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THE IMPACT OF THE INTRODUCTION OF THE DIGITAL EURO ON FINANCIAL  
STABILITY – AN OUTLOOK ON MONEY CREATION AND CAPITAL ADEQUACY

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## **Abstract**

The Digital Euro is a digital currency, to be issued by the ECB and made available to residents of the Euro Area. This thesis examines the potential systemic impact of CBDC on financial stability, with a focus on banks' balance sheets. The study investigates the implications of a CBDC on capital adequacy, credit risk, and liquidity risk, addressing gaps in the existing literature and providing a comprehensive analysis of key balance sheet components. By exploring a scenario with no holding limits, the research offers insights into strategic and regulatory challenges associated with CBDC integration, intending to ensure stability and resilience in the financial system.

## **Keywords**

Digital Euro; Financial stability; Deposits outflow; Funding sources; Liquidity risks; Money creation; Capital adequacy; Capital Requirements; NPL ratio; Bank risk

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## **GROUP PART**

### **1. Introduction**

#### **1.1. What is the Digital Euro? - Overview**

The global financial scene is in constant transformation with the swift advancement of digital technologies and the digitisation of payments, as exemplified by the widespread adoption of digital wallets. With the intention to maintain monetary and financial stability and ensure the smooth functioning of the payments system, central banks are increasingly considering the inception of a Central Bank Digital Currency (CBDC). In fact, a report by the Bank for International Settlements, shared how eighty-four of eighty-six central banks<sup>1</sup> in 2023 were investigating CBDCs (Iorio, Kosse, and Mattei 2024). The introduction of a Euro Area (EA) CBDC - the Digital Euro - could represent a significant advance in currency digitisation, but it could also have considerable downturns for financial stability, the role of the monetary authority and the efficiency of the payment framework.

Building on existing initiatives, the Digital Euro aims to address gaps left by current systems. For instance, the European Payments Initiative (EPI) was created to build a European-wide digital payment framework, aiming to provide a viable alternative to the current reliance on non-European card schemes (Mai 2023). In parallel, instant payment infrastructures like the TARGET Instant Payment Settlement (TIPS) and RT1 systems have been developed to support faster, cross-border payments across the euro area (Passacantando 2022). While these initiatives represent progress, they have not yet achieved full coverage or adoption, leaving Europe's payment structure fragmented.

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<sup>1</sup> The sample was composed of eighty-six respondents (central banks), which accounts for ninety-four percent of global economic production, and eighty-one percent of the global population. In addition, thirty-three percent of central banks of the sample correspond to advanced economies and sixty-seven percent represent emerging markets and developing economies (Iorio, Kosse, and Mattei 2024).

The Digital Euro's proposal consists of a liability for the ECB, captured in digital form, that complements cash and bank deposits. It is designed as a retail<sup>2</sup>, non-interest bearing, Central Bank Digital Currency (CBDC), in accordance with the current proposal for regulation of the Digital Euro (European Commission 2023).

In contrast to cryptocurrencies, a Digital Euro would be backed by the same institution that backs cash – the ECB. Furthermore, it would always be worth its face value, just as cash is. It will be free of charge for natural persons for any digital payment (European Commission 2023, 42, 43, 47, 48). From the perspective of legal persons, the CBDC will be able to be accepted as means of exchange. Indeed, the proposal for a regulation alludes to the attribution of the legal tender status to the Digital Euro, leaving merchants with no option other than mandatory acceptance<sup>3</sup> (European Commission 2023, 5, 12).

## **1.2. Thesis Statement and Objectives**

This thesis examines the possible systemic effects of implementing a CBDC to the financial stability of the EA, with a specific emphasis on how it may affect bank's balance sheets. Its objectives include examining the effect on capital adequacy, credit risk, as well as liquidity risk, so to fill the gaps in literature, and deliver a holistic perspective of the principal components of bank balance sheets. The scope of research is geographically confined to the Euro Area, and it is premised on the assumption that there are no holding limits for retail users

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<sup>2</sup> While a retail CBDC is designed for the public to hold digital central bank money, a wholesale CBDC is intended for authorized financial institutions to use (similar to digital reserves of the central bank). The Digital Euro's proposal to be only a retail CBDC stems from the already well-regulated framework for digital wholesale payments (with TARGET2), CB-money securities settlement (with TARGET2 SECURITIES), as well as for instant payments (with TIPS).

<sup>3</sup> Although merchants will be obliged to accept the CBDC as a means of payment, the application of a zero-holding limit to this group is on the table. In this scenario, the amounts received in Digital Euro would be reversed into physical Euro via a "waterfall" mechanism (European Central Bank 2024a, 7).

of the Digital Euro, considering the present situation where the European competent authorities are still debating the specific limits to be implemented.

This research is timely, considering the ECB's continuing progress on the development of the Digital Euro, with a decision on its launch anticipated by October 2025 (European Central Bank 2024a). Overall, the thesis aims to contribute valuable insights into the strategic planning and regulatory frameworks necessary for the seamless integration of the Digital Euro in the financial system.

## **2. The Case for the Digital Euro**

### **2.1. Motivation and Institutional Support**

The potential introduction of a retail digital euro has collected strong encouragement from key European institutions, including the ECB, Member States, and the European Parliament (European Commission 2023). During the Euro Summit in March 2021, Member Countries urged for more robust payment systems as well as a more creative and effective digital financial sector, promoting preliminary research into the potential launch of a digital euro (European Council 2021). This came after the Council and European Commission jointly issued a statement in 2019, emphasizing the potential risks of “stablecoin” initiatives reaching a global scale (European Council 2019), and incentivizing the ECB, in addition to further central banks and national authorities to assess the pros and cons of central bank digital currencies and to foster discussions with European payment actors on how the private sector can help fulfil the demand for fast, easy and affordable cross-border payments. In 2022, the Council Recommendation on the Economic Policy of the Euro Area highlighted the potential of a digital

euro to support public digital money, promote innovation, and enhance the euro's international position and the open strategic autonomy of the Union (European Council 2022).

Today, 13 out of 20 EA countries rely primarily on international card schemes for digital payments (European Central Bank 2024a). This reliance not only raises concerns about resilience but also limits the ability of the European Union to maintain control over its financial systems, especially in a politically fragmented global economy. A digital euro could supply a safe, effective, and widely accepted payment option within the EA, aligning with Europe's long-term economic and geopolitical interests.

With this institutional backing and strategic motivation in place, it is essential to analyse the practical implications the Digital Euro could bring upon the financial system. The following section expands on the foreseen impacts of Digital Euro.

## **2.2. Implications of the Digital Euro**

This section explores how Digital Euro is being conceived to strengthen retail payments, foster competitiveness and innovation, and safeguard the financial stability and sovereignty of the EA, by assessing its potential to modernise payments and financial operations across member states.

### **Enhancement of Retail Payments**

The ability of the EU to keep control over its payment systems and lessen dependency on non-European service providers is known as strategic autonomy in the payments sector. According to Article 127<sup>3</sup> of the Treaty on the Functioning of the European Union (TFEU), the ECB and the European System of Central Banks (ESCB) have the mission to guarantee "the smooth operation of payment systems" (European Union 2016). This duty is reinforced in Article 22<sup>4</sup> from the Statute of the ESCB and the ECB, clearly stating that the ECB and national central banks can and should establish policies and services that ensure that payment and money

transfer systems operate consistently and smoothly both inside the EU and with other nations (European Central Bank 2011). In short, these articles mandate the ESCB - which includes the Eurosystem - to promote efficient and secure payment systems, as well as to implement the necessary regulations to do so, with the goal of safeguarding the stability and integrity of the EA's payment structure.

CBDCs offer a secure, flexible and efficient form of digital currency, allowing seamless integration into existing financial systems (Ulrich Bindseil, Panetta, and Terol 2021). By adopting CBDCs, central banks can ensure that their monetary systems remain resilient and adaptable to technological advances. Today, the infrastructure supporting international payments and transfers remains fragmented, ineffective and expensive, resulting in significant delays and high charges. One of the key potential applications of CBDCs is in cross-border payments. An EA CBDC could represent the much-needed solution and help to streamline these processes, thereby reducing costs and fostering greater integration of the global financial system. The efficiency of worldwide trade as well as economic cooperation would increase, benefiting both consumers and businesses, if an EA CBDC is able to facilitate seamless cross-border transactions (European Central Bank 2020).

### **Promotion of Competition and Innovation**

The current European payment's structure is heavily dependent on non-European providers, as expressed several times by the ECB (European Central Bank 2022). Global payment services providers (e.g., Visa, Mastercard, and American Express) easily dominate digital payments within the EA and have control over a significant share of cross-border transactions and card payments (European Central Bank 2019). These non-European card and mobile/online payment providers are currently the only ones to facilitate cross-border euro transactions inside the monetary union (Mai 2023). Euro cash is the only truly European solution that functions throughout the union, but cash usage is declining (Khiaonarong & Humphrey 2022, 3) .

The institution of a CBDC is designed to foster greater competition within the retail payments market. Presently, the market is dominated by a few key players in the private sector, which can result in inefficiencies, high fees, and limited consumer choice (Wong and Maniff 2020). On the authority of the European Central Bank, the advent of a public digital currency could serve to diversify the market by introducing a new, state-backed player. Such a measure may contribute to a reduction in market concentration, thus fostering a more competitive environment that benefits consumers through a reduction in transaction costs, an improvement in service quality, and an expansion of access to payment services (European Commission 2023; European Central Bank 2020).

The advent of Digital Euro also represents a monumental opportunity for the advancement of financial inclusion within the European Union and beyond. It is estimated that a significant proportion of the population is still unable to access fundamental financial services (WSBI-ESBG 2022), a shortcoming that could potentially be addressed through the introduction of CBDCs (Lannquist and Tan 2023, 37). While the Payment Accounts Directive (Directive 2014/92/EU 2014) has the goal to guarantee all individuals have access to fundamental financial services, encompassing payment accounts, the Digital Euro builds upon this directive by including several measures to address broader barriers to financial inclusion. These include an offline functionality, which enables access in areas with poor internet connectivity, as well as compliance with the European Accessibility Act (Directive (EU) 2019/882 2019) to ensure usability for individuals with disabilities, and the availability of a physical payment-card for those with low digital literacy or without smartphones. Additionally, onboarding processes through public entities (e.g.: postal offices) will facilitate access for unbanked and vulnerable populations, while support in all EU languages and a universally designed app will further increase accessibility (European Central Bank 2023a).

