

EFFECTS OF A DIGITAL EURO ON FINANCIAL STABILITY AND CONSUMER WELFARE

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PREFACE

On June 28, 2023, the European Commission published a proposal to establish a digital euro. The proposal was released after the Eurosystem launched an investigation phase on introducing a digital euro in October 2021. On 18 October 2023, the European Central Bank (“ECB”) decided to move to the next phase of the digital euro project, the preparation phase. The digital euro will be a retail central bank digital currency (“CBDC”), and as such would be a form of central bank money that is directly accessible to the public, like cash, and with the status of legal tender.

While the reasons and objectives for launching a digital euro have evolved over time, the main objectives of the ECB and the European Commission can be summarised as follows:

- Ensure that the euro remains a monetary anchor in an economy where cash is decreasingly used for making payments and protecting financial stability
- Promote innovation and competition in payments
- Promote financial inclusion
- Strengthen the EU’s strategic autonomy and monetary sovereignty

However, at the time of writing this report, there is still significant uncertainty surrounding the implications of establishing a digital euro. This uncertainty stems from two main facts. First, many of the design features of the digital euro and how it would be implemented in practice are still being defined. Second, there are few analyses that attempt to quantify and estimate the effects a digital euro would have that can enrich the discussion around the work that the ECB and the European Commission have done. Prevalent – although most certainly not unique – among the potential negative effects that a digital euro could have, is a significant negative impact on the financial system’s stability in the euro area.

For this aspect of its potential impact, the European Banking Federation (“EBF”) has asked Copenhagen Economics (“CE” or “us”) to conduct a study which evaluates some of the major implications of establishing a digital euro, both from a quantitative and qualitative point of view. We do so via the following structure:

1. Chapter 1 provides an **overview of the digital euro**, including its intended objectives and key parameters.
2. Chapter 2 analyses the **effects that a digital euro could have on financial stability** by estimating the magnitude of deposit outflows from commercial banks, how that may affect banks’ possibilities for refinancing and at what cost, and how the existence of a CBDC could increase the speed and magnitude of bank runs in a situation of stress.
3. Chapter 3 analyses the **effects that a digital euro could have on consumer welfare** by taking a first look at potential benefits and some of the costs associated with launching a digital euro.

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EXECUTIVE SUMMARY

Key design features and objectives of the digital euro

A central bank digital currency (CBDC) is, as the name implies, the digital form of central bank money that can be used in the same way that consumers today use either physical cash – notes and coins – or a deposit with a commercial bank. A CBDC can be used as a *store of value*, as an *investment* and as a means of *payment*. These are three important functions of a currency, private or public.

The extent to which consumers will hold CBDC depends on some key parameters. In the first place, it may be constrained by any limits on holdings. Secondly, the extent to which consumers will use it depends on how desirable it is relative to holding cash or deposits for the three functions above. High uptake is to be expected either if bank deposits are seen as risky (store of value), if remuneration is high relative to bank deposits (investment), if the CBDC offers a more effective or less costly means of procuring goods and services (payment) or a combination of the above.

The European Commission unveiled its legislative proposal for a digital euro in June 2023, including some, but not all, of the most important design features. It will allow users to have their own digital euro accounts that can also be used as a payment wallet. The legislative proposal foresees that the digital euro will bear no interest and its use for basic functionalities will be free of charge. As for physical cash, the digital euro will have legal tender status, i.e. merchants must generally accept it as payment. It will be available to euro area citizens whether resident in the area or not. By contrast, the proposal does not establish a holding limit (i.e. cap on the size of the deposit holdings) but leaves the ECB to decide upon this. Other dimensions of the implementation around the use cases, other limits to its use and price regulation are also not completely clear.

While the objectives behind creating a digital currency for the euro area have changed over time, our reading of the European Commission's and the ECB's recent statements suggests that the digital euro is now meant to help attain four objectives: (1) preserve the digital euro's role as a monetary anchor and maintain financial stability, (2) promote innovation and competition in payments, (3) promote financial inclusion, and (4) strengthen the EU's strategic autonomy and monetary sovereignty.

Our analysis will primarily focus on the first three objectives, as these have a more immediate impact on financial stability and market dynamics. Although all objectives are important, we consider that objective (4), *strengthen the EU's strategic autonomy and monetary sovereignty*, is not directly within the scope of our study. It is particularly noted that focusing on the digital euro's impact on financial stability does not diminish the significance of other expected impacts for banks, such as investments required, costs and erosion of revenue streams. The digital euro is a highly complex project warranting focused analysis across its different anticipated impacts.

Effects on financial stability

It is recognised that the introduction of a CBDC can affect financial stability, which we define as the ability of the overall financial system to weather shocks and provide critical financial services, also in periods of stress. This is consistent with how the ECB and other institutions use this concept in the context of CBDCs.

The central mechanism via which a CBDC affects the ability of commercial banks to provide credit to the economy is by affecting their access to and the cost of funding. This effect occurs when consumers move money from their deposits in commercial banks to be stored as digital currency backed by central banks. Commercial banks then must switch to alternative sources of funding which, if available, typically will be more expensive than deposit funding. Hence, the cost of providing financial services also increases.

The size of the switch and the resulting impact on banks' funding costs depends on several factors. We have defined several scenarios that, in our view, span the range of possible outcomes. We review the impact of the digital euro on financial stability while considering different:

- Holding limits and other design choices of the digital euro affecting uptake
- Macroeconomic environments (periods of stress versus stability in financial markets)
- Composition of funding sources (capturing heterogeneity across the banking sector)

We start by examining the impact of the digital euro considering different holding limits. We set a maximum limit of 3,000 euros, like other key studies, and consider three more scenarios of limits at 500, 1,000 and 2,000 euros. With the holding limit at 3,000, we find that the digital euro can realistically lead to an outflow of up to 739 billion euro of bank deposits in the euro area. This corresponds to a loss of 10% of the total household deposit base and 3% of the total bank liabilities. With a holding limit of 500 euros, the loss of deposits would be limited to 139 billion euro, a decrease of 81% compared to a 3,000 euro holding limit.

Furthermore, the impacts are diverse across banks. For highly impacted banks, these figures could rise to 20% of the deposit base or 9% of total bank liabilities. Additionally, the impact on smaller banks is disproportionately large. Across the smaller banks in our sample, deposit outflows amount to 7% of total liabilities, more than twice the aggregate outflow across all banks (3%).

Both the scenarios with a 3,000 and 500 euro holding limit described above illustrate a situation of high demand for the digital euro, where users seek to hold the largest amount of digital euro possible. Since the digital euro bears no interest, in a steady state of the financial system, high demand would have to be driven mainly by a perceived superior value as a means of payment. However, such demand could likewise be triggered by market instability, actual or perceived. In this situation, under certain conditions, depositors would see the digital euro account as a very attractive option and seek to exchange their private money (deposits) for central bank money (digital euro). Notably, such a shift from a remunerated to a non-remunerated deposit would have to be driven by a lack of trust in euro area authorities' perceived ability to fulfil deposit guarantees, which typically cover all deposits up to around 100,000 euro, way above any conceivable holding limit for digital euro.

