further explore the potential risks and ways to address or mitigate them.

The international implications of the issuance of CBDCs warrant open dialogue with other central banks and international organisations. The work of the international central bank group established by the Bank of Canada, the Bank of England, the ECB, the Bank of Japan, Sveriges Riksbank and the Swiss National Bank, together with the

Bank for International Settlements, is a notable example, as it will assess the potential use cases for CBDC with reference to its international dimension.[68] The group will closely coordinate with the relevant international institutions and fora, such as the Financial Stability Board, the Financial Action Task Force, the Committee on Payments and Market Infrastructures, and the International Monetary Fund.

[68] See the ECB press release of 21 January 2020 on the "Central bank group to assess potential cases for central bank digital currencies".

Annex 1: Digital euro characteristics identified in the report

Type of characteristic	Description
Core principles	P1: Convertibility at par: Not a parallel currency
	P2: Liability of the Eurosystem: A digital euro is central bank money and its issuance is controlled by the Eurosystem
	P3: European solution: Widely accessible on equal terms in all euro area countries through supervised service providers
	P4: Market neutrality: Not to crowd out private solutions
	P5: Trusted by end users: Trusted solution from the start and over time
Scenario-specific requirements	R1: Enhanced digital efficiency (if launched to support digitalisation): The digital euro should keep pace with state-of-the-art technology at all times in order to best address the needs of the market as regards, among other attributes, usability, convenience, speed, cost efficiency and programmability. It should be made available through standard interoperable front-end solutions throughout the entire euro area and should be interoperable with private payment solutions.
	R2: Cash-like features (if aiming to tackle a decline in the acceptance of cash): To match the key distinctive features of cash, a digital euro aiming to tackle a decline in the acceptance of cash should permit offline payments. Moreover, a digital euro should be easy for vulnerable groups to use, free of charge for basic use by payers and should protect privacy. It should have a strong European branding.
	R3: Competitive features (if introduced to limit the uptake of forms of money that are not denominated in euro and/or not appropriately supervised): The digital euro should have features which are at the technological frontier. It should offer the basis for providing functionalities that are at least as attractive as those of the payment solutions available in foreign currencies or through unregulated entities.
	R4: Monetary policy option: If considered to be a tool for improving the transmission of monetary policy, the digital euro should be remunerated at interest rate(s) that the central bank can modify over time.
	R5: Back-up system: If aiming to improve the overall resilience of the payment system, the digital euro should be widely available and transacted via resilient channels that are separate from those of other payment services and can withstand extreme events.
	R6: International use (if introduced to increase the international role of the euro): The digital euro should be potentially accessible outside the euro area in a way that is consistent with the objectives of the Eurosystem and convenient to non-euro area residents.
	R7a: Cost saving (if launched for cost efficiency): The design of the digital euro should achieve a reduction in the cost of the current payments ecosystem.
	R7b: Environmentally friendly (if launched for environmental reasons): The design of the digital euro should be based on technological solutions that minimise its ecological footprint and improve that of the current payments ecosystem.
General requirements	R8: Ability to control the amount of digital euro in circulation: 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.
	R9: Cooperation with market participants: A project to introduce a digital euro should be carried out in line with best practices in IT project management. The digital euro should then be made available on an equal basis in all euro countries through supervised intermediaries, which could leverage their existing customer-facing services and avoid the costly duplication of processes.
	R10: Compliance with the regulatory framework: Although central bank liabilities are not subject to regulation and oversight, in issuing the digital euro the Eurosystem should still aim at complying with regulatory standards, including in the area of payments.
	R11: Safety and efficiency in the fulfilment of the Eurosystem's goals: The digital euro should be designed in a safe and efficient way. Its project and operating costs should be estimated and compared with the expected benefits, considering alternative solutions in any future scenario. The provision of non-core services should be left to supervised private entities.
	R12: Easy accessibility throughout the euro area. The digital euro should be made available through standardised front-end solutions throughout the entire euro area and should be interoperable with private payment solutions. It should be easily accessible by anyone, including citizens who currently do not participate in the financial system (for example, those who do not have an account at a commercial bank), and should be easy to use. The digital euro would need to co-exist with cash.