It is reasonable to assume that the implementation of the digital euro will play an instrumental role in the advancement of these objectives, offering enhanced and secure means of payment.

### **Safeguarding Public Money as the Monetary System Anchor**

The issuance of public money by central banks has long been regarded as a fundamental component of the monetary system. Its distinctive attributes, most notably its legal tender status and the absence of default and liquidity risks, contribute to its reputation as the safest form of money. In this context, the inception of a Digital Euro is regarded as a crucial milestone in safeguarding the role of public money in the financial system. Such a measure would help to maintain the convertibility of private bank deposits at par with public money, which is essential for maintaining the trust of the public in the currency and the stability of the financial system (Ulrich Bindseil, Panetta, and Terol 2021).

Furthermore, CBDC could strengthen the resilience of the monetary system by ensuring a stable and secure digital alternative to private money during times of financial instability. In periods of crisis, confidence in commercial banks may erode, leading to runs on deposits. Without the availability of central bank money, such scenarios could lead to significant liquidity shortages and threaten financial stability. A CBDC would offer a digital haven for public savings, mitigating the risk of destabilizing shifts between private and public money and reducing the likelihood of large-scale bank runs (Ulrich Bindseil, Panetta, and Terol 2021).

### **Preservation of Financial Stability**

The Digital Euro may bolster monetary sovereignty through the reinforcement of the Euro's dominance in the EU and countering displacement by private digital currencies. As a state-backed, risk-free alternative, it enhances financial stability by reducing dependence on volatile private digital assets (Lambert et al. 2024).

During periods of economic stress, a digital euro mitigates risks of depositors shifting funds to private or foreign assets, preserving bank liquidity. Safeguards, such as holding limits, are necessary to prevent significant outflows from commercial banks, ensuring stability while limiting large-scale withdrawals (Lambert et al. 2024).

The following section oversees the possible impacts on financial stability, considering the chance of bank disintermediation.

### **3. Impact on Financial Stability: Bank Disintermediation**

#### **3.1. Substitutability between the Digital Euro, cash and deposits**

The Digital Euro will behave as a store of value instrument and a means of exchange. Taking that into account, a competitive dynamic between the Digital Euro, the physical Euro and deposits will emerge. Because of this, substitutability among the three assets is estimated to certain degree (Adalid et al. 2022, 7; Burlon et al. 2022, 7; Huynh et al. 2020, 22; Jiang 2020, 3-5; Lambert et al. 2024, 4; Li, Usher, and Zhu 2024, 24-26).

The substitutability between the physical and the digital Euro represents merely the transformation of one type of central bank money – coins and banknotes – into another–digital money. In this scenario, a decline in Euro coins and banknotes and an increase in Digital Euro will be registered on both households and Eurosystem balance sheets. In this context, banks' balance sheet will be not affected (Bindseil 2020, 9; Bindseil and Panetta 2020, 2; Lambert et al. 2024, 4).

By contrast, the substitutability between deposits and the Digital Euro will pose implications for banks' balance sheet via a decrease in deposit funding (Adalid et al. 2022, 7-12; Burlon et al. 2022, 4-5; García et al. 2020, 1; Li, Usher, and Zhu 2024, 23-26). Considering the case of

the Digital Euro, which is most likely to be non-interest bearing and available only for use by natural persons, it is expected to decrease demand deposit funding provided by retail customers (García et al. 2020, 2; Gorelova, Lands, and teNyenhuis 2022, 2; Meller and Soons 2023, 4; Usher et al. 2021, 7).

Besides the Digital Euro's direct competition with retail demand deposits, its attractiveness over other types of retail deposits should also be acknowledged. This will depend on the prevailing interest rate environment. A non-remunerated Digital Euro would be less attractive than savings and term deposits in a positive interest rate environment but much more desirable during periods of low or even negative interest rates (Adalid et al. 2022, 7). With that in mind, different levels of substitutability may occur across different macroeconomic cycles *ceteris paribus*<sup>4</sup> (Li, 2021; Nocciola and Zamora-Pérez 2024).

### **3.2. Structural bank disintermediation: a definition**

The substitutability between retail deposits and the Digital Euro naturally leads to 'bank disintermediation' – a process characterized by the shrinking of banks' balance sheet due to a decrease in retail deposits (Carapella and Jean Flemming 2020)

Assuming banks behave as intermediaries in the distribution of the Digital Euro, this reduction in retail demand deposit funding is paired with a decrease in banks' own excess reserves (Figure 1). In more detail, banks acquire the Digital Euro by purchasing it from the Eurosystem using their own reserves. Subsequently, they facilitate the exchange of demand deposits for the Digital Euro with retail customers (Adalid et al. 2022, 15-16).

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<sup>4</sup> Apart from the remuneration earned, other factors – such as perceived acceptance, privacy, branch network, possibility of obtaining complementary financial products – may influence the level of substitutability between deposits and the Digital Euro (Li, 2021; Li et al., 2024; Nocciola and Zamora-Pérez 2024).

| Households        |                  | Banking sector         |                       |
|-------------------|------------------|------------------------|-----------------------|
| Assets            |                  | Liabilities and equity |                       |
| Physical Euro     | Loans            | ↓ Own bank reserves    | ↓ Demand deposits     |
| ↓ Demand deposits | Household equity | Loans                  | Other retail deposits |
| Other deposits    |                  | Securities held        | Wholesale funding     |
| ↑ Digital Euro    |                  | Equity                 | Equity                |
| Bonds             |                  |                        |                       |
| Equity            |                  |                        |                       |

| Eurosystem            |                          |
|-----------------------|--------------------------|
| Assets                | Liabilities              |
| Securities held       | Physical Euro            |
| Credit lines to banks | ↓ Own bank reserves      |
|                       | Public entities deposits |
|                       | ↑ Digital Euro           |

**Figure 1 - Bank disintermediation mechanism**

Source: Own elaboration

The concept of bank disintermediation can be categorized into two facets: (i) structural disintermediation, which refers to the one-off decrease in deposits by the inception of the CBDC; and (ii) cyclical disintermediation, where banks suffer further deposit outflows throughout periods of financial distress (Adalid et al. 2022, 35-43; Bindseil 2020, 13-16; Carapella et al. 2024, 16-18; Landau 2021, 16; Williamson 2022).

## **5. INDIVIDUAL PART – SARA D'OREY LEAL**

### **5.1. Introduction**

This segment examines the effects of the Digital Euro in view of the process of money creation and banking operations with the European monetary system. Instituting a retail CBDC may disturb the dynamic amongst the European Central Bank, banks, and the general public. We investigate a dual impact from this digital innovation on both the capital adequacy and profitability of commercial banks, addressing the broader question: How will the Digital Euro affect the process of money creation by banks? This study is particularly relevant given the limited amount of literature analysing the adjustments in capital requirements in response to potential deposit outflows triggered by an upcoming digital currency - a significant gap identified in collaboration with the Council of the European Union.

#### **5.1.1. Research Questions and Objectives**

To inspect the dual effect of both capital adequacy and profitability on the money creation role of banks, we structure the investigation in two subsequent research questions:

- How are the capital requirements of banks affected by the establishment of the Digital Euro? - This chapter includes an analysis of the main components of capital adequacy, the prospective impact of the Digital Currency on these mechanisms, some key-takeaways of the 2023 SREP results to assess banks' preparedness, as well as an exploration of the potential adjustment channels banks might employ to adjust their capital adequacy ratios in response to the digital euro, drawing parallels with adjustments made under the then new Basel III requisites, on the repercussions from the 2007-08 financial crisis.

- How is bank profitability impacted by the launch of the digital euro? – This smaller chapter examines the evolving role of banks under the Digital Euro Scheme and assesses the estimated costs of the digital currency on banking operations.

### **5.1.2. Methodology**

The present thesis adopts a qualitative approach, synthesizing information from a range of sources including central bank publications, financial regulatory reports, and academic literature. To answer the research question of impact on capital requirements, we start with a descriptive analysis of the fundamental components, which leads to scenario development and exploration of a theoretical approach to transmission mechanisms of capital classes and buffers, followed by an analytical study of the 2023 SREP results, concluding on historic analysis to propose possible adjustment channels. To study the impacts on profitability, we conduct a cost-benefit analysis, with a trinary-scale.

### **5.1.3. Organization of the Paper**

This paper is organized into several key sections. Initially, an (5.1) Introduction sets the stage with the research questions, as well as the importance of the investigation (the present chapter). Secondly, a (5.2) Review of the Process of Money Creation is presented, which delves into traditional and contemporary theories, but rests on the endogenous theory of money creation. The limitations imposed on banks' role as the primary player in endogenous money creation sets a foundation to analyse the impact of the digital currency. Moreover, we delve into (5.3) Capital Requirements and Regulatory Adaptations, and (5.4) Impact on Bank Profitability - as explained previously in subsection 5.1.1. Research Questions and Objectives.

## 5.2. Review of the Process of Money Creation

Transformative innovations within the European Monetary system, such as the digital euro, could be considered as logical byproduct of the larger trend of the economy becoming more digital and dematerialised (Bibi and Canelli 2024). James Tobin, a world-renowned American economist, introduced in 1987 a proposal to transform the reserves of central banks from wholesale to retail currency that are available to anyone (Tobin 1987). This concept, often referred to as "reserves for all" (Niepelt 2021), by establishing a direct connection of central bank reserves to the private, non-financial industry, introduces the possibility of fundamentally changing the relationship between central banks, banks, and the general public, and thus opens the door for CBDCs to emerge (Bibi and Canelli 2024).

The motivation for this section is to examine how the Euro Area retail CBDC may influence money creation. It is possible that the digital euro could change the way time deposits function and lead to an outflow of deposits (Næss-Schmidt et al. 2023; European Central Bank 2023b). Customers could convert these deposits into digital euros (adhering to the design choices for the digital euro, i.e. holding limits, no-remuneration, etc.), propelling banks to rely on alternative, and possibly less cheap, options for funding (EBF 2021). In response, and in order to offset the increased cost of funding and maintain profitability, banks may feel pressure to take on additional risk in their loan portfolios (Ahnert et al. 2022). Nevertheless, capital requirements act as a constraint, limiting the extent of risk-taking by ensuring that banks maintain a buffer against potential losses (Hellmann, Murdock, and Joseph 2000; Gale 2010).

