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THE ROLE OF CENTRAL BANK DIGITAL CURRENCIES IN STRENGTHENING FINANCIAL RESILIENCE

Abstract

This paper examines the potential of a central bank digital currency, specifically the digital euro, to transform the euro area financial sector and affect the stability of the banking system. It addresses the question of how the introduction and design of a retail CBDC in the form of a digital euro may influence the functioning and resilience of the traditional banking model and works with the hypothesis that, under appropriate design choices, a digital euro can complement cash without unduly undermining bank intermediation. The paper adopts a conceptual and analytical approach based on a review of theoretical and model-based studies on CBDCs and banking, combined with official documents of EU institutions and the European Central Bank. The findings indicate that while existing models suggest that retail CBDCs could accelerate bank runs and reinforce bank disintermediation, particularly for smaller deposit-funded banks, they also show that key design features – in particular non-remuneration and calibrated holding limits – can substantially mitigate these risks under the assumptions of the underlying models, highlighting the need for careful calibration and future empirical validation.

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1. Introduction

Over the last few years, we have witnessed an undeniable trend – the decline of cash payments and their replacement by digital alternatives. The shift, which is evident in our daily lives is also supported by long-term studies [Study on the payment attitudes of consumers in the euro area (SPACE), 2024], which confirm the declining popularity of traditional cash. At the same time, in the current macroeconomic environment marked by recurring fluctuations in the financial markets and rapid technological developments, the stability of the banking sector plays a vital role in sustaining economic growth and public confidence. Traditional risks like mismatches between long-term assets and short-term liabilities, the threat of bank runs or failures of intermediation can lead to a deterioration in credit conditions and a slowdown in economic activity.

In this context, central bank digital currencies (hereinafter referred to as CBDC), whose basic characteristic is issuance and regulation by the central bank, are gaining importance. At European Union level, a flagship project in this area is the digital euro, which is a digital form of the euro issued and developed by the European Central Bank (hereinafter referred to as ECB). CBDCs can be designed in several basic forms varying both in the nature of the intended users and in the technical model of distribution and management. For the purposes of this paper, i.e. to examine the impact on ordinary users and the traditional banking model, the most relevant is the retail CBDC – the digital form of the euro intended for daily payments by retail customers. Therefore, this paper will focus mainly on this type. Against this background, the paper addresses the following research question: how would the introduction and design of a retail CBDC in the form of a digital euro affect the functioning and resilience of the traditional banking model in the euro area, in particular through the channels of bank runs and bank disintermediation? The analysis is guided by the working hypothesis that, provided that key design parameters such as non-remuneration and calibrated holding limits are implemented, a digital euro can complement cash and modernise payments without unduly undermining

banks' core intermediation role or destabilising the banking sector. The paper adopts an analytical and review-oriented approach: it synthesises existing theoretical and model-based studies on CBDCs and banking together with official documents of the EU institutions and the ECB, and applies their insights to the specific case of the digital euro. The first part of the paper outlines the basic structure of the banking sector, including the identification of systemic risks and the approaches taken by central banks and commercial banks to prevent crises. Subsequently, it focuses on the potential impacts of CBDC, ranging from the potential for acceleration and amplification of bank runs due to the ease of moving funds in a digital environment to the increased disintermediation of banks caused by the potential direct access of retail customers to the central bank. Finally, the paper explores proposed mechanisms to mitigate these risks, such as limits on digital euro holdings and the avoidance of interest rate lock-in, and assesses their potential effectiveness in the context of the digital euro project.

1.1. Methodology

The paper adopts a conceptual and analytical approach based on a structured review of recent literature on CBDC and banking. Rather than relying on original empirical data, it synthesises existing theoretical and model-based contributions that analyse the interaction between CBDCs, traditional bank funding structures and financial stability. The core of the analysis draws on classic models of bank runs and intermediation, as well as more recent quantitative studies that explicitly incorporate CBDCs into models of household portfolio choice and bank balance sheets [Diamond, Dybvig 1983; Vazquez, Federico 2012; Chang, Grinberg, Gornicka, Miccoli, Tan 2023; Bidder, Jackson, Rottner 2024; Ponce, Taroco 2024; Bitter 2024].

In addition, the paper makes use of official documents and policy materials produced by European institutions and the ECB, including the ECB's reports on the digital euro project, the preliminary methodology for holding limit calibration and the legislative proposals for regulations on the establishment of the digital euro and the legal tender status of euro cash [Communication from the Commission on a Digital Finance Strategy for the EU 2020]; [Proposal for a Regulation COM(2023) 369 final]; [Annex to preliminary methodology for holding limit calibration 2024]; [Progress on the preparation phase of a digital euro: First progress report 2024]; [Opinion of the European

Central Bank CON/2023/34]. These documents provide the normative and institutional framework within which the economic models of CBDCs are interpreted and applied.