Our overall evaluation is that the effect of the digital euro on financial stability should be measured against periods of stress in the financial system.

Here, we find that the digital euro could exacerbate depositor runs, if depositors perceive it to be safer than the deposit guarantee schemes in place. As indicated above, such deposit runs might especially hit smaller banks for two reasons. First, customers in smaller banks tend to have lower levels of deposits. Hence the holding limit will bind fewer customers, leading to a larger share of deposits being withdrawn from smaller banks than larger banks. Second, deposit funding typically makes up for a larger share of the funding for smaller banks. A situation in which major banks would be seen as likely to fail will possibly coincide with larger imbalances in the financial system where the residual potential for more digital euro deposits would disappear very quickly.

Moreover, banks facing a potential depositor shift would, at the same time, face increasing challenges and costs of replacing the lost deposits. Indeed, the potential sheer magnitude of the possible shift of funding –10% of the depositor base – could itself create stress in the markets. This would be especially true if the adoption of the digital euro failed to include a transitory mechanism allowing markets to adjust.

Overall, in a severe scenario – of a 3,000 euro holding limit and 100% uptake of the digital euro – the additional funding banks will need to compensate for deposit outflows can amount to 681 billion euro in the euro area. Compared to the existing stock of debt securities issued by euro area banks, this implies an expansion of the bank-issued debt securities market of around 20%. More worryingly, for some banks, the magnitude of additional funding can be so large that they will most likely be unable to replenish their liquidity.

Failing to consider a range of scenarios of stress in the financial system would lead to an incomplete assessment of the risks of the digital euro for financial stability. As a departure point for such a scenario, we find that full utilisation of the digital euro could increase a bank's incremental lending costs by 300 basis points¹ for each euro that needs to be refinanced by alternative funding sources. These additional costs of funding triggered by an outflow of deposits to digital euro would correspond to an average decrease in banks' net interest income of 7% on an aggregate euro area level and a corresponding decrease of 13% for the small banks in our sample.

Finally, the magnitude of the impact on financial stability can be even higher if the spread between the costs of wholesale funding and household deposit funding exceeds the 300 basis points scenario. This could be the case either if the financial environment develops unfavourably, or to the extent that individual banks are unable to obtain funding at this rate. We find that in a 3,000 euro holding limit scenario with full uptake, every additional 100 basis point increase in funding spread to the overall market results in an additional reduction of the net interest income of 2.4% of the initial level. If, for instance, the cost funding spread increases to 400 basis points, the net interest income would decrease on average 9.4% on an aggregate euro area level.

Effects on innovation and competition

Promoting innovation and competition through a digital euro should ultimately be about improving consumer welfare by enabling the provision of payment services at lower costs and/or higher quality. The ECB and the European Commission claim that payment markets suffer from a lack of competition and too high fees and that an ECB-supported digital payment facility in the form of a digital euro could tackle these issues.

¹ As per parameter estimates by BIS (2021)

Our assessment is that the case for such positive effects on consumer welfare is weak for several reasons. *First*, we have seen substantial market-driven innovation with new products and services emerging in recent years, largely driven by digitalisation. *Second*, several EU policy initiatives already foster competition and consumer choice (e.g. PAD, PSD2 – and PSD3, PSR -, IPR, DMA). *Third*, almost all use cases currently prioritised for the digital euro are covered by existing solutions, questioning the added value of the digital euro vis-a-vis a costly implementation that will affect all market participants, including consumers. *Fourth*, imposing arbitrary (low) fees for the use of the digital euro does not necessarily improve consumer welfare. If the fee is below overall costs to banks and other PSPs, it will crowd out existing payment means, hinder private innovation and ultimately, the consumers will bear the burden for lack of cost recovery.

Effects on consumer welfare

As a large-scale project that can be highly complex to implement, the digital euro will create a set of additional launch and recurring costs for commercial banks, other PSPs, and merchants in general. The additional costs imposed on these market participants will at least partly be passed on to consumers in the form of higher prices of goods and services. Likewise, increased costs for the ECB in setting up and running the digital euro will partly erode the profits of the central banks and constitute lost public revenues, which ultimately results in higher taxes on the margin.

Notably, additional costs imposed on commercial banks can directly reduce access to credit with a negative impact on economic activity. Indeed, to replenish the liquidity lost with deposits shifting to digital euro, banks would need to seek up to 681 billion euro from more expensive sources. Doing so could cost banks upwards 20.4 billion annually. To cover for these additional costs, banks could need to increase lending rates charged to consumers and businesses. Reducing access to credit could also hinder achieving other national or EU-wide public policy objectives that rely heavily on the financial intermediation role of banks (e.g. the green transition). Furthermore, the increase in the cost of borrowing could have a lasting impact on investment decisions and economic activity, and lead to a permanent reduction in GDP of 0.12-0.34%.

Further, there are other costs related to implementation and compliance which are significant and will eventually spill over to consumers. Commercial banks have invested in building up an infrastructure that allows them to interact with households with small accounts. This includes, for instance, implementing procedures to prevent fraud, money laundering and a whole array of Know-Your-Customer rules. Therefore, there is an open question of whether the digital euro will be built upon a system where central banks essentially make the best use of commercial bank solutions or if the ECB intends to build a parallel technical infrastructure from scratch. Compliance issues and costs will crucially depend on the extent to which existing infrastructures and solutions are leveraged for the digital euro. The final choice needs to be based on a thorough assessment of the cost impact of the different alternatives, accompanied by the anticipated sources of funding to implement them.

Effects on financial inclusion

The idea that a digital euro could improve financial inclusion rests on two arguments. First, that there is a clear tendency for vulnerable groups in society to be less prone to use digital payment means and not even having private payment accounts to do so. Second, that the move towards a 'less cash' society will, in particular, challenge the vulnerable groups. The digital euro is seen as an

instrument through which such groups could be provided with a solution that integrates them into an increasingly digitalised banking sector.

However, evidence indicates that financially excluded people have a low interest in the digital euro and a low perceived need of it, particularly when compared to continuing to use cash. Moreover, it is unclear how a new ECB-based digital payment solution can address financial exclusion caused by lack of digital literacy and means that acts as a barrier to the existing solutions provided by private providers. It is not convincing that whatever prevents financially excluded people from holding a private bank account will not also prevent them from opening a digital euro account.

Many of the design features of the digital euro intended to cater to the demands of the financially excluded can be provided more efficiently through already existing solutions. There are numerous examples of how EU governments have developed targeted solutions for vulnerable groups, operated by banks or other financial service providers. One example is the European Payment Accounts Directive, which allows universal access to basic payment services. The drastic reduction in the number of financially excluded people over the last years (from 8.2% in 2017 to 3.6% in 2021) strongly suggests that ongoing initiatives have already improved financial inclusion through existing solutions and will continue to do so.

Overall conclusions

Our overall evaluation is that it is not clear what existing or emerging financial sector challenges the digital euro will solve. Having said that, if a digital euro is to be issued, then it is of the utmost importance to deep dive into all possible consequences well in advance, so as to clarify a number of issues that still remain open and mitigate a number of risks, not only for banks but for society as a whole. In our study, we mainly focus on only one aspect of those significant consequences, the potential impact of a digital euro on financial stability.