### 5.2.1. The process of Money Creation

Taking a step back, historically, money creation was viewed through an exogenous lens, i.e. central banks exercised control over the money-supply via monetary reserves through a “money multiplier” model (quantity-based restriction). According to this framework, commercial banks were considered intermediaries, channelling pre-existing savings-accounts to provide loans to borrowers (Bibi and Canelli 2024). Lending was thought to be constrained by the quantity of reserves that the central bank would make available, which would dictate the extent to which deposits could be loaned out (Fontana, Realfonzo, and Passarella 2020). However, this traditional view has been challenged by a considerable amount of the literature and largely supplanted by the endogenous money perspective, particularly after the 2007-08 financial crisis (Moore 1988; Mcleay, Radia, and Thomas 2014; Bibi and Canelli 2024).

In this regard, a different strategy known as endogenous money theory asserts that the money stock is credit-driven and driven by demand Jakab and Kumhof (2018) introduced the concept of “money creation financing”, a perception of commercial banks’ role as more than mere “warehouse” intermediaries. As they argued, money originates “ex nihilo”<sup>5</sup> from commercial banks, by issuing loans (Jakab and Kumhof 2018; Werner 2014) For example, granting a loan of €100,000 generates an equivalent €100,000 deposit in the borrower’s account.

In today’s world, setting aside physical currency in circulation, within the Eurozone, most of the money supply constituted by the monetary aggregate M3, consists largely of sight (overnight) deposits, created through transactions between banks and their customers (Bundesbank 2017, 15). Furthermore, loans are not tied to reserves or savings, as is proved by research, such as Werner's (2014) empirical tests, by providing strong evidence that loan

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<sup>5</sup> out of nothing.

creation involves generating entirely new deposits without redistributing existing funds. Money creation is then independent of pre-existing reserves - as instead of controlling the quantity of reserves, the ECB exerts monetary policy through interest rates. Central banks provide reserves on demand (at least in normal times) after loans are issued to support settlement needs (Mcleay, Radia, and Thomas 2014, 16)

## 5.2.2. Limitations on Money Creation

To understand how the Digital Euro might impact banks' ability to create money, we first examine the existing limitations that restrict money creation. After establishing these constraints, the analysis can explore how the Digital Euro might influence them.

| Money Creation Constraints by Agent Type |                                     |                                  |
|------------------------------------------|-------------------------------------|----------------------------------|
| Banks                                    | Consumers                           | Central Banks                    |
| Market Forces                            | Behaviour of Household and Deposits | Monetary Policy - interest rates |
| Risk Management                          |                                     |                                  |
| Regulatory Policy                        |                                     |                                  |

*Table 1 - Summary of limitations to money creation*

As Tobin (1963) argues, commercial banks do not withhold a “widow’s curse”<sup>6</sup>, i.e. there are inherent limits to the extent that loans can be automatically matched by deposits. There are several constraints on money creation, regarding banks’ activity, the behaviour of consumers, and monetary policy mandated by central banks (Mcleay, Radia, and Thomas 2014). For the interest of the thesis goals, we explore limitations with direct impact on banks.

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<sup>6</sup> The “widow’s curse” referred in James Tobin’s paper “Commercial Banks as Creators of Money”, recalls a biblical passage (I Kings 17:7–16) describing “an inexhaustible supply of something,” but Tobin uses it to highlight that, unlike the widow’s endless resources, banks face natural limits to the expansion of their liabilities.

Market forces, such as competition in the lending market, shape how banks determine their lending activities - profitability in lending activities is fundamental (Bundesbank 2017). Risk management is also crucial, considering that banks must ensure that new loans are both profitable and sustainable. To do so, banks need to manage liquidity risk which often requires banks to hold a portion of their deposits as fixed-term deposits to ensure funding stability. Simultaneously, they must mitigate credit risk, to make sure that borrowers can repay their loans - this is where capital requirements first come into discussion, as these minimum requirements and buffers are able to absorb such losses<sup>7</sup>. Third, regulatory policies, which includes capital adequacy and liquidity requirements, impose limits on how much money banks can lend. Both micro prudential and macroprudential regulations act as guardrails to maintain financial stability (Bundesbank 2017).

This framework of limitations provides a foundation to explore how the Digital Euro could influence these constraints and, by extension, bank's role in money creation. Among these limitations, capital adequacy plays a central role, seeing as it acts both as a constraint that limits the extent of banks' risk-appetite (through required buffers designed to absorb losses), thus influencing market forces, and also directly impacts credit and liquidity risks. Moving forward, the focus of the research rests on capital adequacy, studying how the Digital Euro affects capital structure, emphasizing its foundational impact across all limitations outlined.

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<sup>7</sup> Despite these capital buffers, banks' pricing models take into account these risks beforehand.

## 5.3. Capital Requirements and Regulatory Adaptations

### 5.3.1. Analysis of the Components

In this subsection we examine capital requirements and buffers so we can then explore how these components may interact. For the purposes of this discussion, the focus of this study lies on Pillar 1 requirements of Basel III, seeing as it sets out capital requirements applicable to all banks - to cover credit, operational, and market risks, along with guidelines for calculating Risk-Weighted Assets (RWAs). By focusing on Pillar 1, we aim for a simplified examination of the regulatory requirements that every bank must meet and thus avoid the complexities associated with Pillar 2, which addresses bank-specific risks by allowing regulatory bodies to mandate additional capital buffers based on an individual risk profile, like the IRRBB.

Capital adequacy requirements are set to guarantee that banks have enough capital to withstand unforeseen losses and continue to be solvent during times of financial strain. These requirements are expressed in the ratio of Capital Adequacy (CAR) shown below as a ratio of capital - which sums together Tier 1 (T1) Capital and Tier 2 (T2) Capital - to its risk-weighted assets (RWAs). The key objectives of these requirements are to protect depositors, maintain confidence in the banking sector, and mitigate systemic risks.

$$CAR = \left( \frac{\text{Tier 1 Capital} + \text{Tier 2 Capital}}{\text{Risk-Weighted Assets (RWAs)}} \right) \times 100\% \quad (1)$$

The division of capital between Tier 1 and Tier 2 is because of the quality and its intended use<sup>8</sup>. Tier 1 Capital - which acts on a “going concern” - supports the bank in absorbing losses while allowing it to continue its operations. Tier 1 is composed of Common Equity Tier 1 (CET1) Capital and Additional Tier 1 (AT1) Capital. CET1 capital (mostly retained earnings and the

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<sup>8</sup> Tier 3 capital was of much lower quality and was used to diminish trading risk. It is no longer in use or part of the Basel agreements, as it is thought to have contributed to the 2007-2008 crisis.

equity of shareholders) directly absorbs losses - the minimum required CET1 capital ratio is 4.5% of RWAs. AT1 Capital is composed of instruments like perpetual contingent convertible capital instruments, i.e. instruments that cushion losses but don't satisfy all CET1 conditions - CET1 added to AT1 capital must be above 6% of RWAs. When a bank fails, Tier 2 Capital steps in as an extra layer to absorb damage before depositors and other creditors do. This kind of capital is not as liquid as Tier 1 and so it is less apt to sustain losses right away, given that it is formed by instruments with a maturity date, e.g., revalued and undisclosed reserves, as well as hybrid securities.

Adding to the core capital requirements, the Basel III framework adds two critical buffers<sup>9</sup> designed to fortify bank resilience: Capital Conservation Buffer (CCoB) and Countercyclical Capital Buffer (CCyB). The first one - Capital Conservation Buffer - is made up entirely of CET1 capital and is set at 2.5% of total RWAs. The CCoB is designed to be above the regulatory minimum capital requirements. If the buffer is breached, banks are automatically subject to limitations on capital distributions, including bonuses and dividends, to guarantee that they quickly restore their capital base. On the other hand, the goal of the CCyB is to handle times of rapid credit expansion that frequently precede financial turmoil. The buffer, which also includes CET1 capital, fluctuates in a 0 - 2.5% range of RWAs based on the economic cycle. Based on their evaluation of credit growth and the hazards involved, authorities modify the CCyB. The buffer is lowered in a downturn to ensure that credit to the economy continues, and it is raised during times of credit expansion to restrain growth. For simplification reasons, we consider only these two buffers and exclude the analysis of Systemically Important Institutions Buffer, so to give a general and holistic view into banks capital requirements.

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<sup>9</sup> There are also additional requirements for systemically important banks to address risks to the financial system, but the two buffers in analysis are applied to all banks, with no regard of their systemic importance.

### 5.3.2. Scenario Setting

After outlining the components of the analysis, we now proceed to define the specific scenario in which these elements will be examined.

The available literature on the impact of this financial innovation on the balance sheet of banks presents that the possible uptake of the digital euro is not expected to generate significant risks for financial stability (Petracco Giudici and Di Girolamo 2023; Bellia and Calès 2023). This argument, brought by the European Commission's Joint Research Center (JRC), proves the aforementioned conclusion in a scenario of a modest up-take of just about 3000€ per household. However, the currently proposed design features of the digital euro progress reports have not yet decided on a definite holding limit for individual holdings of digital euro. In light of that, and as we expressed in subsection 1.2. Thesis Statement and Objectives, we follow an assumption that there is no holding limit set for our analysis.

Research from JRC also highlights how there may be a change in funding sources and structural adjustments to balance sheets, a result from increased demand advanced by the widespread utilization of the CBDC (Petracco and Di Girolamo 2023). This could put in action several reaction mechanisms such as the need of banks to rely on funding sources other than deposits, such as increasing the usage of central bank reserves – an important question that will be explored thoroughly in another section of this research paper.

Our theoretical analysis builds on the hypothesis of significant bank disintermediation and focuses on how the mechanism of capital adequacy may react.

### 5.3.3. Reaction Mechanisms of Capital

This segment explores a theoretical approach to the reaction mechanisms of capital, based on a framework outlined in the table provided in *Appendix 6 - Capital Adequacy components' reaction mechanism*. This table provides the sequence of defence mechanisms, from CET1 to T2 capital, and identifies the triggers that lead to each component's use. Moreover, it distinguishes between direct effects of core capital classes and indirect effects of buffers. In sum, the digital euro's effects on the different capital requirements outlined in Basel III rules are examined in the appendix.