	R13: Conditional use by non-euro area residents: The design of the digital euro should include specific conditions for access and use by non-euro area residents, to ensure that it does not contribute to excessively volatile capital flows or exchange rates. Such conditions could take the form, for instance, of limits or adequate remuneration policies for holdings of digital euro of non-euro area residents.
	R14: Cyber resilience: Digital euro services will need to be highly resilient to cyber threats and capable of providing a high level of protection to the financial ecosystem from cyberattacks. In the event of successful attacks, the recovery time should be short and the integrity of the data protected.

Annex 2: The digital euro is not a crypto-asset or ‘stablecoin’

The digital euro would be a risk-free form of central bank money (i.e. a digital representation of cash), which means that it is issued by the central bank and remains its liability at all times. In simple words, the Eurosystem is accountable to the European citizens for ensuring that the value of the instruments it issues is unchanged over time (i.e. one euro today is worth one euro tomorrow, be it in the form of cash or digital euro) and the amount of goods and services they can buy with such instruments – i.e. the “purchasing power” of money issued by the central bank – does not fluctuate beyond a predefined threshold.[69]

Commercial bank money and electronic money are by contrast liabilities of supervised private entities. Private money issuance needs to comply with the regulations and the issuing private institution is subject to supervision or oversight by public authorities. While such entities might in theory default and become unable to satisfy the claims of their customers to, for example, convert their holdings into central bank money, their customers are protected by a legally binding regulatory framework that obliges the supervised private issuer to take measures to protect the value of their liabilities. The central bank, beside its supervisory function, acts as a lender of last resort to avoid default by the commercial banks in exceptional situations. Moreover, deposits with commercial banks are protected in the euro area by deposit insurance schemes.

Crypto-assets, in contrast, are not a liability of any entity,[70] thus there is no reliable framework to sustain their value and to protect their direct holders. These assets are mostly unregulated, which poses high risks to the users. Their price is highly volatile because crypto-assets lack any intrinsic value, which means that they trade like a speculative commodity. These characteristics limit the use of crypto-assets to only a limited set of investors and make their market illiquid; this in turn implies that users might fail to convert their crypto-asset holdings back into the amount of euro they initially invested. Regardless of the technology used for a digital euro, its nature – i.e. the fact that it is a risk-free liability of the central bank – makes it fundamentally different from crypto-assets.

The considerations outlined in this annex are valid irrespective of the technology used for different types of asset. For instance, blockchain technology could be used for the issuance and trading of any asset type. So called ‘stablecoins’ are a case in point:[71] in spite of the fact that they are all recorded by means of distributed ledger technology,

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69 Maintaining price stability is the primary objective of the Eurosystem and of the single monetary policy for which it is responsible. This is laid down in Article 127(1) of the Treaty on the Functioning of the European Union, Article 127 (1).

70 See “Crypto-Assets: Implications for financial stability, monetary policy, and payments and market infrastructures”, Occasional Paper Series, No 223, ECB Crypto-Assets Task Force, 2019.

71 The characteristics of stablecoins and their implications of the financial system are analysed in “Stablecoins: Implications for monetary policy, financial stability, market infrastructure and payments, and banking supervision in the euro area”, Occasional Paper Series, No 247, ECB Crypto-Assets Task Force, 2020.

their characteristics differ according to the type of claim they represent, which could make them similar to commercial bank money, electronic money, investment funds or crypto-assets.[72] All forms of "stablecoins", aim at keeping their value stable over time, but this can only be guaranteed by a digital euro.

[72] See Bullmann D., Klemm J. and Pinna, A. "In search for stability in crypto-assets: are stablecoins the solution?", Occasional Paper Series, No 230, ECB, 2019.

Annex 3: Wholesale application of a distributed infrastructure

Digital central bank money for wholesale transactions is not new, as banks have been able to access central bank money in digital form for decades.