We find that the real test of the digital euro and its impact on financial stability should be considered in the light of likely effects in times of market stress. Here, we find the potential effects to be highly problematic, particularly in the context of smaller banks with large deposit bases. We would also highlight that the digital euro, particularly with a high holding limit, could be perceived as a safer option than the deposit guarantee schemes in place.

Setting an adequate holding limit and ensuring a viable business model for the digital euro from the start are critical if a digital euro is implemented. Our analysis suggests that setting a low holding limit with a robust governance would mitigate risks to financial stability without necessarily reducing effectiveness in achieving other objectives as the digital euro could still be used for payment transactions, even at a zero holding limit. Lower holding limits – including a possible zero holding limit – would likewise reduce the risk of adverse impact on lending interest rates and thus overall economic activity. As an example, setting a holding limit of 500 euro rather than 3,000 euro would decrease the required balance-sheet adjustment for commercial banks by more than 80%, significantly reducing the potential impact on financial stability. In turn, a permanent holding limit set at zero would completely alleviate the risk of a bank run in times of market stress but would merit a separate deep-dive analysis into how it would be linked with other envisaged design features, such as the (de)funding and off-line functionalities.

It is repeated that settling issues around the holding limit is only one parameter for a safe landing of a digital euro. The implementation of this project is complex and will entail costs across the financial ecosystem, with potential negative spillover to consumers and the economy. A comprehensive quantification of costs, including infrastructure costs, would be key to assess its broader impacts.

Finally, for the wider societal impact linked to consumer welfare, innovation, competition, and financial inclusion, we suggest that, in each of these areas, European consumers are already benefiting from targeted policies at EU or national level that specifically address the identified problems.

CHAPTER 1

**DIGITAL EURO: DESIGN FEATURES,
OBJECTIVES AND CRITICAL PARAMETERS**

In this chapter, we introduce the digital euro, its core design features (1.1), and identify and describe its intended objectives (1.2). Furthermore, we set out a framework for the parameters that determines what effects a digital euro would have (1.3).

The effects of a digital euro include both its anticipated benefits (and the likelihood of achieving such benefits) as well as its associated costs and risks of launching. Where this chapter sets out the qualitative framework to explain what such effects hinges upon, we then evaluate the anticipated benefits and costs of a digital euro, based on this framework, in the following chapters.

1.1 CBDCs AND THE DIGITAL EURO

A CBDC is a digital form of central bank money that can be used as a means of payment or store of value. CBDCs can have legal tender status, meaning they are accepted as an official form of payment. Like other forms of central bank money, such as banknotes, a CBDC is a direct claim on the central bank that issues it and is thus risk-free. A CBDC can be accessible to the public (retail CBDCs), or available only to financial institutions (wholesale). Whilst in most jurisdictions, a wholesale CBDC is already available for wholesale payments in capital markets and other inter-bank transactions², we in this report refer to and focus on retail CBDCs, unless explicitly stated otherwise.

Central banks recently started exploring the launch of CBDCs.³ Central banks' interest in CBDCs stems from three developments perceived as a risk to central banks' control over monetary systems. *First*, the growing adoption of cryptocurrencies and stablecoins.⁴ *Second*, the entry of big techs into the financial services space.⁵ *Third*, the decline of cash as a payment instrument.⁶ Broadly, central banks argue that these phenomena can weaken the effectiveness of monetary policy and reduce people's confidence in the financial system. CBDCs are central banks' response to mitigate those risks.

Recent developments provide valuable indications of what a CBDC in the euro area, i.e. a digital euro, will look like. *First*, the ECB has published reports on the progress of its investigation into the launch of a digital euro.⁷ *Second*, in June 2023 the European Commission published the proposed regulation for introducing the digital euro.

² For wholesale CBDCs the next expected wave of innovation is an upgrade to their technology, e.g. by using distributed ledger technology.

³ In 2022, 93% of central banks were engaged in some form of central bank digital currency (CBDC) work". See BIS (2023).

⁴ See e.g. BIS Annual Economic Report (2021), chapter III. CBDCs: an opportunity for the monetary system.

⁵ See, e.g. the speech *Payments in a digital world* by Christine Lagarde, President of the ECB, highlighting the risks to monetary sovereignty and central bank money posed by technology firms with broad user-bases entering the payments industry. <https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200910~31e6ae9835.en.html>

⁶ See, e.g. speech by Yves Mersch, in his capacity then as Member of the Executive Board of the ECB and Vice-Chair of the Supervisory Board of the ECB, at the Consensus 2020 virtual conference, linking the reduction of cash to the debate on the introduction of CBDCs. <https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200511~01209cb324.en.html>

⁷ Together with national central banks of the euro area, the ECB launched an investigation on introducing a digital euro in October 2021.

Overall, the digital euro is intended to be a retail CBDC issued and controlled by the ECB. It will function alongside cash, have legal tender status, and be convertible to cash and private money.⁸ Digital euro accounts will be available to the public through payment service providers and its basic features will be provided to end users free of charge.

Despite the progress, several design features of the digital euro are still unclear, see Table 1. Notably, the holding limit – i.e. the maximum amount of digital euro users can hold has not been defined nor the mechanisms for its adjustment. The ECB can also adopt complementary measures to limit the use of the digital euro as a store of value. The choice of limits to the use of the digital euro will significantly influence its impact on financial stability, consumers, and the wider economy.

⁸ Private money refers to any form not issued by a central bank (e.g. money issued by commercial banks, payment providers, or other private entities). Private money includes holdings in commercial banks' deposits.

Table 1
Expected characteristics and design features of the digital euro

DIMENSION	WHAT WE KNOW	WHAT IS UNCLEAR
Access	<ul style="list-style-type: none"> Available to euro area residents and non-resident citizens. Merchants in the euro area must accept digital euro. Merchants, including those outside the euro area. 	
Onboarding	<ul style="list-style-type: none"> Like opening a non-digital euro payment account. Users can link a bank account to their digital euro account. 	
Use cases	<ul style="list-style-type: none"> P2P payments: contactless and QR code or alias/proxy.⁹ E-commerce: QR code and alias/proxy. In-store payments: contactless and QR code. Offline feature available in low-value proximity payments.¹⁰ Business to business use case (Industry 4.0, Web3) 	<ul style="list-style-type: none"> What transaction limit will be set for offline payments. What features will come in the first release. Why business-to-business use cases are included in the legislative proposal whilst the ECB project deprioritises those.
Payment services	<ul style="list-style-type: none"> Basic services: open account, check balances, make, and receive payments, non-automated funding/defunding. Intermediaries can provide other services. 	<ul style="list-style-type: none"> Whether basic services be available for free without any limit in the number of iterations (e.g. per day/week/month)?
Distribution	<ul style="list-style-type: none"> Credit institutions must distribute digital euro services. All PSPs must distribute the digital euro via the ECB app and have the option to offer an additional proprietary solution. PSPs authorised in the EU can provide digital euro services.¹¹ 	
Limits to use as a store of value	<ul style="list-style-type: none"> No interest in digital euro holdings. Holding limits may be defined by the ECB. Possibly other limits may apply (set by the ECB). 	<ul style="list-style-type: none"> What holding limit the ECB will set. What other instruments will limit the use of the digital euro within the basic use. Why the application of holding limits is optional in the draft regulation. How the overall limit will be enforced in practice across more than one account and/or in case of accounts held by more than one person and across offline holdings not accessible for the PSPs beyond the withdrawal/deposit transaction.
Funding and Defunding	<ul style="list-style-type: none"> Through non-digital euro payment accounts, manual or automatic ("waterfall" and "reverse waterfall" features¹²). Through euro banknotes/coins. 	
Fees	<ul style="list-style-type: none"> Basic services free of charge for consumers (end users) Other (value-added) services can have fees. Regulated prices for inter-PSP fees and merchant service charges related to digital euro-acquiring services. 	<ul style="list-style-type: none"> Whether fees can apply for automatic funding/defunding. How prices will be determined and enforced.