As a major shift in the monetary scenery, the ECB's adoption of the Digital Euro has the capacity to alter bank capital adequacy requirements - as explained in the scenario of analysis. The potential change from traditional bank deposits to holdings of Digital Euros threatens to reduce excess liquidity and even profitability, which in turn pose the biggest threat to CET1 Capital by lowering retained earnings. Seeing as the failure to keep the CET1 ratio at a minimum of 4.5% would require urgent regulatory corrective steps, a decline in CET1 capital will most likely lead banks to impose limitations on dividend payouts or look for other funds to restore their capital. The levels at which instruments such as contingent convertibles are triggered to convert into equity might be impacted by the increase of market volatility or even changes in the bank's risk profile - which could potentially impact AT1 capital. This in turn might destabilize the view of the market on the bank, by temporarily increasing CET1 capital at the expense of diluting shareholder equity. In sum, the larger category of T1 capital, that includes both CET1 and AT1, may be put under pressure. If the Tier 1 capital ratio dropped to 6%, regulators would have to step in and force banks to either reassess their capital structure or raise more money to reach higher criteria. Seeing as T2 capital is made up of less liquid assets, like hybrid securities and revalued reserves, it is vital for reducing damages in the case

of bank failure. The implementation of the digital euro has raised operational and security risks, which calls for a revaluation of T2 capital's sufficiency. The function of T2 capital as a supplemental becomes essential if T1 capital is inadequate. Because banks may create new services and products based on the digital euro - a question that is analysed in another segment - which may have varying risk weights, RWAs will be impacted. In order to maintain compliance with regulatory capital adequacy standards, a growth in RWAs necessitates larger amounts of both T1 and T2 capital.

Moving this analysis over to capital buffers, even though the Capital Adequacy Ratio doesn't account these buffers as part of its expression, they are composed of CET1, meaning that its impact is relevant for our holistic analysis. We account for these effects as indirect effect on the table of *Appendix 6 - Capital Adequacy components' reaction mechanism*, as these buffers may need to be significantly adjusted in our scenario of analysis. Even if adoption is small, changes in deposit patterns may put pressure on banks' balance sheets, necessitating a rise in the Capital Conservation Buffer to cover any losses. To maintain financial stability, the Countercyclical Capital Buffer may also require more regular modifications to adapt shifts in credit cycles brought about by the digital euro.

In conclusion, the comprehensive effect of the Digital Euro could exert dual pressures on the Capital Adequacy Ratio (CAR). By reducing T1 and/or T2 capital (depending on the exact impact), the move to digital euro holdings would decrease the numerator in the CAR calculation. As a result, banks may find it more difficult to maintain regulatory capital ratios beyond the minimal standards, necessitating the use of stronger risk management techniques and greater capital levels. At the same time, the anticipated increase in banks' risk appetite, as noted by (Bank for International Settlements 2021) and Bouis et al. (2024), would elevate RWAs, thus increasing the denominator. When we combine these two effects together, we conclude on a dual pressure on the CAR, as both the numerator is expected to decline and the

denominator to rise. Nevertheless, if banks' behaviour were to remain unchanged (which is unlikely as previously stated), then the capital adequacy ratio would still decrease thanks to a decrease of capital.

#### **5.3.4. Analysis of banks' resilience to capital absorption**

Following the theoretical investigation into reaction mechanisms of capital adequacy, we can rely on the information provided by the 2023 Supervisory Review and Evaluation Process (SREP) cycle and ECB Banking Supervision's targets between 2024 and 2026 to analyse the resilience of European banks. Even though the previous theoretical approach explained what could happen, the provided information from stress tests conducted by the ECB Banking Supervision gives us reason to believe the determined minimum requirements for capital are enough to withstand the accurate expected impact - the prediction that a Digital Euro won't have a significant impact on financial stability (Petracco and Di Girolamo 2023; Bellia and Calès 2023).

Broadly speaking, 2023 SREP results<sup>10</sup> confirmed that banks have a firm stance on capital and liquidity, as well as increased profitability (European Central Bank 2023c). Following the overall SREP defined score<sup>11</sup>, that ranges from 1 (best score) to 4 (worst score), this value remained stable as 2,6, for 2023. In terms of capital positions, the report also showed an increment of 0,4 pp of the all-inclusive capital requirements and guidance, reaching 15,5% of RWAs (European Central Bank 2023d). Although the exact level of capital requirement varies depending on the bank's size and risk profile, - considering the baseline requirements (8% of RWAs), including buffers (2% for CCoB and 0-2,5% for CCyB, excluding systemic

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<sup>10</sup> The 2023 SREP results were published on December 19 of 2023 and were built on year-end data of 2022. The 2024 SREP results are not yet available.

<sup>11</sup> This number represents the supervisor's overall evaluation of the institution's viability. An annual exercise is conducted to evaluate a bank's risks and establish the necessary guidance and capital requirements for each bank. These additional capital requirements add to the already defined minimum capital.

importance buffer for simplicity) it averages between 10,5% - 13% of RWAs. This suggests that banks currently hold approximately 2,5 to 5 pp above these requirements, meaning that banks are currently well-capitalized. However, as noted in our previous theoretical analysis, the dual pressure on the CAR could erode these buffers, limiting the room for flexibility and challenging the sustainability of this buffer in the medium to long term.

Part of the increase of the overall capital requirements and guidance came from the (re)establishment of countercyclical capital buffers, as well as adjustments of risk profiles of banks (among other effects). This stronger perception of capital positions gives us an indicator of banks' ability to meet stricter regulatory demands, while at the same time maintaining CET1 ratios above the minimum regulated.

Attention must be drawn to the fact that the banking sector was affected by macroeconomic challenges of the period, these being geopolitical risks such as Russia's ongoing war against Ukraine, higher inflation that eventually led to interest rate soaring, as well as market volatility (bank collapses in Switzerland and the US). Even so, the findings from 2023's EU-wide stress test demonstrate that the banking industry could survive a significant economic downturn, even when subjected to the most unfavourable stress testing scenario since the beginning of European Banking Regulation (European Central Bank 2023d). Adding to this, the supervisors have indicated that capital planning procedures have advanced, and guarantee that banks are accounting for future-oriented scenarios like unrealised losses and developing risks - which gives us a positive perception of banks' ability to endure implications from the Digital Euro. In addition, the possibility of a deposit shift (that puts pressure on CET1 ratios) doesn't scare our perception, at least for short-term impacts, because liquidity risk is currently rated as low-to-moderate, at least in the short term.

Lessons can be drawn from the strategies and policies already supported by ECB experts, such as the need for banks to incorporate forward-looking models, in order to better address systemic risks and improve planning of capital – e.g., ICAAP<sup>12</sup>. In addition, as part of a broader regulatory agenda, these experts are also developing a framework that evaluates banks' preparedness to meet ESG directives under the upcoming Capital Requirements Directive (CRD VI). Even though these mandates' primary focus is on environmental, social, and governance risks, this framework emphasises transition planning, which means it could apply to possible transitions required by impacts caused by the digital euro. Truth be told, both concerns require banks to adopt robust risk management strategies, to ensure alignment with long-term regulatory expectations.

Moreover, supervisory add-ons such as Pillar 2 Requirements (P2R) or Pillar 2 Guidance (P2G) could be used to address vulnerabilities that specific banks may face<sup>13</sup>. In 2023, there was a 0,10 pp increase of the P2R about total capital (totalling 2,25%), seeing as six banks required leverage ratio additions and almost ten banks got leveraged finance add-ons. In addition to add-on measures, the ECB Banking Supervision may also rely on periodic penalty payments, to make sure that banks meet requirements and expectations.

In this section we covered how banks currently hold approximately 2,5 to 5 pp above required levels of capital, and how this stemmed from an increase of CCoB and adjustments in risk-profile. In addition, we also explored how recent events of macroeconomic magnitude impacted banks and how they came on top in stress tests, nonetheless. Finally, we draw lessons from capital planning and even ESG-related policies to grasp how banks keep integrating new measures for risk management, showing adaptability to different scenarios. In conclusion, the

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<sup>12</sup> Internal Capital Adequacy Assessment Process.

<sup>13</sup> As was explained before, Pillar 2 requirements were not explored in our theoretical analysis because they are not generic to all banks.

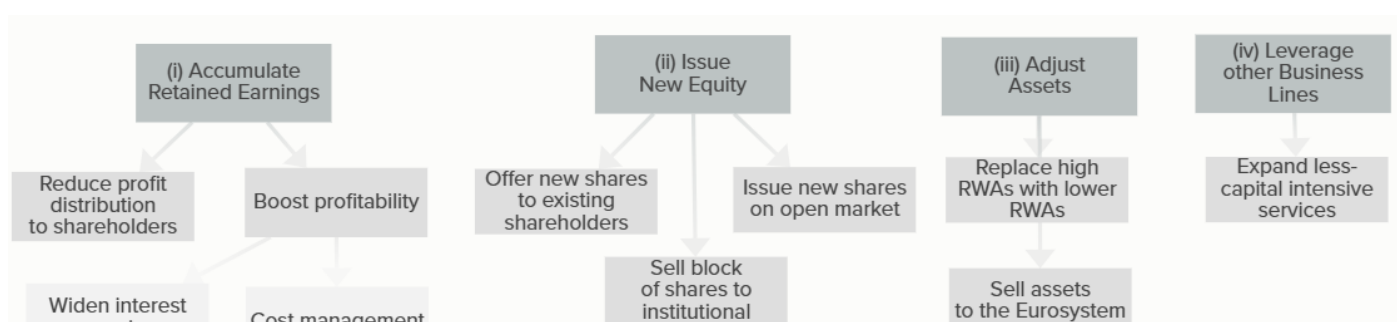
results of the 2023 SREP cycle justify that the European banking sector is ready and resilient enough to handle only short-term shocks such as the possible launch of the digital euro.

### 5.3.5. Channels of Adjustment for banks to strengthen Risk-Adjusted

#### Capital Ratios

After assessing the theoretical impact on capital requirements and buffers and subsequently dismissing possible concerns about banks' short-term unpreparedness based on the 2023 SREP results, it is relevant to consider the possibility that the Digital Euro could pose more substantial long-term challenges. In response to it, we outlined potential strategies that banks could implement to strengthen their risk-adjusted capital ratios.

Our proposed strategies draw as inspiration the repercussions of the 2007-2008 financial crisis, because in this period banks were mandated to adhere to stricter capital and liquidity requirements to transition into Basel III<sup>14</sup>. The adjustment period that followed the financial crisis and the binding requirements established in Basel III (2009-2012), allow us to understand banks' channels of adjustment. Using this as a history lesson, we have prioritized these strategies based on the ease of implementation, historical precedence, and their potential market and economic impact, which can be categorized into four main channels: (i) accumulate retained earnings; (ii) issue new equity; (iii) adjust the asset side of the balance sheet; (iv) leverage other business lines.