Methodologically, the analysis proceeds in three steps. First, it identifies the main channels through which the existing structure of the banking sector and traditional risks such as liquidity mismatches, bank runs and failures of intermediation affect financial stability. Second, it examines how these channels are modified in theoretical and model-based studies once a retail CBDC is introduced, with particular attention to the dynamics of digital bank runs and the processes of slow and fast bank disintermediation. Third, it applies these insights to the specific design features of the digital euro as currently envisaged in the EU legislative proposals and ECB documentation, focusing in particular on the role of holding limits and non-remuneration as tools to balance the benefits and risks of a retail CBDC for financial resilience in the euro area.

Finally, the paper acknowledges important limitations of this approach. Since a fully-fledged retail CBDC has not yet been implemented in the euro area and empirical evidence from other jurisdictions remains very limited, the conclusions are necessarily based on model-based simulations and scenario analysis rather than on observed data from large-scale CBDC deployments. The results should therefore be understood as conditional on the assumptions embedded in the underlying models and on the specific institutional setting of the digital euro project.

2. Structure of banking sector

The banking sector is an essential part of the modern economy and has a complex structure in which three basic types of institutions play a key role: the central bank, commercial banks and non-bank financial institutions. At the top of this hierarchy is the central bank as regulator, supervisor and issuer whose main objective is to ensure the stability of the financial system through monetary policy. By contrast, commercial banks constitute the backbone of the sector, as they are involved in taking deposits from customers and providing credit, thereby ensuring financial intermediation between actors in the economy. Bank deposits can be considered a form of money, which is created by commercial banks via the credit creation theory of banking, therefore it can be referred to as “commercial bank money”.

In this context, some authors describe the theoretical possibility of banks creating money "out of nothing" through the process of extending loans and creating corresponding deposits [Werner 2014: 16–18]. In practice, however, the ability of individual banks to expand their balance sheets is constrained by prudential regulation and supervision, including capital and liquidity requirements and other risk limits set by the regulatory framework. While the fractional reserve nature of the system allows banks to hold only a fraction of their deposits in reserves and lend out the remainder, these regulatory constraints and internal risk management practices significantly limit the extent of credit creation. In addition to these two primary types, there is a wide range of non-bank financial institutions such as insurance companies, pension funds, investment companies and others that complement the spectrum of financial services and products.

While necessary for the efficient functioning of the economy, this structure is associated with risks that can threaten financial stability. In fact, the banking sector is exposed to liquidity risk, credit risk, market risk and others, and the interconnectedness of individual institutions can lead to the system-wide propagation of these risks. The importance of banking sector stability for the overall stability of the economy is particularly evident during the financial crisis, as problems in the banking sector can quickly escalate into a systemic crisis with far-reaching negative effects.

Against this backdrop, the institutional structure of the banking sector outlined in this section serves as the starting point for the subsequent analysis. The following parts of the paper build on this framework when examining through which channels the introduction of a retail CBDC, in particular in the form of a digital euro, may affect financial stability, bank runs and the degree of bank disintermediation.

3. Traditional risks to the stability of the banking sector

The stability of financial institutions is closely linked to the structure of their funding. A recurring theme of financial crises is the destabilising effect of insufficient bank funding, which is primarily characterised by a heavy reliance on short-term funding and a dangerous mismatch between assets and liabilities.

Research shows that banks with weaker structural liquidity were more predisposed to failure in the period preceding the global financial crisis [Vazquez, Federico 2012: 10]. This vulnerability stems from the possibility of a shock reduction in funding sources, which can occur as a result of a loss of confidence or broader market disruptions. In such scenarios, banks may be forced to liquidate assets quickly and potentially value-destroyingly in order to meet their obligations. The mismatch between a bank's assets and liabilities often represents an additional layer of risk. Banks typically hold assets with longer maturities, such as loans, while their liabilities, such as deposits, are often short-term. This maturity mismatch creates an underlying liquidity risk, as banks may find it difficult to meet short-term obligations if their longer-term assets cannot be quickly converted into cash.

The structural vulnerabilities of the banking sector arising from asset-liability maturity mismatches are linked to a number of threats that may further aggravate these imbalances. In particular, the sudden loss of confidence leading to bank runs and the weakening of the traditional role of banks in the redistribution of financial resources will be addressed here. Both of these phenomena within the banking system respond to changes in customer behaviour, either as a result of irrational fears or in response to new, more competitive forms of storing value and making payments. The fundamental challenge here is the ability of banks to perform their core function of effectively intermediating between savers and investors. These traditional channels of instability, such as liquidity risk, the possibility of sudden deposit withdrawals and failures of intermediation constitute the baseline against which the subsequent analysis evaluates how the introduction of a retail CBDC may modify or amplify risks to the banking sector. In terms of the research framework outlined in the introduction, this section thus covers the part relating to the main channels through which the current structure of the banking sector affects financial resilience.