Note: This summary translates our best understanding of (i) the European Commission's proposed rules and functioning for the digital euro and (ii) the ECB's stated intentions on the design of the digital euro.

Source: Copenhagen Economics, based on information published by the ECB and the European Commission.

⁹ An alias/proxy is an easily memorable, unique identifier (e.g. mobile phone number) that is linked to the technical identifier of a payment account number (e.g. IBAN) or a payment card (e.g. PAN) – ECB, Third progress report.

¹⁰ Digital euro payments/use in the absence of connectivity, where transactions are settled offline (i.e. with payer and payee in physical proximity). The necessary digital euro holdings must be preloaded on user devices before losing network access.

¹¹ E.g. credit institutions, electronic money institutions and payment institutions.

¹² The waterfall feature lets a user receive payments that exceed the digital euro holding limit, with the excess automatically transferred to a non-digital euro account. The reverse waterfall enables users to make payments larger than their digital euro holdings by automatically sourcing the needed funds from a non-digital euro account.

1.2 OBJECTIVES OF THE DIGITAL EURO

An assessment of the digital euro requires an understanding of its objectives and intended benefits. The ECB and the European Commission have been key stakeholders in advancing the digital euro.¹³ Their support for the initiative provides the starting point for a common understanding of the intended benefits.

There is no one agreed definition of the objectives of the digital euro. Instead, these objectives have both developed over time, and differ between the ECB and the European Commission. Still, considering the overlap between the ECB's and the European Commission's perspectives, the main objectives of the digital euro – simultaneously viewed and its intended benefits – can be summarised as follows:

1. Ensure that the euro remains a monetary anchor and protect financial stability¹⁴

The digital euro is intended to ensure that the euro remains a monetary anchor by countering the declining use of central bank money. This claim, put forward by the ECB and the European Commission, rests on three arguments:

- Confidence in private money depends on the ability to convert it at par with central bank money.¹⁵
- A decline in the use of central bank money erodes people's trust in their ability to convert private money into central bank money and ultimately in the currency itself.
- Low confidence in the euro weakens financial stability¹⁶ and the transmission of monetary policy. In this context, the digital euro aims to offset the declining use of cash to keep the euro's role as a monetary anchor.

2. Promote innovation and competition in payments

The ECB and the European Commission argue that the digital euro will promote innovation and competition in payment systems for four reasons:

- The digital euro is an alternative to current payment options. Coupled with its universal access¹⁷ and price caps, the digital euro is intended to be the cheapest payment option available and exert competitive pressure on other services.

¹³ The ECB has developed a two-year investigation and is set to make a final decision. Moreover, it will be the ECB issuing and managing the digital euro. At the same time, the European Commission has advocated for introducing the digital euro and has been working to ensure regulatory and policy alignment within the EU framework.

¹⁴ According to the ECB, “*financial stability can be defined as a condition in which the financial system – which comprises financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances*” (<https://www.ecb.europa.eu/pub/financial-stability/html/index.en.html>). Financial stability encompasses financial institutions' ability to keep their solvency and liquidity in adverse economic conditions, function smoothly and keep continuous access to financial services.

¹⁵ See “Central bank digital currencies: defining the problems, designing the solutions”, speech by Fabio Panetta, member of the executive board of the ECB, New York, 18 February, 2022. https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220218_1~938e881b13.en.html; and https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220218_1~938e881b13.en.html

¹⁶ According to the ECB, “*financial stability can be defined as a condition in which the financial system – which comprises financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances*”. As such, a low confidence in the euro could make the euro more volatile to changes in the macroeconomic environment and thereby less resistant to shocks. For instance, in a worse economic environment, individuals and companies may have a higher tendency to exchange currencies with low confidence for other currencies or withdraw money from banks quickly at a large scale, causing a bank run.

¹⁷ The digital euro would be available to all citizens and businesses in the euro area.

- Users can switch their digital euro accounts among PSPs. Making switching easier further fosters competition.
- The digital euro will be a common platform compatible with private services. This is intended to facilitate the technical development of new services while simultaneously making it easier for PSPs to roll out their services across the euro area and gain scale. It also aims to allow smaller firms to offer more technologically advanced services at competitive prices.
- The digital euro will undermine the big tech and other potentially dominant providers' ability to leverage large customer bases and network effects to expand quickly. This will (i) curb the risk that non-European solutions and technologies dominate European payments and (ii) reduce the risk of market-abusive behaviour.

3. Promote financial inclusion

Several characteristics of the digital euro are claimed to help achieve this objective:

- Access to basic digital payment features will be universal and free for all users. The digital euro will be distributed by all PSPs and all euro area residents can open an account with any provider. Moreover, public entities should also distribute the digital euro to users that do not wish to onboard with a PSP.
- The digital euro design is claimed to cater to the needs of persons with disabilities, with limited digital skills, and older people.
- Users will not be required to have a non-digital euro payment account,¹⁸ meaning that it will be an option for people who wish to remain “unbanked”.

4. Strengthen the EU's strategic autonomy and monetary sovereignty

The digital euro aims to bolster the EU's strategic autonomy by providing a payment infrastructure that can withstand external disruptions and does not depend on foreign providers. It also serves as a backup during network outages. Moreover, issuing digital euro is intended to strengthen monetary sovereignty by enhancing the international status of the euro against other currencies, including existing and future CBDCs or private stablecoins issued by non-EU actors.

In Appendix A, we outline further details on the objectives of the digital euro by the ECB and the European Commission, as well as the development over time.

1.3 WHAT DETERMINES THE EFFECTS OF LAUNCHING A DIGITAL EURO?

In this Section, we establish a framework on which the effects of launching a digital euro depend. The framework considers three aspects. *First*, the objectives of the digital euro rely on certain inherent conditions. For the digital euro to be able to achieve its objectives, such conditions need to be valid and aligned with the current reality. We outline these conditions in 1.3.1. *Second*, the four main objectives of the digital euro present some inherent conflicts, both within and across the objectives. Such conflicts could limit the overall effectiveness of the digital euro in achieving its intended benefits. We outline these conflicts in 1.3.2. *Third*, the effects of a digital euro are highly dependent on the extent of its adoption. The adoption is in turn dependent on some of the key digital euro design features. We outline the key design features that will affect the adoption in 1.3.3.