*Table 2 - Proposed Strategies to strengthen risk-adjusted capital ratios*

<sup>14</sup> More information on the strategies for adjustment during 2009-2012, can be found under an evidence-based study by Cohen and Scatigna (2016).

(i) Historically, the primary method for increasing capital ratios is through retained earnings, i.e. profits that banks choose to reinvest rather than distribute as dividends. In actuality, retained earnings were primarily responsible for the increase in capital ratios across advanced economy banks between 2009 and 2012. When stated in pp of RWA, these accounted for 1.7 pp of the 2.8 pp rise in capital. These made up 22 pp of the 35.5 pp rise in total capital (Cohen and Scatigna 2016, 8). This mechanism goes as follows: through a reduction of the proportion of profits distributed to shareholders, banks can retain more earnings that directly augment their CET1 capital. Another way to increase retained earnings is to boost profitability. This can be achieved by widening net interest margins, through an increase in lending spreads. Cost management could also help achieve such results, even though it was not an historically significant contributor. Nevertheless, and as was previously mentioned, banks' role as money creators is limited by competitive market forces, meaning that banks can't freely adjust their lending spreads with no fear of insolvency.

(ii) Another approach to raise additional CET1 capital is by issuing new equity. This can be achieved through: (i) offering new shares to existing shareholders; (ii) issuing shares on the open market to attract new investors; or (iii) selling a bloc of shares to institutional investors. Issuing new equity can be considered a secondary-line of defence, seeing as it can dilute existing shareholders' equity, but ensures a faster capital buildup. All in all, issuing new equity increases CET1 capital directly, but can be faced with resistance from shareholders of the bank, especially if the bank's stock is undervalued.

(iii) The third proposed channel for capital adjustment consisted in adjusting the asset side of the balance sheet<sup>15</sup>. To improve capital ratios, banks can replace high-risk-weighted loans (e.g. subprime mortgages) with lower risk assets (e.g. government securities). Instead, banks could reduce temporarily the pace of new lending, allowing retained earnings to catch up with the RWA growth. In addition, banks could opt by offloading trading portfolios or other assets to reduce liabilities or reinvest in lower-risk assets. Adalid et al. (2022) examines various methods for evaluating how a digital euro would affect banks in the euro area and calibrates the asset side adjustment channel by centring this strategy on banks selling assets to the Eurosystem to generate reserves, the same ones that would subsequently provide individuals with digital euro. This mechanism reveals two potential outcomes: a contraction in banks' balance sheets when selling their own assets or an increase in the money supply if assets are sold on behalf of customers.

(iv) Lastly, banks can enhance their capital by leveraging other business lines. This technique could potentially boost profitability without adding to RWAs, even though it may require upfront investments in capabilities. In brief, banks could expand their fee-based advisory services, such as investment advisory or wealth management (less capital-intensive business lines), or also services with low-risk capital requirements, but a consistent revenue-generating business line.

This brings us to another question: How is bank profitability impacted by the launch of the digital euro? This question is answered in the next segment.

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<sup>15</sup> The sample of banks studied by Cohen and Scatigna (2016) actually increased their asset composition between 2009 and 2012. Notably, the increases in capital ratios were attained by increases of equity and by a reduction of RWAs. Especially european banks, their differentiated increase of bank assets (5.6%) when compared to other assets (25.9%) shows how european banks showed preference over cash holdings and government securities, to this effect. Nevertheless, results show that this did not resonate with lower credit provision but reflects a shift from cross-border assets towards domestic ones.

## 5.4. Impact on Bank Profitability

This segment of the thesis explores the foreseen influence of the digital euro on banks' profitability. For simplification reasons, hereinafter, we refer to these intermediaries as "banks" only, seeing as these players are the main focus of the analysis.

A key component of the impact endured by banks lies in the scale of adoption of the digital euro. The investments required from banks benefit from a high adoption rate so that economies of scale cover the costs of providing these "free-of-charge" services and adaptation costs (European Savings and Retail Banking Group 2023). Seeing as banks are at the front-line to distribute the digital currency (Hobelsberger, Kok Sørensen, and Mongelli 2022), its uptake therefore relies on banks' ability to promote the adoption, to facilitate the onboarding services, etc. (European Savings and Retail Banking Group 2023). For the group of intermediaries, the European Commission acknowledges that the definitive design features that affect costs for banks are not settled yet. In fact, the preparation phase is estimated to end by October 2025 (European Central Bank 2024c), when the Governing Council will decide if it's worth it to initiate the next stage (European Central Bank 2024c). Nevertheless, the EC projects a one-time cost of between 3.6 and 6.8 billion euros for distributing costs (European Council 2023). In addition, Næss-Schmidt et al. (2023) also estimate that commercial banks as a whole group could face added funding costs up to 20.6 billion euros.

With that in mind, the costs faced by the private sector are of considerable magnitude but are difficult to estimate on an individual level in the present moment. *Table 3 - Cost-benefit analysis of Digital Euro introduction*, provides some perspective into the responsibilities assigned to banks by the ECB as supervised intermediaries. These responsibilities include significant adaptation costs, but also represent opportunities for banks to further develop their business-lines and generate new profit. The available information from the investigation and

progress reports and other ECB reports is still very limited to allow for proper estimates or predictions of how much the adaptation process will cost for banks individually - as was briefly explained above. Despite these limitations, we can begin to understand how this process may constrain banks activity and where there might be room to play with<sup>16</sup>.

*Table 3 - Cost-benefit analysis of Digital Euro introduction*, describes the responsibilities and opportunities banks may face with the launch of the digital euro. The impact study is conducted through qualitative assessment of each component's burden on banks. To do so, we first factor whether this impact represents a cost, a benefit, or if the effect is undetermined (mixed effect). To add depth, we categorize each component as either of substantial or moderate impact, based on the degree of impact and change it may cause (e.g.: "substantial" indicates major changes or costs such as significant software restructuring that impacts the core system; "moderate" covers impacts that, while less intense, would still require adjustments and resource allocation, but wouldn't imply much change to the overall core system).

This trinary-scale analysis draws inspiration from the European Savings and Retail Banking Group (2023) "T-Shirt size" model, where they use simple terms to forecast investment costs by comparing clothing sizes (small, medium and large) to the degree of costs. Here, we refine it to focus specifically on the more pronounced impacts, but also consider positive effects from the prospective inception of the digital euro. We consider that despite the change brought by this digital currency, it is of utmost importance to highlight how banks may benefit from it.

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<sup>16</sup> The European Savings and Retail Banking Group (ESRB) developed a study where they detail their approach to forecasting investing expenditures, as well as the aforementioned one-time investment needed.

| Aspect                           | Factor                | Description                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Onboarding and Compliance        | Significant Cost (--) | Banks are responsible for onboarding customers, conducting KYC/AML checks, and ensuring compliance with digital euro regulations, validation, etc. Users will be able to link an existing bank account to their digital euro account.                                                                                                                                                                                |
| System Updates                   | Significant Cost (--) | Necessary upgrades to integrate digital euro functionalities, including adapting to a single vendor approach for online and offline transactions. The digital euro services must be programmed for P2P payments, e-commerce, POS payments, online and offline, compatibility with industry 4.0 and Web3. The development of an in-house wallet needs to be fully integrated into the back-end ecosystem of the bank. |
| Funding and Defunding Mechanisms | Moderate Cost (-)     | Facilitating the conversion between private money and digital euros, managing both funding and defunding processes seamlessly, including waterfall and reverse waterfall procedures.                                                                                                                                                                                                                                 |
| POS Terminal Adaptations         | Moderate Cost (-)     | Older POS terminals may need upgrades or replacements to support digital euro transactions. We identify a market opportunity for banks to provide or finance new POS systems. The ECB highlights its commitment of developing the digital euro with stakeholders such as the intermediaries (banks).                                                                                                                 |
| Digital Euro App                 | Mixed Impact (+/-)    | Provision of a uniform digital euro app by the Eurosystem, which requires banks to onboard customers and possibly offer compatible services. This app lowers barriers to entry, by removing the need for banks to develop their own apps. Nevertheless, an in-house solution is an opportunity to offer supplementary digital services.                                                                              |
| Merchant Services and Fees       | Moderate Benefit (+)  | Despite providing some services for free, banks can generate revenue through merchant services and transaction fees. The compensation model proposes an "inter-PSP" fee structure.                                                                                                                                                                                                                                   |
| Value-Added Services             | High Benefit (++)     | Development of innovative payment solutions such as micropayments, split payments, and enhanced cross-border payment services. Focus on programmability and e-commerce. Customer experience is essential.                                                                                                                                                                                                            |

*Table 3 - Cost-benefit analysis of Digital Euro introduction*

To conclude the analysis of table 5, the digital euro poses initial costs for banks, but it also opens new revenue opportunities, through the creation of additional fee-based services (e.g. payment processing and advisory roles). This discussion of possible costs and benefits brings us full circle to the potential channels of capital adjustment thoroughly explored in the previous segment. As we have shown, by integrating the digital euro, banks can strategically enhance their profits, which optimizes capital efficiency by expanding less capital-intensive services. The investment in value-added services through the full integration of the digital euro can bring banks' balance to the initial bumpy roads of the digital euro introduction (deposit outflows, funding concerns, capital adjustment, initial investments, etc.).

## 6. Conclusions

The present work project aims to explore the implications of the issuance of the Digital Euro, a retail non-interest-bearing CBDC, for financial stability in the Euro Area, with a specific focus on banks' balance sheet. As a premise for the research, it is assumed that there are no holding limits on the adoption and usage of the Digital Euro. To this end, the study examines the three fundamental components of banks' balance sheet: (i) funding structure, (ii) capital structure, and (iii) asset structure. The discussion considers the associated risks for each of these components – (i) liquidity risk for funding structure, (ii) capital adequacy for capital structure, and (iii) credit risk for asset structure – accompanied by a brief discussion of their implications for banks' profitability.

To begin, sections 1 and 2 elaborate on the definition of the Digital Euro and the key advantages of its issuance, with particular emphasis on the enhancement of the current Euro Area payment system, which is highly reliant on non-European payment providers, and the safeguard of the Euro currency as public money in the digital era. Section 3 introduces the topic of financial stability, focusing on the impact of the Digital Euro on financial stability, particularly on banks' balance sheets through the disintermediation of deposits.