3.1. Bank Runs

Bank runs typically characterised by sudden and massive deposit withdrawals are often triggered by a loss of depositor confidence, which can be triggered by a number of factors, including concerns about bank solvency, broader economic uncertainty, or may even be a largely irrational self-fulfilling prophecy. In this case, it is also necessary to consider the now widespread

and traditional demand deposit accounts. This instrument bears a number of non-negligible advantages and benefits for clients and allows flexibility in the provision of liquidity; however, this flexibility also implies risks associated with the ease of withdrawing funds and converting them into cash [Diamond and Dybvig 1983: 409–411].

The dynamics of runs on banks are complex and it is not always just a matter of sub-optimal contract settings; often a bank can find itself in a liquidity crisis even with optimally designed contracts [Peck, Shell 2003: 116–118]. The possibility of runs is affected by factors such as uncertainty about aggregate liquidity demand and the nature of depositors' preferences. Importantly, runs on banks are not simply a reflection of other underlying problems; they can cause real economic damage on their own. As already indicated, the interconnectedness of banks and other financial institutions within the financial system can act as a risk multiplier, hence runs can spread very quickly and pose a systemic risk. Among the mechanisms that serve to mitigate the risk associated with runs on a bank are, for example, deposit insurance schemes which act as a tool of prevention on the one hand, as it calms down possible concerns about deposit loss, and on the other hand as an actual hedge for depositors in the event of a liquidity shortage [Diamond, Dybvig 1983: 416]. The role of lender of last resort through the central bank discount window is in a similar position. This mechanism allows depository institutions to obtain short-term loans secured by collateral, which helps them to manage liquidity risks and avoid actions that could have a negative impact on their clients, such as restricting lending. A mechanism that allows depositors to express their expectations about the stability of the bank while encouraging early warning of the risk of run could be a valuable tool, with the threat of suspension of payments acting as a precautionary safeguard [Andolfatto, Nosal, Sultanum 2017: 1016–1018]. Taken together, these classical mechanisms and insights provide the conceptual baseline for the later discussion of how the availability of a retail CBDC may change both the speed and the scale of bank runs in the euro area.

3.2. Bank disintermediation

Banks represent a central agent in the present form of financial intermediation, as they convert deposits into loans and mediate the flow of capital from depositors to entities demanding funds for investment or consumption.

The contraction in lending activity could seriously threaten the real economy in terms of economic growth and macroeconomic stability. In particular, sectors that are heavily dependent on external financing that tend to be more severely affected during banking crises than sectors with less dependence [Kroszner, Laeven, Klingebiel 2006: 31]. This phenomenon is particularly evident in countries with more developed financial systems. The failure of bank intermediation in these economies leads to a reduction in financing for businesses, which translates into a decline in investment, output and economic growth. Moreover, banks combining low levels of liquidity with high levels of debt have a higher probability of default, which can severely limit their ability to lend. In this context, it appears that smaller banks focused on the domestic market tend to be more sensitive to liquidity risk, while large multinational institutions are more vulnerable to solvency problems, especially as a result of excessive debt. [Vazquez, Federico 2012: 16–17]. The impact of banking intermediation failures on the real economy can be widespread and long-lasting. Restricted access to credit hinders innovation, limits business expansion and reduces consumer demand. In extreme cases it can lead to economic recession. The notion of bank disintermediation developed in this section is therefore used in the subsequent analysis of CBDCs to examine how the introduction of a digital euro could alter the allocation of savings and credit. In particular, the distinction between gradual and rapid forms of disintermediation introduced later in the paper builds directly on these traditional channels through which disruptions in bank intermediation are transmitted to the real economy.

4. The role of CBDCs and their impact on the banking sector

4.1. CBDC and bank runs

One of the main concerns about the introduction of CBDCs is their potential to increase the risk of bank runs. In this regard, it is necessary to consider that the introduction of CBDCs raises the possibility of transferring funds from commercial bank deposits through a new channel that may transmit a significant number of sudden transactions – a risk that poses a potential problem for the financial system. The traditional run on banks, characterised by sudden and massive deposit withdrawals due to concerns about the bank's solvency, could be amplified in the digital age with the advent of CBDCs. The ease and speed with which funds can be transferred electronically is changing

the dynamics of deposit withdrawals. A particularly important aspect here is the digital nature of CBDC, which in itself changes the dynamics of this risk. Unlike traditional bank runs, which are to some extent constrained by physical limits such as branch opening hours and the time it takes to process withdrawals, digital bank runs can occur almost instantaneously and on a mass scale. In times of economic uncertainty or perceived financial instability, the fact that CBDCs are a direct claim on the central bank and are therefore perceived as free from credit risk could motivate depositors to quickly move their funds from commercial bank accounts to the relatively safer haven of CBDC holdings, even though CBDCs themselves remain exposed to operational and cyber risks associated with digital payment infrastructures [Tian, Zhao, Olivares 2022: 9].