¹⁸ However, some features require linking a non-digital payment to the digital euro account (e.g. waterfall mechanisms).

Given the focus of this report, we will only discuss objectives 1, 2 and 3, and not objective 4.¹⁹

1.3.1 Conditions that need to be true for the digital euro to reach its objectives

The objectives of the digital euro hinge on crucial conditions without which its intended benefits are unlikely to materialise.

Regarding the first objective of strengthening the euro's role as a monetary anchor and ensuring financial stability, the digital euro will only deliver benefits if there is a lack of trust in private money without it, and if the introduction of a digital euro does not harm financial stability.

Indeed, if people's trust in private money is not affected by how much they demand central bank money (including digital euro), it is hard to envisage how the digital euro will improve the role of the euro as a monetary anchor. Similarly, if the digital euro poses a risk to financial stability, it threatens the very objective it is trying to attain.

Regarding the second objective of promoting innovation and competition, the digital euro will only be beneficial if there is unsurmountable market fragmentation, insufficient competition, and if it delivers innovative services that would not otherwise be developed. If there is evidence that the market is increasingly competitive or that economic conditions are increasingly favourable for competition, it is unclear how the digital euro will make a difference.

Moreover, even if there is scope for the digital euro to improve competition and innovation in the market, it will occur only if it differentiates from existing solutions. It will otherwise replicate what is available in the market, without affecting competition nor delivering a clear added value to consumers.

Finally, the digital euro will only contribute to higher financial inclusion if it is easier to access and use than existing digital payment solutions or if people trust it more than other digital alternatives. If the digital euro is not easier to access and use than other existing digital services, it is difficult to envisage why it would contribute to more inclusion of people with disabilities and limited digital skills. Similarly, if the digital euro is not more trusted than other alternatives, it will not cater to the voluntarily unbanked population, especially to those who distrust the financial system.

1.3.2 Conflicts limiting the effectiveness of the digital euro

The key objectives of the digital euro partially rest on conflicting conditions, both within and across the objectives. Such conflicts can seriously limit the overall effectiveness of the digital euro in achieving its intended objectives. We identify the following conflicts:

- **Conflict 1:** *Increasing the demand for central bank money and maintaining financial stability (objective 1)*

¹⁹ Our analysis will be centred on the following objectives (1) Ensure that the euro stays a monetary anchor and protect financial stability; (2) Promote innovation and competition in payments; and (3) Promote financial inclusion. While all objectives warrant consideration from policymakers, objective 4 (Strengthen the EU's strategic autonomy and monetary sovereignty) does not directly relate to financial stability and market dynamics and is therefore not within the focus of our study.

Objective 1 includes an inherent trade-off as it simultaneously hinges on fostering demand (to strengthen the monetary anchor role of the euro) and limiting demand (to avoid hurting financial stability). According to the ECB, for a digital euro to remain a monetary anchor, there needs to be sufficient demand (and use) for central bank money. However, to protect financial stability, demand must be limited by holding limits and no remuneration to avoid crowding out deposits and payment activities that would harm financial stability.

- **Conflict 2:** *Improving competition and maintaining financial stability (objectives 1 and 2)*

Similarly, improving the competitive situation in the payment market hinges on significant demand for a digital euro, if it is to have any effect on the competitive landscape. At the same time, the larger the adoption of the digital euro, the larger is the risk that financial stability is reduced.

- **Conflict 3:** *Increasing the demand for central bank money and improving financial inclusion (objectives 1 and 3)*

With the current design features, including a zero-interest rate, the digital euro is mostly similar to cash (i.e. central bank money), rather than private money. Given this, it is possible that consumers would not consider the digital euro a substitute to private money (e.g. bank deposits) but rather to cash. As such, it is claimed to contribute to financial inclusion because it caters to people who e.g. wish to remain unbanked or who find current digital solutions too complex. At the same time, as cash constitutes central bank money, replacing cash with digital euro would not influence the demand for central bank money as it would simply replace one form of central bank money with another.

1.3.3 Key design features affecting the adoption of the digital euro

The effects of launching a digital euro, both in terms of the ability to realise the intended objectives and the costs/risks associated with its launch, are highly dependent on its level of adoption. The level of adoption is thus a key parameter across the objectives of the digital euro and different levels of adoption will entail varying net benefits.

With the current design features, the level of adoption is *uncertain*. In a first step, the adoption level is largely limited by the **holding limit**, i.e. the maximum amount of digital euro users can hold. The holding limit thus sets an upper bound for its take-up.²⁰ Consequently, different ranges of adoption of the digital euro will exist depending on the holding limit. The ECB is yet to propose a holding limit for the digital euro.

In a second step, the actual take-up (between 0-100% of the holding limit), will depend on the **demand for digital euro**. The extent to which consumers will utilise a digital euro depends on how desirable it is relative to holding cash or deposits in the three functions *store of value*, as an *investment* and as a means of *payment*. High uptake is to be expected if bank deposits are seen as risky relative to a digital euro (store of value), if remuneration is high relative to bank deposits

²⁰ We approach the adoption of the digital euro as a stock, where the level of adoption translates to the amount of digital euro in held by users and is therefore restricted by the holding limit. Since design features allow for payments of values above the holding limit it cannot be excluded that the stock of digital euros at any point in time is above that (including both users' existing holdings as well as the amount of digital euros being transacted). We consider that the former effect is unlikely to be material in the first stage of the introduction of the digital euro. However, its effects become more significant as the digital euro matures and its use as a payment wallet increases.

(investment), or if the CBDC offers a more effective or less costly means of procuring goods and services (payment). This, in turn, depends on digital euro design features such as the remuneration (interest rate) of digital euro accounts, the convenience and price of value-added services, the prevailing monetary environment at the time of its introduction, and the intrinsic personal characteristics of the different users.²¹ All of these factors cast uncertainty on the demand for the digital euro. While the current proposal from the European Commission proposes a zero-interest rate, many other factors are still uncertain.

Given these uncertainties, our quantitative analysis in the following chapter will consider multiple scenarios for the adoption of the digital euro. The different scenarios will encompass different combinations of *(i)* holding limit, and *(ii)* demand for digital euro (set as a percentage of 0-100% of the holding limit).

²¹ See e.g. Bijlsma, M., van der Cruysen, C., Jonker, N., & Reijerink, J. (2021). What triggers consumer adoption of CBDC?.

CHAPTER 2

THE DIGITAL EURO AND FINANCIAL STABILITY

As apparent from *Objective 1*, safeguarding the euro as the monetary anchor and ensuring financial stability is among the main aims of the digital euro. This requires in part that the trust in the anchoring ability of the euro is threatened and may be restored by a digital euro, and in part that the launch of a digital euro itself does not threaten financial stability. While the ECB and the European Commission recognise that the adoption of the digital euro poses a risk to financial stability,²² the magnitude of such a risk depends on the design features of the digital euro, as there are instruments to limit the use of the digital euro as a store of value such as zero remuneration of the digital euro, (currently unknown) holding limits, and possibly other limitations to be determined by the ECB.²³

This chapter focuses on evaluating the effects that a digital euro could have on financial stability, drawing upon a bespoke balance sheet model across a large sample of euro area banks, relying on both public data and proprietary data collected for the occasion from members of the EBF.