Based on the analysis of banks' funding structure and liquidity position (in section 4), savings and cooperative are the most likely to experience significant impacts on their funding structure with the launch of the Digital Euro. They rely heavily on retail demand deposits and dispose of relatively low levels of internal funds. Additionally, if they need to raise funding, their liquidity positions may be jeopardized. In that scenario, these are the types of banks most likely to require central bank funding, which while less damaging for their liquidity, is the most expensive funding option.

On the other side of the spectrum are non-banking credit and mortgage institutions, which have minimal reliance on retail demand deposits. However, if they need to raise funding, it is complex to evaluate the likelihood of borrowing from central banks, as their liquidity buffers are challenging to evaluate due to the small number of observations and high dispersion. The same limitation applies to investment banks and private banking institutions. While a comparative analysis allows to hypothesize about potential impacts on the funding structure of savings, cooperative and commercial banks, the same is not feasible to investment banks and private banking institutions. This highlights the limitations encountered in data collection, particularly for these types of banks.

The following segment explores the effect of the Digital Euro issuance through the endogenous lens of money creation. Capital adequacy emerges as a critical constraint, acting as both a regulator of banks' risk appetite through required buffers and a direct influence on credit and liquidity risks. This section concludes that the Digital Euro could theoretically exert a dual pressure on the Capital Adequacy Ratio and analyses in parallel European banks' current capital position (which stands at about 2,5 to 5 pp above the required), even considering recent macroeconomic challenges. Despite confirming banks' short-term capital resilience, the proposed strategies – prioritized by ease of implementation and historical precedence – offer a roadmap to strengthen banks' risk-adjusted capital ratios, addressing medium to long-term impacts on the balance sheet of banks. In terms of impact on profitability, the Digital Euro significantly introduces initial costs for banks but also creates opportunities for new revenue streams, such as fee-based services, enabling banks to optimize capital efficiency and offset early challenges.

The model examined in the last section highlights the crucial function of deposit funding in upholding financial stability, particularly during periods of economic stagnation or contraction. A larger proportion of deposit funding enables banks to withstand external economic shocks

more effectively, which in turn leads to a reduction in non-performing loans (NPLs) and an improvement in the management of credit risk. The findings of the analysis indicate that the stabilizing impact of deposit funding is most evident during economic contractions, a time when systemic credit risks are heightened. Conversely, its relative significance is diminished during periods of economic expansion. This dynamic emphasizes the critical interdependence between the structural characteristics of financial funding, macroeconomic conditions and the risk of credit default in guaranteeing the stability of the financial system.

The implementation of the Digital Euro may potentially disrupt this equilibrium, with the possibility of triggering significant deposit outflows on a large scale. Such a shift could necessitate that banks rely on alternative funding sources that are less stable, thereby intensifying credit risk and systemic fragility, particularly during periods of economic turbulence. To mitigate these risks, the design of the Digital Euro must prioritize measures that minimize disruptions to funding stability. Features such as holding limits, tiered interest rates, or restrictions on its use as a store of value could serve to mitigate deposit migration and thereby preserve the stabilizing role of traditional deposit funding.

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## Appendix - Vanessa

| Specialisation                                         | No. obs. | Assets share |
|--------------------------------------------------------|----------|--------------|
| Savings bank                                           | 197      | 38.71        |
| Cooperative bank                                       | 308      | 30.70        |
| Commercial bank                                        | 42       | 18.24        |
| Real estate & mortgage finance institution             | 10       | 8.20         |
| Investment bank                                        | 4        | 2.88         |
| Finance company & Other non-banking credit institution | 4        | 0.78         |

|                                                 |            |            |
|-------------------------------------------------|------------|------------|
| Private banking, Investment & trust corporation | 7          | 0.49       |
| <b>Total</b>                                    | <b>572</b> | <b>100</b> |

**Appendix 1** - Distribution of banks by specialization: number of observations and asset share

Source: Calculations based on 2023 data from Orbis BankFocus.

Note: Asset share (%) represents the share of each bank category's assets relative to the total assets of the banking sector.

|                  |                                       | Mean    | SD      | Min.   | P5      | P25     | P50     | P75     | P95     | Max.     |
|------------------|---------------------------------------|---------|---------|--------|---------|---------|---------|---------|---------|----------|
| Total            | Demand deposit funding                | 50.912  | 16.069  | 0.028  | 19.235  | 43.573  | 53.373  | 61.254  | 73.004  | 94.433   |
|                  | Other retail deposit funding          | 31.547  | 13.868  | 0      | 10.008  | 24.615  | 30.094  | 36.142  | 57.783  | 98.369   |
|                  | Interbank liabilities                 | 14.651  | 11.01   | 0      | 1.946   | 7.702   | 12.711  | 18.961  | 35.073  | 83.387   |
|                  | Wholesale funding except interbanking | 2.891   | 7.717   | 0      | 0       | 0.248   | 0.859   | 1.879   | 13.286  | 83.758   |
|                  | Short-term wholesale funding          | 14.914  | 11.197  | 0      | 1.961   | 7.8     | 12.895  | 19.137  | 35.336  | 83.387   |
|                  | Long-term wholesale funding           | 2.627   | 7.337   | 0      | 0       | 0.208   | 0.824   | 1.734   | 12.106  | 83.758   |
|                  | Excess reserves to demand deposits    | 0.130   | 1.067   | -0.01  | 0       | 0.011   | 0.018   | 0.032   | 0.349   | 18.778   |
|                  | HQLA to demand deposits               | 23.193  | 261.689 | 1.934  | 4.104   | 7.59    | 10.232  | 13.349  | 30.352  | 6316.362 |
|                  | LCR                                   | 214.692 | 109.347 | 119.2  | 130.4   | 157     | 183     | 222.9   | 441.54  | 987      |
|                  | NSFR                                  | 127.841 | 18.774  | 105.46 | 112.24  | 118.19  | 123.035 | 130.11  | 162.168 | 257      |
| Commercial bank  | Demand deposit funding                | 45.684  | 25.127  | 1.181  | 4.507   | 28.273  | 45.27   | 65.772  | 86.36   | 94.433   |
|                  | Other retail deposit funding          | 29.418  | 19.256  | 0.032  | 2.624   | 13.373  | 28.931  | 40.429  | 66.057  | 80.724   |
|                  | Interbank liabilities                 | 15.82   | 19.741  | 0      | 0.007   | 1.153   | 10.991  | 23.183  | 50.595  | 83.387   |
|                  | Wholesale funding except interbanking | 9.079   | 13.573  | 0      | 0.001   | 0.706   | 3.718   | 11.023  | 40.781  | 54.723   |
|                  | Short-term wholesale funding          | 17.195  | 20.532  | 0      | 0.029   | 1.784   | 11.574  | 23.74   | 54.995  | 83.387   |
|                  | Long-term wholesale funding           | 7.703   | 11.729  | 0      | 0       | 0.283   | 2.975   | 10.138  | 39.005  | 52.455   |
|                  | Excess reserves to demand deposits    | 0.332   | 0.438   | -0.01  | -0.001  | 0.018   | 0.166   | 0.487   | 1.404   | 1.929    |
|                  | HQLA to demand deposits               | 29.848  | 16.344  | 4.921  | 10.716  | 17.147  | 28.212  | 38.533  | 54.024  | 81.376   |
|                  | LCR                                   | 270.161 | 154.296 | 124.1  | 147.4   | 169.25  | 205.48  | 325.5   | 512     | 855.14   |
|                  | NSFR                                  | 158.611 | 38.264  | 110.11 | 113.829 | 128.396 | 149.254 | 186.154 | 227.35  | 257      |
| Cooperative bank | Demand deposit funding                | 50.079  | 13.538  | 5.431  | 25.806  | 42.573  | 51.347  | 58.486  | 73.578  | 83.664   |
|                  | Other retail deposit funding          | 32.697  | 11.964  | 0.196  | 12.750  | 27.146  | 31.842  | 38.815  | 57.783  | 77.328   |
|                  | Interbank liabilities                 | 15.44   | 10.112  | 0      | 2.563   | 8.642   | 14.316  | 20.554  | 35.336  | 65.642   |
|                  | Wholesale funding except interbanking | 1.784   | 4.956   | 0      | 0       | 0.153   | 0.64    | 1.396   | 6.247   | 50.618   |
|                  | Short-term wholesale funding          | 15.621  | 10.166  | 0      | 2.563   | 8.677   | 14.452  | 21.057  | 35.336  | 65.642   |
|                  | Long-term wholesale funding           | 1.603   | 4.829   | 0      | 0       | 0.088   | 0.611   | 1.327   | 4.503   | 50.618   |
|                  | Excess reserves to demand deposits    | 0.04    | 0.135   | -0.009 | 0       | 0.006   | 0.017   | 0.029   | 0.114   | 2.157    |