By using a deep neural network (DNN) approach, the introduction of CBDC is likely to lead to significant deposit outflows from commercial banks, especially during periods of higher perceived financial risk [Sanchez-Roger, Puyol-Antón 2021: 16–17]. The model shows how different CBDC designs can affect these outflows and highlights the inherent perception of CBDC as "risk-free" compared to commercial bank deposits, which are perceived as (low) risk. In the context of this model, "risk-free" refers specifically to the absence of credit risk on CBDC holdings as a direct liability of the central bank, not to the absence of all other forms of risk. This modelled risk-free feature of CBDCs, combined with the ease of digital transfers, creates a strong incentive for depositors to move their funds quickly to safety in times of perceived financial instability. Notably, the DNN model, calibrated on euro area data, suggested that the likelihood of outflows from digital banks is strongly correlated with overall perceptions of financial risk, as measured by indicators such as the composite indicator of systemic stress.

The relationship between CBDC issuance and banking sector stability is complex, and while CBDC creates new liabilities for central banks and affects the balance sheets of commercial banks, its impact on financial stability may not be clearly negative [Bitter 2022: 25]. In the calibrated model used by Bitter, CBDC alters the composition of household savings, the way banks are financed, and the allocation of capital investment, which puts pressure on bank profitability under normal conditions. However, in the case of shocks that do not themselves lead to a run on banks, CBDC issuance can, in the simulations, mitigate output declines and welfare losses by stabilizing asset

prices, even at the cost of higher deposit outflows. The ability to stabilise asset prices in these scenarios is what can delay bank insolvencies and failures caused by a lack of liquidity in times of crisis, thereby strengthening overall financial stability.

Moreover, CBDC designed as a cash-like instrument can, in theoretical scenarios, serve as a means to prevent systemic depletion of bank reserves caused by a sudden liquidity shortfall, particularly when combined with emergency liquidity assistance provided by the central bank [Ponce 2023: 14–15] In such a case it can be assumed that, if a sufficient number of depositors transfer funds to the CBDC, the central bank will obtain the necessary funds to support illiquid banks and can effectively act as a lender of last resort. However, the success of this approach relies on the ability of the central bank to manage liquidity effectively, to respond quickly to problems as they arise, and on the quality of the institutional and regulatory framework that defines the functioning of the CBDC. In cases of severe systemic crises, the activation of deposit-rescue mechanisms may in fact amplify financial instability by causing losses to creditors, which may trigger further insolvencies throughout the banking network. Empirical analysis [Siebenbrunner, Hafner-Guth, Spitzer, Trappl 2024: 12] based on Austrian banking data shows that while bail-ins are more socially beneficial than insolvency in isolated cases, they may be less effective or even counterproductive in systemic scenarios, where they may increase legal risk and bring no clear social welfare benefits.

The primary risk arising from the combination of CBDCs and run on the bank is the increased potential for rapid and large-scale deposit outflows from commercial banks to CBDCs due to the ease and speed of digital transactions and the perceived credit-risk-free nature of CBDCs as direct central bank liabilities. This digitalisation of deposit outflows from banks could destabilise the banking system and make it more vulnerable to sudden crises, as depositors can quickly move their funds to CBDCs in times of financial instability. Although CBDCs could also present an opportunity to prevent bank runs by facilitating emergency liquidity assistance, the more prevalent concern now is that the ease with which depositors can move to CBDCs may amplify the speed and scale of bank runs. Within the research framework of this paper, this section examines how the introduction of a retail CBDC may change the dynamics, speed and scale of bank runs in the euro area.

4.2. CBDC and bank disintermediation

The introduction of the CBDC may significantly transform the relationship between financial market participants and financial institutions, particularly in terms of the allocation of resources between the central bank, commercial banks and households and businesses. This concern stems from the fundamental nature of CBDC as a direct liability of the central bank, which could be perceived as a safer and more liquid form of money compared to commercial bank deposits, especially in terms of credit risk. In times of economic uncertainty or perceived instability in the financial system, individuals and businesses might prefer to hold their funds in the form of CBDC, which offer a direct claim on the central bank, rather than a deposit with a commercial bank, which carries a degree of credit and liquidity risk, albeit minimal due to the already discussed deposit insurance schemes. Current data [Risk Assessment Report of the European Banking Authority 2024: 44–45] confirm that customer deposits remain the main funding base of banks – their share is expected to reach 54.9% by the end of 2026 (53.6% in 2023) and grow slightly further. Deposits serve as a stable and relatively inexpensive way of raising funds, therefore, any outflow of these funds – for example, in favour of a safer perceived alternative such as CBDC – could constrain banks' ability to lend and thus negatively affect credit dynamics across the economy.

It is important to note that bank disintermediation indicates the process whereby the flow of funds passes directly between lenders and borrowers, bypassing traditional financial intermediaries such as banks. In the context of CBDC, this phenomenon can manifest itself in two main ways. "Slow disintermediation" describes the gradual shift of deposits from commercial banks to CBDC during normal economic periods. This could occur if individuals find CBDC attractive as a payment method or as a safe, albeit non-interest-bearing, store of value. In contrast, "fast disintermediation" involves a rapid shift of bank deposits to CBDC in times of financial stress or banking distress [Bidder, Jackson, Rottner 2024: 35]. In the model of Bidder, Jackson and Rottner, the distinction between slow and fast disintermediation captures different macro-financial scenarios and is used to analyse how various CBDC designs affect the stability of bank funding. It is particularly the speed with which deposits are withdrawn, influenced by the broader economic context, that can lead to varied outcomes for financial stability.