Commercial banks are instrumental in ensuring the stability of the financial system, as they are acting as the primary intermediaries. As explained in Section 1.3, this bank intermediation may be threatened by the launch of a (broadly adopted) digital euro, as it draws funds away from the current financial system. This requires commercial banks to adjust their balance sheets.

With this in mind, we first explain the close link between financial stability and commercial banks and their performance, and what determines commercial banks' ability to maintain financial stability (2.1). Second, we, in further detail, explain the mechanisms through which the launch of a digital euro could impact financial stability via commercial banks (2.2). Third, we describe key considerations in our modelling scenario design (2.3). Finally, we estimate the magnitude of such an impact in the form of how much commercial banks' operations would be affected due to an outflow of commercial bank deposits from their balance sheets (2.4), including under various financial environments and circumstances.

2.1 FINANCIAL STABILITY AND THE ROLE OF COMMERCIAL BANKS

In this report, we define financial stability as the resilience of the financial system to absorb shocks and settle financial imbalances through efficient capital allocation, even in times of idiosyncratic or systemwide financial stress.²⁴

Financial stability thus hinges largely on the resilience of commercial banks. As highlighted by ECB, "*financial stability depends on the shock-absorption capacity of the financial system [...*

²² See e.g. European Commission (2023b), Annex 11 and (ii) *Central bank digital currency and bank intermediation* (ECB, 2022).

²³ See article 16 (Limits to the use of the digital euro as a store of value) of the proposed regulation on the establishment of the digital euro.

²⁴ This broadly aligns with the definition posed by ECB, see e.g. <https://www.ecb.europa.eu/pub/financial-stability/html/index.en.html>.

*and especially] banks, which operate at the core of the system”.*²⁵ When the conditions under which commercial banks operate are changed, so is the degree of financial stability.

For this reason, commercial banks are expected to continuously monitor and manage risks to ensure stability of the financial system, as well as their individual exposure to risk. The importance of this was underlined recently during the financial turmoil observed in the financial systems of American and Swiss banks, where banks either collapsed or were on the verge of doing so, leading to interventions into the respective financial systems.²⁶

The ability of commercial banks to maintain financial stability through uninterrupted operations is affected by both internal and external factors. On the internal side, this includes measures such as liquidity management, profitability, and asset quality. On the external side, factors such as actions by the central bank and consumers, as well as the macroeconomic environment, must be considered. Due to the reliance on banks as intermediaries, these factors are all interlinked.

With the introduction of a digital euro, an external factor as fundamental as the nature of central bank money will change. This change will impact commercial banks’ internal measures and force the banks to adjust their operations, which in turn will impact their resilience. This is how the introduction of a digital euro evidently will impact financial stability. The remainder of this chapter examines how and to which extent the stability of the financial system is impacted.

2.2 POSSIBLE ADJUSTMENT CHANNELS FOR BANKS FOLLOWING THE INTRODUCTION OF A DIGITAL EURO

As pointed out by numerous researchers, including the ECB (2021) and BIS (2021), the introduction of a digital euro will lead to an outflow of deposits from commercial banks. This is an inevitable outcome of the public adopting the digital euro and funding their new digital euro wallets.

The impact of such an outflow can be illustrated as in Figure 1, which shows a stylized version of the balance sheets among the public, an intermediary commercial bank, and a central bank. Given the launch of a digital euro, households reshuffle their asset side to hold some digital euro. This decreases liabilities with the commercial bank, while increasing liabilities in the central bank. This immediate imbalance must be settled, which may take one of several forms.

One way to do this is for commercial banks to reduce the reserves they hold with central banks one-to-one with the lost deposits. This would simultaneously decrease the size of the asset side of commercial banks (to match the decreased liability side) and offset the increase on the liability side of the central bank balance sheet. These adjustments to the balance sheets of the financial system are shown in Figure 1.

²⁵ See ECB (2023): Financial Stability Review, May 2023. The full quote reads: “Recent stresses in the US and Swiss banking sectors have served as a timely reminder of just how much the preservation of financial stability depends on the shock-absorption capacity of the financial system. This is especially true for banks, which operate at the core of the system.”

²⁶ See, e.g. ECB Financial Stability Review, May 2023 for a view on the importance of euro area bank resilience for containing these financial risks.

Figure 1
Stylised balance sheet of the financial system

Other sectors incl. households		Commercial banks		Central banks	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Generic assets	Loans	Reserves ↓	Deposits ↓	Cash	Reserves ↓
Deposits ↓		Loans	Loans from central bank	Loans to banks	Digital Euro deposits ↑
Digital Euro ↑			Wholesale funding		

Note: The figure shows a simplified version of the financial system, and how the launch of a digital euro may impact it. Arrows indicate the financial flows induced by the digital euro. In this scenario, commercial banks draw down reserves, which decreases their resilience, requiring further adjustments.

Source: Copenhagen Economics based on ECB (2022), Bank of England (2023).

Such an adjustment would inevitably lead to a decrease in the degree of financial stability, as cash reserves are a fundamental part of the safety net banks rely on to absorb shocks. For the same reason, regulation is in place for minimum levels of reserve holdings, as well as minimum liquidity levels, which reserves also play a vital role in. Indeed, for several banks, relying on a drawdown of reserves would breach regulatory liquidity requirements, as shown by researchers at the ECB²⁷.

Considering the expectation of commercial banks to maintain their ability to absorb shocks and ensure financial stability, our modelling assumes a Liquidity Coverage Ratio (LCR) neutral²⁸ implementation of a digital euro, following similar (theoretical) modelling by e.g. Bank of International Settlements (BIS)²⁹. This implies that the so-called managerial buffer – the excess buffer that banks hold above a regulatory threshold – is assumed to be chosen to optimize banks' ability to absorb shocks given the current economic environment and that this level of financial safeguarding is maintained after the launch of a digital euro. In Appendix B, we have expanded on this theme, providing a more detailed argumentation for the choice of the LCR as the relevant measure in ensuring financial stability.

Ultimately, preserving financial stability can thus not rely on drawing down reserves alone, and banks are thus left with two choices: Decreasing their stock of assets or increasing their (long-term) funding base. Both have potential impacts on the financial system.

Reducing the stock of assets may be a sensible adjustment channel for individual banks, as it allows banks to rebalance their balance sheets while managing liquidity risks. However, on a systemic level, if banks choose to dispose of or reduce lending, this removes a deposit elsewhere in

²⁷ See ECB (2023b): The study shows that a not insignificant number of banks will breach LCR or NSFR requirements if drawing down reserves to combat deposit outflow.

²⁸ The Liquidity Coverage Ratio is a measure of high quality liquid assets (HQLA) compared to the estimated net outflow during a 30-day stress period. LCR-neutrality implies that the current LCR is maintained after the implementation of a digital euro and subsequent outflow of deposits. Deposit outflows leads to a one-to-one decrease in HQLA, but this is in part mitigated by a decrease in the estimated net outflow. Hence, the funding need following a deposit outflow is slightly smaller than the deposit outflow itself. See Appendix C for details.