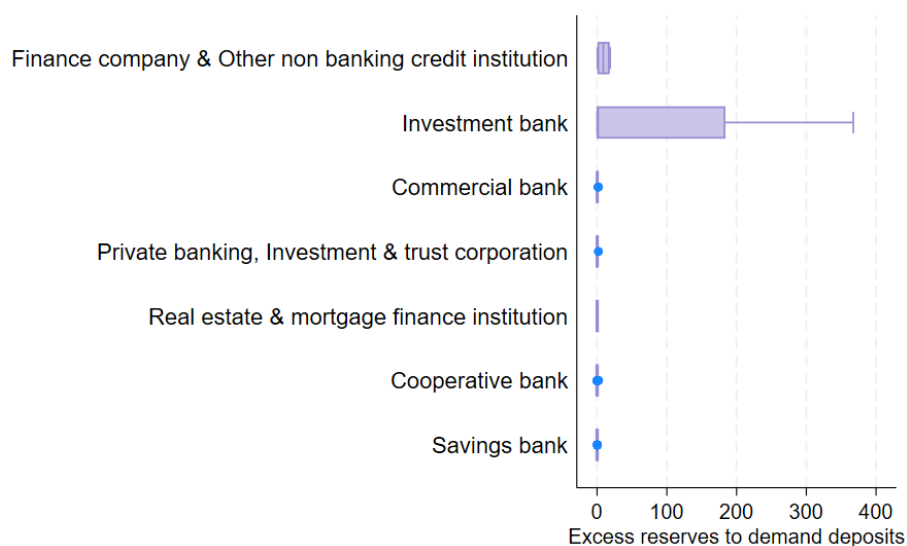
|                                                        |                                       |         |         |         |         |         |         |         |         |        |
|--------------------------------------------------------|---------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
|                                                        | HQLA to demand deposits               | 9.401   | 5.611   | 1.934   | 3.509   | 6.079   | 8.367   | 10.124  | 22.595  | 41.915 |
|                                                        | LCR                                   | 202.523 | 83.666  | 119     | 120     | 151     | 180.05  | 222.81  | 399     | 635.78 |
|                                                        | NSFR                                  | 122.376 | 9.626   | 106.855 | 111.545 | 116.769 | 120.473 | 124.822 | 140.442 | 167.46 |
| Finance company & Other non-banking credit institution | Demand deposit funding                | 22.029  | 37.942  | 0.086   | 0.086   | 0.199   | 4.667   | 16.333  | 88.861  | 88.861 |
|                                                        | Other retail deposit funding          | 41.78   | 43.465  | 0       | 0       | 14.681  | 17.933  | 77.918  | 98.369  | 98.369 |
|                                                        | Interbank liabilities                 | 32.502  | 38.562  | 0.363   | 0.363   | 5.749   | 8.113   | 65.868  | 82.416  | 82.416 |
|                                                        | Wholesale funding except interbanking | 3.689   | 4.551   | 0       | 0       | 1.182   | 2.704   | 3.025   | 11.533  | 11.533 |
|                                                        | Short-term wholesale funding          | 32.502  | 38.562  | 0.363   | 0.363   | 5.749   | 8.113   | 65.868  | 82.416  | 82.416 |
|                                                        | Long-term wholesale funding           | 3.689   | 4.551   | 0       | 0       | 1.182   | 2.704   | 3.025   | 11.533  | 11.533 |
|                                                        | Excess reserves to demand deposits    | 7.391   | 9.641   | 0.027   | 0.027   | 0.419   | 0.652   | 17.078  | 18.778  | 18.778 |
|                                                        | HQLA to demand deposits               | 19.679  | 21.669  | 4.213   | 4.213   | 6.78    | 8.477   | 22.662  | 56.261  | 56.261 |
|                                                        | LCR                                   | 463.142 | 364.733 | 159.79  | 159.79  | 188.93  | 279     | 700.99  | 987     | 987    |
|                                                        | NSFR                                  | 144.588 | 43.951  | 112.92  | 112.92  | 116.59  | 125.47  | 148.83  | 219.13  | 219.13 |
| Investment bank                                        | Demand deposit funding                | 47.186  | 22.369  | 33.610  | 33.610  | 33.610  | 34.945  | 73.004  | 73.004  | 73.004 |
|                                                        | Other retail deposit funding          | 23.013  | 13.961  | 7.239   | 7.239   | 7.239   | 28.022  | 33.779  | 33.779  | 33.779 |
|                                                        | Interbank liabilities                 | 20.725  | 7.43    | 14.35   | 14.35   | 14.35   | 18.942  | 28.884  | 28.884  | 28.884 |
|                                                        | Wholesale funding except interbanking | 9.075   | 8.063   | 0.815   | 0.815   | 0.815   | 9.484   | 16.926  | 16.926  | 16.926 |
|                                                        | Short-term wholesale funding          | 27.092  | 7.059   | 18.942  | 18.942  | 18.942  | 31.057  | 31.276  | 31.276  | 31.276 |
|                                                        | Long-term wholesale funding           | 2.709   | 4.006   | 0       | 0       | 0       | 0.815   | 7.311   | 7.311   | 7.311  |
|                                                        | Excess reserves to demand deposits    | 0.343   | 0.360   | 0.133   | 0.133   | 0.133   | 0.137   | 0.759   | 0.759   | 0.759  |
|                                                        | HQLA to demand deposits               | 23.806  | 8.482   | 14.209  | 14.209  | 14.209  | 26.914  | 30.295  | 30.295  | 30.295 |
|                                                        | LCR                                   | 296.237 | 141.586 | 144.61  | 144.61  | 144.61  | 319.1   | 425     | 425     | 425    |
|                                                        | NSFR                                  | 152.353 | 5.251   | 146.3   | 146.3   | 146.3   | 155.08  | 155.68  | 155.68  | 155.68 |
| Private banking, Investment & trust                    | Demand deposit funding                | 56.664  | 27.726  | 7.274   | 7.274   | 46.681  | 53.44   | 75.848  | 94.102  | 94.102 |
|                                                        | Other retail deposit funding          | 31.729  | 27.486  | 3.588   | 3.588   | 4.918   | 33.969  | 44.259  | 83.951  | 83.951 |
|                                                        | Interbank liabilities                 | 5.3     | 2.914   | 0.64    | 0.64    | 2.48    | 7.04    | 7.456   | 7.809   | 7.809  |
|                                                        | Wholesale funding except interbanking | 6.307   | 14.83   | 0       | 0       | 0.628   | 1.406   | 1.706   | 42.978  | 42.978 |
|                                                        | Short-term wholesale funding          | 5.3     | 2.914   | 0.64    | 0.64    | 2.48    | 7.04    | 7.456   | 7.809   | 7.809  |
|                                                        | Long-term wholesale funding           | 6.307   | 14.83   | 0       | 0       | 0.628   | 1.406   | 1.706   | 42.978  | 42.978 |
|                                                        | Excess reserves to demand deposits    | 0.401   | 0.651   | -0.009  | -0.009  | 0.01    | 0.139   | 0.504   | 1.908   | 1.908  |

|                                            |                                       |         |         |         |         |         |         |         |          |          |
|--------------------------------------------|---------------------------------------|---------|---------|---------|---------|---------|---------|---------|----------|----------|
|                                            | HQLA to demand deposits               | 810.299 | 2224.84 | 10.997  | 10.997  | 11.778  | 18.352  | 47.384  | 6316.362 | 6316.362 |
|                                            | LCR                                   | 320.880 | 203.933 | 160.9   | 160.9   | 184.97  | 244.765 | 389.77  | 767.13   | 767.13   |
|                                            | NSFR                                  | 154.112 | 45.864  | 111.394 | 111.394 | 127.701 | 130.92  | 185.131 | 234      | 234      |
| Real estate & mortgage finance institution | Demand deposit funding                | 2.092   | 2.939   | 0.028   | 0.028   | 0.275   | 0.659   | 2.777   | 7.764    | 7.764    |
|                                            | Other retail deposit funding          | 68.452  | 32.679  | 10.008  | 10.008  | 54.392  | 81.467  | 92.05   | 95.318   | 95.318   |
|                                            | Interbank liabilities                 | 10.562  | 11.806  | 3.522   | 3.522   | 4.387   | 6.958   | 10.204  | 43.363   | 43.363   |
|                                            | Wholesale funding except interbanking | 18.894  | 33.157  | 0.548   | 0.548   | 0.66    | 1.329   | 12.106  | 83.758   | 83.758   |
|                                            | Short-term wholesale funding          | 10.562  | 11.806  | 3.522   | 3.522   | 4.387   | 6.958   | 10.204  | 43.363   | 43.363   |
|                                            | Long-term wholesale funding           | 18.894  | 33.157  | 0.548   | 0.548   | 0.66    | 1.329   | 12.106  | 83.758   | 83.758   |
|                                            | Excess reserves to demand deposits    | 0.158   | 0.181   | 0.01    | 0.01    | 0.011   | 0.058   | 0.282   | 0.524    | 0.524    |
|                                            | HQLA to demand deposits               | 6.52    | 2.862   | 3.029   | 3.029   | 3.85    | 6.27    | 8.641   | 11.633   | 11.633   |
|                                            | LCR                                   | 380.618 | 263.421 | 149.8   | 149.8   | 187.31  | 275.405 | 470     | 921      | 921      |
|                                            | NSFR                                  | 124.837 | 10.28   | 109.5   | 109.5   | 117.44  | 125.345 | 133.14  | 140.03   | 140.03   |
| Savings bank                               | Demand deposit funding                | 56.41   | 9.426   | 23.724  | 40.107  | 51.276  | 56.837  | 63.248  | 69.964   | 82.054   |
|                                            | Other retail deposit funding          | 28.2    | 7.441   | 2.751   | 17.156  | 23.687  | 27.682  | 32.087  | 39.275   | 57.705   |
|                                            | Interbank liabilities                 | 13.184  | 7.48    | 0.03    | 2.523   | 8.538   | 12.049  | 16.784  | 26.55    | 47.537   |
|                                            | Wholesale funding except interbanking | 2.206   | 3.472   | 0       | 0.005   | 0.385   | 0.95    | 2.102   | 11.9     | 18.832   |
|                                            | Short-term wholesale funding          | 13.269  | 7.517   | 0.03    | 2.523   | 8.584   | 12.193  | 16.855  | 26.55    | 47.537   |
|                                            | Long-term wholesale funding           | 2.12    | 3.352   | 0       | 0.001   | 0.381   | 0.931   | 2.058   | 10.591   | 18.832   |
|                                            | Excess reserves to demand deposits    | 0.028   | 0.054   | -0.004  | 0.009   | 0.013   | 0.017   | 0.023   | 0.09     | 0.6      |
|                                            | HQLA to demand deposits               | 12.637  | 4.17    | 2.918   | 8.02    | 10.519  | 12.033  | 13.47   | 20.607   | 32.281   |
|                                            | LCR                                   | 201.421 | 82.126  | 126.34  | 141.88  | 162.66  | 180.4   | 209.48  | 352.23   | 839.7    |
|                                            | NSFR                                  | 127.938 | 12.193  | 105.46  | 114.57  | 121.47  | 125.195 | 131.61  | 157.911  | 205.19   |

**Appendix 2 - Summary statistics of bank funding and liquidity by banking sector specialisation**

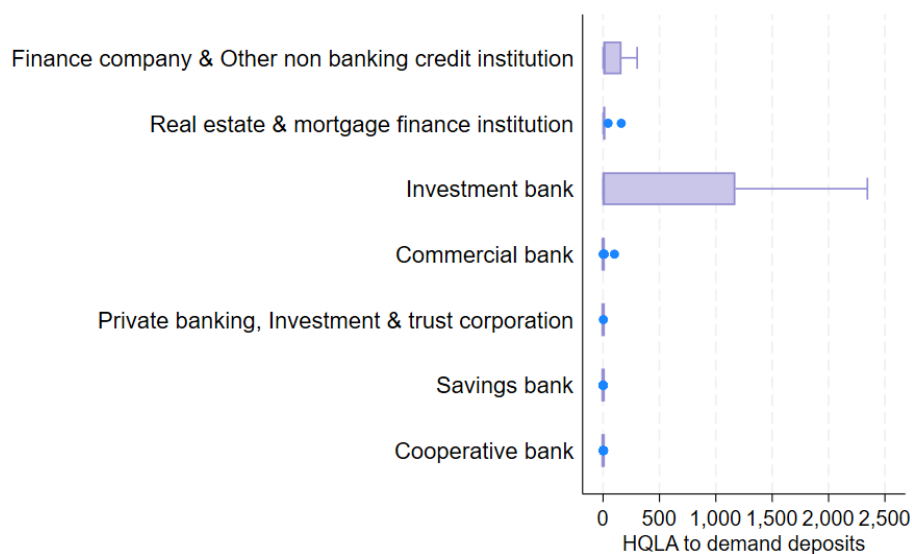
Source: Calculations based on 2023 data from Orbis BankFocus.