A gradual outflow of deposits may pose manageable problems for bank funding, while a rapid shift during a crisis could pose a more immediate and serious threat to financial stability.

CBDCs could have the capacity to replace a significant portion of bank deposits, particularly if designed as an interest-bearing instrument [Whited, Wu, Xiao 2023: 30]. In their model, the relative attractiveness of CBDC compared to traditional bank deposits depends on its remuneration and perceived safety, and higher CBDC interest rates can induce sizeable shifts in household portfolios. Although most CBDC proposals do not involve interest, their attractiveness relative to traditional bank deposits stems from their relative safety and liquidity. Should a portion of deposits be transferred to CBDCs, banks could respond by increasing their use of wholesale funding, which could lead to a higher sensitivity to short-term interest rates and hence an increase in interest rate risk and funding costs. On the other hand, there are arguments based on theoretical models that interest-bearing CBDC could promote financial inclusion and would not necessarily lead to a weakening of the role of banks in intermediating finance [Andolfatto 2018: 20–21]. Increased competition for deposits could induce banks to raise interest rates on deposits, potentially leading to deposit expansion. In the event that CBDC is not interest-bearing, its efficiency and availability as a payment instrument could put upward pressure on interest rates on deposits as banks seek to retain their customers.

Furthermore, in the portfolio choice model of Chang, Grinberg, Gornicka, Miccoli and Tan the impact of CBDC on bank lending is not necessarily substantial even in the event of some deposit outflows, particularly in advanced economies where banks have access to alternative sources of funding such as wholesale funding or central bank funds. In their simulations, banks in such advanced economies can, to a certain extent, substitute lost deposits with other forms of funding without a large contraction in credit supply. By contrast, the same model suggests that larger deposit shifts to CBDCs can be expected in developing economies where the cost of access to banking services is higher and a larger proportion of the population are low-income households [Chang, Grinberg, Gornicka, Miccoli, Tan 2023: 25–29].

From a microprudential perspective, the effects of disintermediation are also likely to be heterogeneous across individual institutions. Smaller savings and cooperative banks that rely heavily on retail deposits and often operate

with tighter liquidity buffers may be more vulnerable to even moderate shifts of funds into CBDC than large, diversified banks. Model-based analyses of the digital euro suggest that, while aggregate deposit outflows at the level of the euro area banking sector may remain manageable, for some smaller institutions a full use of CBDC holding limits by their customers could bring their liquidity coverage ratio close to, or even below, regulatory minima [Fritz, Krüger, Wong 2024: 5–6]. This heterogeneity is particularly relevant for the calibration of holding limits and other design features intended to protect financial stability and will be explored in more detail in the following sections.

Based on the above analyses and modelling approaches, the impact of CBDC on the banking sector will not be uniform or linear – it will depend strongly on its specific design, the economic context and the speed with which disintermediation occurs. It is possible to work with the basic idea that CBDC in itself does not pose an immediate threat to financial intermediation, but rather a new factor that changes the motivations of different subjects, both on the side of clients and banks. While in normal circumstances the introduction of CBDC may lead to a gradual shift of a portion of deposits and increased competitive pressure on banks via interest rates, in crisis situations it may act as a catalyst for a rapid flight to safer forms of value preservation. In this paper, this dynamic "slow versus fast disintermediation", derived from the model-based literature, is used as a simple conceptual framework for assessing the benefits and risks of CBDC for financial stability.

5. Digital euro

The digital euro is an electronic means of payment developed and issued by the ECB, which can be simply described as a digital version of cash. This means of payment would be on a par with cash – thus acquiring legal tender status – and on a user level on a par with electronic money – thus becoming easily accessible to the general public. Designed to complement, rather than replace, existing physical cash with the aim of offering retail users an additional payment option. Its features include universal acceptance throughout the euro area, free basic use for euro area citizens, potential offline availability and a stable one-to-one parity with the physical euro. Users would be able to store and manage digital euros through an electronic wallet, which they could set up with their existing bank or a designated public intermediary.

The distribution model is likely to be based on a two-tier system, with the ECB issuing the digital euro and managing the underlying infrastructure and overseeing intermediaries such as credit institutions and other payment service providers who will distribute the digital euro to end-users. Initially, the digital euro is expected to be non-programmable, which means that the ECB will not impose any specific conditions or restrictions on its use.