²⁹ BIS (2021) See Central bank digital currencies: financial stability implications. September 2021.

the financial system, potentially moving the problem to a different bank. In severe cases, such dynamics tighten credit availability, make banks less able to absorb shocks, and may ultimately decrease financial stability.

Alternatively, replacing lost deposits with increased wholesale funding may be a viable option for banks, but with a different set of trade-offs. Depending on circumstances, banks may choose between a multitude of funding instruments, but long-term debt issuance is likely to be the steady state choice given the need to maintain liquidity positions. To the extent banks have collateral available, this may take the form of covered instruments, but at the expense of increased encumbrance ratios, which further threatens the resilience of banks, and incentivises the issuance of unsecured, senior debt.

Durable (unsecured) wholesale funding is more expensive than the lost deposit funding, impacting the resilience of banks. Further, wholesale markets may be unable to accommodate the required reallocation of capital, the risk of which is amplified by the fact that the impact of a digital euro will take form as a system-wide shock, in which most, if not all, banks will be impacted simultaneously and in a similar manner. Finally, for a range of smaller banks, the option of unsecured wholesale funding may be out of the question entirely.

Ultimately, banks will likely react through a mix of reducing assets and increasing their funding base, dependent on the relative prices of doing so, the availability of credit and collateral and the severity of deposit outflows. In normal times, the optimal strategy will favour increased funding, but this may not be possible under financial stress, necessitating the liquidation of assets.

These effects and risks are broadly recognised. To contain the impact on financial stability from these changes to the financial system, the ECB suggests limiting the deposit outflow to enforce an upper limit on digital euro holdings. This caps the potential deposit outflow but is equipped with a set of limitations, as described in Box 1 below.

Box 1 Holding limits as a mechanism to contain financial stability risks

Initially proposed as one of several tools to regulate the quantity of digital euro in circulation, and thus contain financial stability risks, a simple holding limit has increasingly emerged as the favoured option. In essence, a personal holding limit defines an upper boundary on the amount of digital euro in circulation based on the eligible population within the euro area. This approach has several advantages, including simplicity and transparency, but it also faces certain practical challenges.

One significant concern is that once set by the ECB, the holding limit might face future adjustments. It is essential that this limit remains predictably stable, allowing banks to internalize and mitigate any adverse effects from deposit outflows. Moreover, external pressures, including political influences, should not dictate changes to this limit. Any rules allowing for the increase of holding limits at short notice will by itself impose costs and uncertainty on the banking system, leading to banks holding higher levels of precautionary capital. While simple in theory, the sparse experience available shows that predictability is not necessarily given: the Bahamian Sand Dollar, one of the only currently operational CBDCs, was launched with a B\$5,000 limit, which was later increased to B\$8,000.

In addition, setting a single, optimal holding limit across the euro area may prove difficult or even infeasible. Given disparities in purchasing power and financial conditions for households in different jurisdictions of the euro area, a limit suitable in one country area might lead to over-adoption of the digital euro in another, and vice versa.

Finally, ensuring absolute compliance with the holding cap on an individual level will have to rely on some sort of central register of digital euro holdings. While different technical solutions may solve this issue, it may, in practice, raise potentially perceived concerns regarding privacy and anonymity and thus be at odds with the digital euro objective of improving financial inclusion. Alternatively, an implementation absent a central register will introduce the risk for the holding limit not serving as an effective upper bound.

In Section 2.4, we estimate the impact of each adjustment channel under a range of scenarios of digital euro demand and holding limits. The scenarios we consider are described next.

2.3 RELEVANT FACTORS TO CONSIDER WHEN ASSESSING THE IMPACT OF A DIGITAL EURO

The conditions around the launch of a new digital currency are inherently uncertain. Our modelling acknowledges this by being based on a range of scenarios, and by encompassing heterogeneity among banks, countries, and consumers. There are three important factors to consider in this regard:

- Design choices of the digital euro and their impact on demand
- Macroeconomic environment, including variations in impact for periods of stress versus stability in financial markets
- Bank heterogeneity with respect to business models and funding composition

Ultimately, we collapse these into a set of modelling scenarios encompassing demand and holding limits. We apply these scenarios to a bottom-up balance sheet model based on granular bank-level data to encompass the differences between individual banks. This Section briefly discusses each of the three factors listed above as well as the importance of considering severe scenarios and their non-symmetrical impact.

The design features of a digital euro will ultimately decide the demand. As discussed in Chapter 1, this includes the chosen holding limit and demand. Demand itself will depend on a range of design choices, among others, on remuneration, fee structure, ease-of-use, and offline capabilities. Each of these factors – and any other design choice – will impact the utilization of the digital euro with impacts that are difficult to predict.

Rather than meticulously evaluating the impact of each design feature, we present our results across a range of demand from 20% to 100% of the holding limit, as well as across various holding limits of the digital euro, across the euro area.

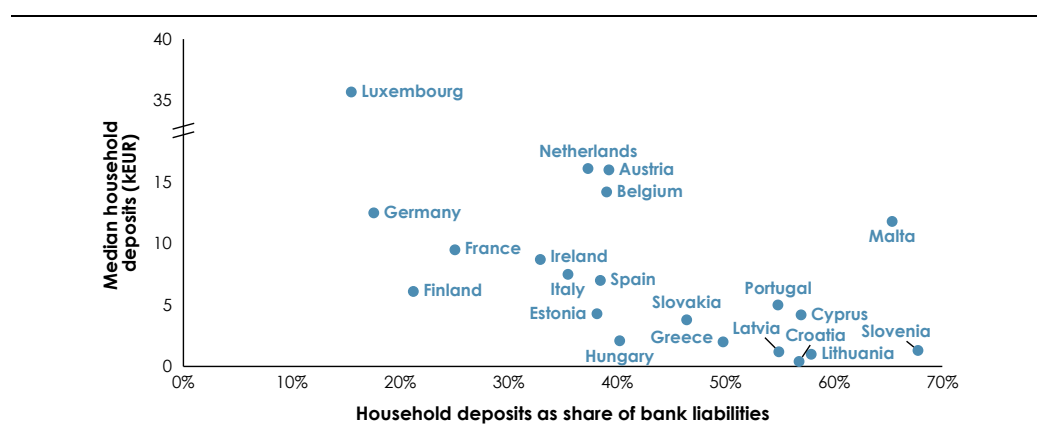
The macroeconomic environment is important as a determinant of the impact of deposit outflows on financial stability as it limits the scope of commercial banks to adjust and impacts their decision-making. In times of normal activity on financial markets, banks can access interbank markets and wholesale funding at stable pricing. In periods of financial stress, this window tightens and wholesale funding either increases in price or evaporates completely. Additionally, times of financial stress may lead to a rapid outflow of deposits to a digital euro if it is perceived as a safe haven.³⁰

We capture this impact by considering extreme scenarios of uptake as well as presenting results over varying degrees of accessible wholesale funding and the associated funding cost.

Finally, *bank heterogeneity leads to diverse outcomes* across regions, countries, and types of banks. This is one aspect that seems to be underrepresented in the current literature, where studies currently assume symmetrical effects across banks, see e.g. ECB (2023). As evident from Figure 2 below, countries and banks vary greatly in funding composition and levels and dispersion of household deposits, leading to varying effects. These heterogeneous effects are considered at every stage of our analysis. See Appendix B for further details of the modelling exercise.