Note: All variables are expressed as percentages, except for 'Excess reserves to demand deposits' and 'HQLA to demand deposits', which represent the proportion of own excess reserves and HQLA relative to retail demand deposit, respectively.



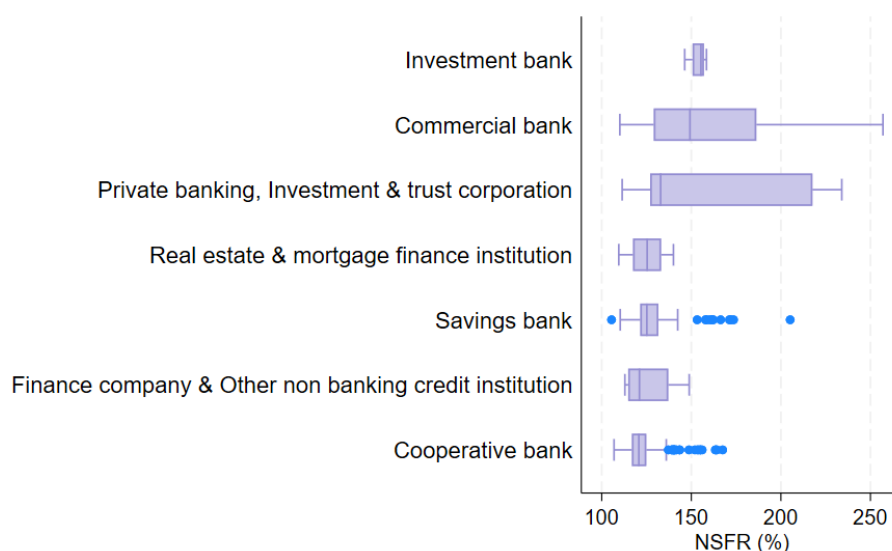
### ***Appendix 3 - Excess reserves to retail demand deposits by banking sector specialisation***

Source: Own computations based on 2023 data provided by Orbis BankFocus.



### ***Appendix 4 - HQLA to retail demand deposits by banking sector specialisation***

Source: Own computations based on 2023 data provided by Orbis BankFocus.



**Appendix 5 - NSFR by banking sector specialisation**

Source: Own computations based on 2023 data provided by Orbis BankFocus.

## Appendix – Sara

The table below provides an in-depth breakdown of the components of the Capital Adequacy ratio, and additionally, to capital buffers as well. This table overviews how each components reacts to absorb losses (Column 2), as well as outlining an “order of defence” against these (Column 3). The table also provides an analysis on what would trigger the next line of defence, i.e., at which extend would the component in analysis be able to withstand loss before the bank recurring to other capital reserves (Column 4). As this analysis studies the impact of the Digital Euro on the Capital Adequacy Ratio, column 5 explains the direct or indirect effects on the ratio. Lastly, column 6 presents the cumulative capital requirements to serve as a means of comparison for the 2023 SREP results analysis.

The components shaded in grey represent the key elements to the CAR analysis, and they have a direct effect on it. On the other hand, the unshaded components (specifically the buffers) represent an indirect effect. The first two components (CET1 and AT1 capital) are not shaded, as their result is summed into the third component (Tier 1 capital).

|                              | Component                                    | Impact Mechanism                                                                                                                                                                                         | Order                                              | Trigger to Move to Next Defence                                                                                                                                         | Impact on Capital Adequacy Ratio                                                                                                                                                                                                                                                                    | Cumulative capital (% of RWAs) |
|------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Minimum Capital Requirements | <b>CET1 Capital</b>                          | Reduction in retained earnings (part of CET1), lowering CET1 capital. Banks may be prevented from distributing dividends or employee bonuses.                                                            | First line of defence                              | CET1 ratio falls below the regulatory minimum of 4.5%.                                                                                                                  | Reduction lowers CET1 adequacy ratio (CAR numerator), making it harder for the bank to meet the required threshold.                                                                                                                                                                                 | 4,5%                           |
|                              | <b>AT1 Capital</b>                           | AT1 instruments (e.g., contingent convertibles and hybrid securities) convert to equity if CET1 ratio falls below a certain threshold.                                                                   | Second line of defence                             | CET1 ratio hits the AT1 threshold (CET1 Ratio = CET1 Capital ÷ Risk-Weighted Assets). Conversion boosts CET1 capital but dilutes shareholder equity.                    | Conversion maintains the CAR numerator, as the total capital remains unchanged, but it signals financial stress and may affect market confidence.                                                                                                                                                   | 6%                             |
|                              | <b>Tier 1 Capital</b>                        | Includes CET1 and AT1. Both components are affected by CET1 depletion and AT1 conversion. Acts as "going concern."                                                                                       | Follows CET1 and AT1                               | Tier 1 capital ratio of 6% triggers regulatory intervention.                                                                                                            | Reduction in CET1 directly lowers T1 capital, but AT1 conversion into CET1 mitigates some of this impact. Nevertheless, the overall effect would be a reduction of the CAR numerator. Tier 1 capital exacerbates pressure on CAR and signals a need for stricter regulatory measures.               | 6%                             |
|                              | <b>Tier 2 Capital</b>                        | Acts as an additional layer to absorb losses in the event of a bank's failure; includes revalued reserves, undisclosed reserves, and hybrid securities (less liquid).                                    | After Tier 1 capital is depleted                   | Insufficient Tier 1 capital to cover losses, particularly during severe financial stress or bank failure. CET1 + AT1 + Tier 2 must be above 8% of RWAs.                 | Supports overall capital adequacy but is less immediate in loss absorption, providing a secondary buffer that complements Tier 1 capital.                                                                                                                                                           | 8%                             |
| RWAs                         | <b>Risk-Weighted Assets (RWAs)</b>           | Increase in RWAs due to a shift towards higher-risk lending or investments as banks seek to offset higher funding costs from deposit outflows.                                                           | Continuous impact                                  | Higher risk lending or investments increase RWAs. Regulatory stress tests may flag insufficient capital coverage (such as SREP Stress Tests).                           | Increased RWAs raise the denominator in the CAR, requiring banks to hold more CET1 and Tier 1 capital to maintain compliance.                                                                                                                                                                       | N/A                            |
| Capital Buffers              | <b>Capital Conservation Buffer (CCoB)</b>    | Buffer of 2.5% of RWAs used to absorb losses in periods of stress. Composed entirely of CET1 capital. Constraints on distribution apply only when the buffer is not on the operational side of the bank. | First buffer after regulatory minimum requirements | CET1 ratio falls below the combined regulatory minimum + CCoB (e.g., 10,5% under Basel III)                                                                             | Depletion of the buffer indirectly increases pressure on CAR by reducing the CET1 capital available for regulatory minimum requirements. While the CAR numerator remains composed of CET1, AT1 and T2, depletion of the CCoB restricts distribution and raises regulatory and stress test concerns. | 10,5%                          |
|                              | <b>Countercyclical Capital Buffer (CCyB)</b> | Adjusts to economic cycles to mitigate risks during periods of rapid credit growth, which often lead to financial instability. Composed of CET1 capital, fluctuates between 0 and 2.5% of RWAs.          | Dynamic, based on economic conditions              | Changes based on regulatory assessment of credit growth and systemic risk. Lowered during downturns to maintain credit flow; increased during booms to restrain growth. | Fluctuating CCyB helps stabilize the financial system by adapting to economic conditions, enhancing overall banking resilience against external shocks.                                                                                                                                             | 10,5% - 13%                    |

### Appendix 6 - Capital Adequacy components' reaction mechanism

## Appendix 3 - Isabella

### Variable selection

The analysis included a number of variables that were deemed to be relevant to the performance of banks, the risks they face, and the sources from which they fund their activities. The abovementioned variables represent fundamental elements of a banking institution's balance sheet and funding structure.

- Total Assets (in EUR): The total assets of a bank represent a critical measure of its size, and are often correlated with a number of key financial variables, including economies of scale, capital adequacy, and systemic risk. The larger the bank, the greater the potential benefits of diversification, but also the greater the risks in the event of financial instability.

This measure was subsequently transformed into the natural logarithm of total assets in order to account for non-linear scale effects associated with bank size and to address skewness in the distribution of bank size. This approach facilitates the normalisation of data, thereby enabling a more accurate interpretation of the effects of bank size across a range of differently sized banks.

- Profit (or loss) after tax (m EUR): This variable is used to measure the net profit of the bank, thereby capturing the overall profitability and operational efficiency of the institution.
- Gross loans and advances to customers (in millions of euros): This variable indicates the total lending volume, which represents a significant source of revenue for banks. The level of lending undertaken by a financial institution reflects both the inherent risk exposure and the business model employed. It is therefore reasonable to conclude that higher loan volumes are potentially associated with greater credit risk.

The proportion of customer deposits as a share of total funding provides insight into the stability of the bank's funding base. The proportion of customer deposits as a share of total funding provides an indication of the stability of the bank's funding base. A greater reliance on customer deposits is typically regarded as a more stable funding source than wholesale funding, given that deposits are often less volatile during economic downturns. The variable was renamed as "Deposit share".

NPL Ratio (Non-Performing Loan Ratio): This metric is employed for the purpose of measuring the extent of the bank's credit risk and the quality of its outstanding loans. A high ratio indicates that the bank is exposed to a greater risk of loss in the event of an inability to recover the outstanding amounts, whereas a low ratio suggests that the loans are relatively low-risk for the bank. The level of non-performing loans is of significant economic importance, as these loans have a detrimental impact on the profitability of banks and result in the absorption of valuable resources, thereby limiting the capacity of banks to extend new loans (ECB n.d.).