With its TARGET services, the Eurosystem already operates an efficient infrastructure for digital wholesale money: TARGET2 (T2) for wholesale payments, TARGET2 SECURITIES (T2S) for the settlement of securities trading in central bank money, and the TARGET Instant Payment Settlement (TIPS) service for instant payments. The Eurosystem is currently enhancing its service in particular through the consolidation of the platforms of T2 and T2S.

It will also study whether the use of a distributed infrastructure in wholesale transactions might improve the efficiency and fluidity of payment systems and financial infrastructures. Payment should in any case remain traceable by the central bank even if a central transaction database is not used. The objective is to reinforce the stability of the financial sector by ensuring that central bank money remains the asset at the core of the payment system, used for the settlement of the majority of wholesale transactions. The question that emerges is whether, for this purpose, settlement in central bank money should be available at all times for wholesale transactions and, if so, what are the possible technical options to achieve this and to facilitate its use for the settlement of transactions conducted via distributed infrastructures.

Applications of decentralised infrastructures may also be considered in the management of collateral, processing of securities lending operations, processing of repo transactions, processing of delivery versus payment (DVP) transactions, creation and processing of over the counter (OTC) derivatives contracts and conditional payments (for example back-insurance payments or trade finance).Some financial market participants support the idea that distribution of book-keeping responsibilities through settlement platforms where participants can share responsibilities for the validation of transactions would shorten settlement times and lower reconciliation costs.

The Eurosystem would need to study whether balances in the distributed infrastructure would form part of the monetary base, along with banknotes and reserves, with these components representing different forms of central bank money that can be exchanged at par.

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Participants in the HLTF-CBDC

Fabio Panetta	Chairperson, European Central Bank
Yves Mersch	European Central Bank
Tim Hermans	Banque Nationale de Belgique
Burkhard Balz	Deutsche Bundesbank
Maive Rute and Rainer Olt	Eesti Pank
Sharon Donnery and William Molloy	Central Bank of Ireland
Heather Gibson	Bank of Greece
Juan Ayuso Huertas	Banco de España
Nathalie Aufauvre	Banque de France
Piero Cipollone	Banca d'Italia
Photini Frank and Theroula Louca	Central Bank of Cyprus
Harijs Ozols and Egons Gailītis	Latvijas Banka
Marius Jurgilas	Lietuvos bankas
Pierre Beck	Banque centrale du Luxembourg
Jesmond Gatt	Central Bank of Malta
Olaf Sleijpen	De Nederlandsche Bank
Martin Summer	Oesterreichische Nationalbank
Hélder Rosalino	Banco de Portugal
Jožef Bradeško	Banka Slovenije
Ľudovít Ódor	Národná banka Slovenska
Tuomas Välimäki	Suomen Pankki
Ulrich Bindseil	Rapporteur, European Central Bank

Joint secretariat of the HLTF-CBDC

Andrea Pinna (Coordinator, European Central Bank), Heike Winter (Deutsche Bundesbank), Andrej Bachmann (European Central Bank), Vassilis Spiliotopoulos (Bank of Greece), José Manuel Marqués (Banco de España), Christian Pfister (Banque de France), Angela Caporrini (Banca d'Italia), Klāvs Ozoliņš (Latvijas Banka), Šarūnas Grigas (Lietuvos bankas), Christina Rivellini (Banque centrale du Luxembourg), Peter Wierts (De Nederlandsche Bank), Beat Weber (Oesterreichische Nationalbank), Rita Soares (Banco de Portugal), Domen Božeglav (Banka Slovenije), Aleksi Grym (Suomen Pankki).

Input was provided by the following ECB staff: Holger Neuhaus, Ignacio Terol, Diego Castejon Molina, Francesco Gavanna, Cedric Humbert, Ioana Valentina Naghel, Naisa Tussi, Austėja Šostakaitė. ECB Directorates Banknotes, Financial Stability, Information Systems, International Relations, Legal Services, Market Operations, Monetary Policy, Risk Management and Single Supervisory Mechanism also contributed to the preparation of the report.

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

For specific terminology please refer to the ECB glossary (available in English only).