As of May 2025, the digital euro project is in the preparatory phase, which started in November 2023 and is expected to last until October 2025. This phase builds on the previous two-year investigation phase during which various technical and policy aspects of the project were examined. In October 2025, the Governing Council of the ECB is expected to decide whether the project will proceed to the next phase, potentially leading to the issuance of the digital euro. However, this decision is conditional on the successful completion of the legislative process at European Union level. The analysis in this paper therefore works with the current preparatory design and legislative proposals for the digital euro as a working scenario rather than as a definitive description of a future instrument.

The formal start of the discussion on the digital euro can be dated back to September 2020, when the European Commission, in its Digital Finance Strategy [Communication from the Commission to the European Parliament, the Council, the Europe and Economic and Social Committee of the Regions on a Digital Finance Strategy for the EU 2020], welcomed the ECB's initiative to create a retail version of CBDC, arguing that it would be an alternative to cash and a catalyst for further innovation in payments, finance and commerce. Almost three years later, the European Parliament and the Council issued three draft documents to serve as foundation stones of the digital euro:

I. Proposal for a Regulation of the European Parliament and the Council COM(2023) 369 final as of June 28, 2026, on the establishment of the digital euro;
II. Proposal for a Regulation of the European Parliament and the Council COM(2023) 364 final as of June 28, 2026, on the legal tender of euro banknotes and coins; and
III. Proposal for a Regulation of the European Parliament and the Council COM(2023) 368 final as of June 28, 2026, on the provision of digital euro services by payment services providers incorporated in Member

States whose currency is not the euro and amending Regulation (EU) 2021/1230 of the European Parliament and the Council;

including proposals to amend other relevant legal instruments to reflect future changes with the adoption of the digital euro.

A key element of future digital euro is the intended legal tender status throughout the euro area, which would ensure its general acceptance as a means of payment. The definition of legal tender can be found, inter alia, in the CJEU ruling in Dietrich and Haring v. Rundfunk: "The concept of 'legal tender' of a means of payment denominated in a currency unit signifies, in its ordinary sense, that that means of payment cannot generally be refused in settlement of a debt denominated in the same currency unit, at its full-face value, with the effect of discharging the debt." [CJEU, C-422/19 & C-423/19, para 46]. This definition emphasises the legitimate presumption of the general acceptance of legal tender as a means of settling debts, irrespective of the personal preferences of the individual. However, it is not possible to reconcile the term legal tender and all forms of money, as only banknotes and coins have legal tender status within the euro area at the moment, pursuant to Article 128 of the Treaty on the Functioning of the European Union. With the adoption of the digital euro, this "digital gap" would be covered. The regulatory framework also addresses important issues such as the protection of user privacy and the prevention of money laundering and terrorist financing. In accordance, online payments made in the digital euro should be subject to the same rules on data protection and prevention of illicit financial activities as other private digital payment methods.

The European regulator has taken into account the potential risks to financial stability when designing the digital euro, in particular with regard to the possibility of bank runs and bank disintermediation. In the current legislative proposals, specific design features have therefore been put forward with the explicit aim of mitigating these risks. In particular, the envisaged limits on individual digital euro holdings and the decision not to remunerate digital euro balances are intended to discourage the use of the instrument as a large-scale store of value and to constrain the speed and scale of potential deposit outflows from banks. The following sections examine these design features in more detail and assess, on the basis of existing models, the extent to which

they can balance the benefits and risks of a retail CBDC such as the digital euro for financial stability.

5.1. Holding limits on digital euro

Digital euro holding limits represent a fixed upper limit on the amount that a single user will be allowed to hold in their digital wallet. Current discussions on the specific level of these limits range from EUR 500 to EUR 3,000 to EUR 4,000, with no final decision on the level yet taken. In addition, a zero holding limit is being considered for businesses and merchants, which would mean that the digital euros received would have to be immediately transferred to their bank accounts [Progress on the preparation phase of a digital euro: First progress report 2024: 9].

The main objective of introducing holding limits is to ensure financial stability. In general, the aim is to prevent the use of the digital euro as a store of value, and in this respect the ECB lists the following tools that can be used to achieve this objective in the digital euro proposal: "quantitative limits to individual digital euro holdings and limits to conversion of other categories of funds to digital euro in a specified timeframe" [Proposal for a Regulation of the European Parliament and the Council COM(2023) 369 final: Preamble 32]. In the absence of such limits, there could be a risk of large-scale transfers of funds from traditional bank accounts to the digital euro. Such a shift could lead to a significant reduction in deposits in commercial banks, which would negatively affect their ability to lend and finance the economy. Thus, by limiting the maximum amount of digital euro that an individual can hold, the incentive to withdraw deposits from bank accounts in bulk in order to store them in digital form decreases.

Considerations on the optimal level of holding limits include an assessment of the potential consequences of both too high and too low limits. In general, the ECB should follow the basic principles set out in the proposed regulation on the digital euro [Proposal for a Regulation of the European Parliament and the Council COM(2023) 369 final: Art. 16] when calibrating the holding limits for the digital euro. This means that the instruments to limit the use of the digital euro as a store of value and the parameters of these instruments should be designed to ensure the financial stability, usability and acceptance of the digital euro as legal tender while respecting the principle of proportionality. All instruments and their parameters should

be applied in a non-discriminatory and uniform manner throughout the euro area. In parallel, the ECB is developing a specific methodology [Annex to preliminary methodology for holding limit calibration 2024] for the calibration of the holding limits and methodology includes several key tools and analyses. Namely, it focuses on an analysis of household consumption and income, which considers both overall trends in the euro area and country specificities, and a survey on user behaviour aimed at predicting their reactions to the introduction of the digital euro. Moreover, a bank balance sheet optimisation model is used to simulate the effects of the conversion of bank deposits to the digital euro on banks' funding costs and net interest income. It should be stressed that the objective of the limit calibration is to strike a balance between user convenience, potential monetary policy implications and financial system stability.

Based on available model-based analyses [Bidder, Jackson, Rottner 2024: 43–46] and the preliminary calibration work of the ECB [Annex to preliminary methodology for holding limit calibration 2024], the introduction of a limit on digital euro holdings can significantly restrict the ability of households to move large amounts of funds into CBDC at short notice, thereby avoiding "bulk storage" and rapid disintermediation. In the calibrated simulations of Bidder, Jackson and Rottner, limits in the lower thousands of euros markedly reduce the risk of destabilising liquidity shifts while preserving much of the transactional convenience of CBDC. Model simulations suggest that if the limit is set at a level broadly consistent with typical transaction balances in calm times, for example around EUR 1,500 to EUR 2,500, the digital euro can function in normal conditions without a significant impact on bank funding, while remaining below the threshold at which it could trigger large-scale flows in times of stress. At the same time, these studies indicate that a CBDC without any holding limit would, under their assumptions, reduce aggregate welfare, whereas introducing CBDC together with a calibrated limit yields a net welfare gain. Taken together, this model-based evidence points to a realistic and appropriate range for digital euro holding limits of roughly EUR 2,000–3,000 in the European context, subject to further refinement as more data become available.

Alternatively, the issue can be viewed from the perspective of the impact on particular financial institutions and, as mentioned earlier in this paper, the implementation of CBDC would have a greater impact on liquidity

management for smaller institutions – particularly savings and cooperative banks. These institutions are more sensitive to retail deposit outflows because they often operate with tighter liquidity buffers and have a higher share of stable household deposits on the liability side. In a technical paper based on simulations for the German banking sector, Fritz, Krüger and Wong show that, under stress scenarios in which customers make full use of an illustrative digital euro holding limit (for example EUR 3,000 per person), only a relatively small set of institutions would see their liquidity coverage ratio fall below the regulatory minimum, and that these cases are concentrated mainly among smaller savings and cooperative banks [Fritz, Krüger, Wong 2024: 5–6]. This model-based evidence underlines that the aggregate impact of holding limits on the banking sector can remain manageable, while the short-term liquidity risk may be much more acute for specific groups of smaller banks.

Taken together, the existing model-based analyses suggest that reasonably calibrated holding limits on a retail CBDC such as the digital euro can substantially mitigate the risks of rapid disintermediation and destabilising deposit outflows, while still allowing the instrument to function as a convenient means of payment for households. At the same time, the evidence also highlights pronounced heterogeneity in the impact of such limits across different types of institutions, with smaller savings and cooperative banks being more exposed to liquidity strains in adverse scenarios. In the context of the working hypothesis of this paper, these findings support the view that design features such as holding limits can help the digital euro complement cash and modernise payments without unduly undermining banks' intermediation role, provided that their calibration explicitly takes into account the vulnerabilities of smaller banks.

5.2. Interest-bearing digital euro

Under the ECB's current proposals, the digital euro will not be designed as renumerated which reflects its intended role as a digital equivalent of cash, serving as a common means of payment, not an investment instrument [Opinion of the European Central Bank CON/2023/34: Clause 10.7]. Similarly, most of the other central banks that are not part of the European System of Central Banks seem to reject the possibility of remunerating their CBDC [Lukonga 2023: 9]; [The digital pound: a new form of money for households and businesses?: 79]. In fact, if the digital euro offered interest rates similar

to or higher than bank deposits, it could become a more attractive alternative, undermining the ability of banks to lend and fulfil their role in the real economy. Thus, the non-interest-bearing design reinforces the view that the digital euro is primarily meant to be a medium of exchange rather than a long-term store of value. At the same time, the non-remunerated form may be less attractive to the general public, which could slow down its adoption, particularly if there are no clear advantages over existing payment methods, for example in terms of convenience or privacy [Tan 2023: 26–28]. In what follows, therefore, scenarios involving an interest-bearing digital euro are discussed as alternative designs examined in the academic and policy literature, rather than as options currently envisaged in the official proposals for the digital euro.

However, the literature also considers hypothetical scenarios in which an interest-bearing digital euro could, under certain conditions, promote financial stability and competition. One channel emphasised in these contributions is that offering a positive return on CBDC could induce commercial banks to become more competitive in terms of deposit rates. Empirical research suggests that current bank deposits exhibit a high degree of "stickiness", meaning that interest rates on deposits are significantly more rigid upwards than downwards [Driscoll, Judson 2013: 30–31], as the pressure on banks to offer more attractive rates to customers is relatively low. In theoretical models such as Andolfatto's assessment of CBDC [Andolfatto 2018: 15–18], an interest-bearing CBDC can, in a stylised setting, strengthen financial inclusion and incentivise greater efficiency in the deposit market by limiting banks' ability to maintain low deposit rates without losing customers. At the same time, models of CBDC adoption on two-sided payment platforms suggest that a non-interest-bearing CBDC may face adoption challenges unless it offers clear non-price advantages, such as convenience, security or privacy [Tan 2023: 26–28]. As long as the interest rate on an interest-bearing digital euro were to remain below the rate at which commercial banks deposit money with the ECB (the interest on reserves, IOR), there would, in these models, remain space for banks to keep deposits competitive.

An interesting alternative considered in the literature is the model of an interest-bearing digital euro developed by Bidder, Jackson and Rottner [Bidder, Jackson, Rottner 2024: 46–48]. In their calibrated macro-financial framework, the interest rate on the digital euro is linked to the monetary policy rate, but

with a policy-controlled spread that can turn negative in stress situations. Such a rule would allow the digital euro, in normal times with positive and higher policy rates, to offer a positive return and thus compete to some extent with bank deposits, thereby dampening excessive credit expansion in their simulations. Conversely, in times of crisis or incipient runs on banks, the spread in the model can be adjusted so that the effective rate on the digital euro becomes negative, which reduces the attractiveness of moving funds into the digital euro and mitigates the risk of rapid disintermediation. Under the assumptions of this model, such a state-contingent interest rate rule can increase overall welfare and reduce the likelihood of runs compared to a non-interest-bearing digital euro with a fixed holding limit. At the same time, the authors emphasise that this type of design would require the legal and political feasibility of introducing negative interest rates on retail CBDC, which may represent a significant practical constraint in many jurisdictions.

6. Conclusion

The implementation of retail CBDC, respectively the digital euro, represents a completely new challenge and opportunity for the traditional banking model. On the basis of the literature and model-based analyses reviewed in this paper, the central research question – how the introduction and design of a retail CBDC in the form of a digital euro may affect the functioning and resilience of the traditional banking model – can only be answered conditionally. According to the current design of the digital euro and the very nature of CBDCs as such, there is an opportunity to increase the efficiency of payments and promote financial inclusion, but the obvious and potentially imminent amplification of the traditional risks of the sector – in particular the rapid disintermediation and amplification of bank runs by digital channels – should not be overlooked. Existing simulations and model-based studies discussed in this paper suggest that restrictive design instruments, in particular non-remuneration and holding limits in the lower thousands of euros, can, under their assumptions, preserve competitive equilibrium in calm times and provide users with flexible payments without seriously undermining banks' liquidity, while at the same time mitigating "fast disintermediation" in moments of crisis. These findings, however, remain dependent on the specific modelling frameworks, calibration choices and institutional environment, and should therefore be interpreted as indicative guidance rather than precise forecasts of the impact of the digital euro.

At the level of financial stability, the analysis also underlines that small savings banks and cooperative banks in particular show the greatest vulnerability, for which the full use of holding limits may undermine the liquidity coverage ratio requirements in the short term. These institutions are more exposed to deposit outflows because they rely heavily on retail funding and typically have less room to absorb sudden liquidity shocks. They will therefore need to be taken into account with particular care when calibrating the final design of the digital euro and, in particular, the level of holding limits and any complementary measures, given the interconnected nature of the financial system. Last but not least, the ECB's mandate to protect price stability and the legislative constraints on interest rates need to be balanced in order not to lose the ability to react flexibly to monetary shocks in the future.

From a broader perspective, the main contribution of this paper lies in bringing together the traditional literature on banking sector risks and intermediation with the emerging model-based analyses of CBDCs and the specific legal and institutional framework of the digital euro project. By structuring the discussion around the channels of bank runs and bank disintermediation, distinguishing between slow and fast forms of disintermediation, and highlighting the position of smaller banks through the lens of liquidity coverage constraints and holding limits, the paper provides a coherent framework for assessing the financial stability implications of the digital euro.

Overall, the analysis in this paper supports the working hypothesis that a digital euro designed to be non-interest-bearing and complemented by calibrated holding limits and coordination with the banking sector can, under appropriate conditions, serve as a complement to cash without compromising the core function of bank intermediation. At the same time, these conclusions remain grounded in model-based evidence rather than on empirical data from a fully operational retail CBDC, and must be verified and refined as experience from future pilot programmes and real-world use accumulates. Future research should therefore focus on integrating data from such pilots, better capturing the heterogeneity of users and institutions, and examining how different design options for the digital euro interact with broader macroeconomic objectives and the transmission of monetary policy.

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