³⁰ See, e.g. Bank of England (2023) for a further discussion on the role of a CBDC under financial stresses.

Figure 2
Availability of and reliance on household deposits vary greatly
 Median deposits (kEUR) and household deposits as a share of bank liabilities (%)



Note: Deposits are self-reported in the Household Finance and Consumption Survey and differ from those used in our estimation. Note that Y-axis is broken.

Source: ECB Household Finance and Consumption Survey, Wave 2021 (2023) and EBA Risk Dashboard (June 2022)

2.3.1 Heterogeneity and the importance of worst-case scenarios

The current body of research, notably work by the ECB and the Joint Research Centre (JRC) of the European Commission³¹, contains a series of assumptions that might downplay the risks of adverse outcomes following the launch of a digital euro. This includes assumed uniform effects across markets and deposit outflows, relying on aggregate level impact analysis, or by assuming that the shift from cash to a digital euro would naturally contain the deposit outflows.

It is worth noting that uniform deposit outflows across all sectors are improbable. As highlighted in the previous section, financial markets and the dispersion of household deposits differ significantly among countries within the euro area. Additionally, business models of banks within countries differ. Overlooking these variances risks misrepresenting the potential impacts, which in turn could undermine financial stability.

We contend that simply ensuring resilience of the average commercial banks against potential shocks from the introduction of the digital euro is not enough. Financial stability could be harmed in the event of the disruption of a few banks given the integration of the financial system in the euro area.

While consumers may indeed shift from cash to the digital euro, several compelling factors suggest we should analyse scenarios where uptake is much higher than anticipated:

- The digital euro might witness significant, higher-than-expected traction, e.g. due to the availability of digital peer-to-peer transfers.
- In a negative interest rate environment, a nominal storage of value could become appealing.

³¹ See e.g. ECB (2023) and JRC (2023), which are among the few studies based on empirical data rather than theory.

- Amid financial turbulence, a central bank-issued currency might be perceived as a bastion of safety, fostering rapid inflows notably if associated with lack of confidence of deposit guarantee schemes.

Furthermore, as pointed out by e.g. the Bank of England,³² the existence of a CBDC could increase the speed and magnitude of bank runs due to its facilitation of swift, safe transfers to a central bank. If the initial adoption of the digital euro is moderate and leads to many dormant digital euro wallets, it could cause sudden shifts in deposits during economic distress.³³ Uncertainties surrounding the implementation of holding limits when (i) users have several accounts and (ii) the same account is shared by more than one person can increase the potential for sudden shifts in deposits, depending on technical implementation. In the context of bank runs, it is important to recognise that a bank run towards digital euro is a compounding risk, materialising alongside any other risk factor.

For these reasons, banks cannot rely on transformation of cash to digital euro to keep deposit outflows in check, and worst-case scenarios must be considered as part of the analysis. For financial stability to remain unchanged, commercial banks would have to internalise this additional risk to their existing risk management. For this reason, our 100% uptake scenario relies on an implicit assumption of no substitution of cash.³⁴

2.4 DEPOSIT OUTFLOWS AND BANK ADJUSTMENTS

In this Section, we estimate the potential implications of introducing a digital euro, including its impact during financial stress periods. We start by estimating the deposit outflow that commercial banks could experience due to an introduction of a digital euro (2.4.1) and how this effect could differ across banks (2.4.2). We then explain what this means in terms of funding needs on an aggregate basis (2.4.3), as well as how this could impact individual banks (2.4.4). Subsequently, we show the effect that such refinancing could have on banks' net interest income (2.4.5) and conclude what the results throughout this Section imply for financial stability (2.4.6).

Our analysis is anchored on a bespoke deposit outflow model and an adapted version of our Balance Sheet Model. A comprehensive breakdown of both models is available in Appendix B.

2.4.1 Aggregate deposit outflows from commercial banks

The estimated deposit outflows range from virtually nothing (in the case of a low uptake of digital euro) to 739 billion euro in the most severe scenario, as seen from panel A of Figure 3 below. This corresponds to roughly 20 times the largest observed net outflow of household deposits over a calendar month in the euro area³⁵, and to just shy of 10% of all household deposits in commercial banks.

³² See the consultation paper for the potential launch of a digital pound, Bank of England (2023).

³³ The recent collapses of SVB and Signature Bank in the US provide an instructive example of the critical risks posed by rapid bank runs during periods of financial turmoil. The deposit outflow reached 25% of deposits in one day for SVB and 20% of deposits outflow for Signature Bank in a matter of hours, see Rose (2023). A retail CBDC may further add to the ease and speed of further outflows.

³⁴ Implicitly, any substitution of cash can be interpreted into lower-uptake scenarios we provide estimations for.

³⁵ In January 2023, euro area households withdrew roughly 37 billion euro from monetary financial institutions, which was the largest monthly net withdrawal. See ECB: https://sdw.ecb.europa.eu/quickview.do?SE-RIES_KEY=117.BSI.M.U2.N.A.L20.A.4.U2.2250.Z01.E

Measured in terms of bank liabilities, the possible outflow amounts to approximately 3% of all commercial bank liabilities within the euro area system. This signifies a notable reduction in the banking balance sheet. A detailed representation of impacts across various scenarios can be seen in Panel B of Figure 3.

These results largely align with prior studies, including estimates given 3,000 euro holding limits from the JRC (2023), which finds a deposit outflow of roughly 9% of total household deposits, compared to our estimate of about 10%.

Figure 3 Estimated deposit outflow following the launch of a digital euro

(A) **Aggregate deposit outflow**

Deposit outflow in billion euro

(B) **Displaced liabilities**

Deposit outflows as share of bank liabilities (%)

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	29	58	112	165	0.1%	0.2%	0.4%	0.6%	
40%	58	112	218	317	0.2%	0.4%	0.8%	1.2%	
60%	85	165	317	464	0.3%	0.6%	1.2%	1.8%	
80%	112	218	416	603	0.4%	0.8%	1.6%	2.3%	
100%	139	268	511	739	0.5%	1.0%	2.0%	2.9%	

Note: Estimates cover aggregate outflows and liabilities across banks within the euro area.

Source: Copenhagen Economics Balance Sheet Model

2.4.2 Differences within deposit outflows across banks

While the overall deposit outflow for the euro area commercial banking sector lies between 0.1% and 2.9% of liabilities, the variance is particularly notable when considering individual banks.

Figure 4 illustrates the deposit outflow as a proportion of total liabilities for commercial banks in the euro area, focusing on the 10th and 90th percentiles. Banks less reliant on household deposits make up the first decile and hence see a lower impact, with outflows equating to 0-0.5% of total liabilities for the least affected decile.

On the other end, over ten percent of banks could see household deposit outflows reaching at least 8.7% of liabilities in the most severe cases. These affected banks typically share two distinct traits: a higher dependence on household deposits for funding and customers with smaller deposit holdings. Consequently, a larger portion of their deposit base could be affected by the introduction of a digital euro.³⁶ For these reasons, the highly impacted banks generally have similar characteristics, and tend to be clustered geographically. This includes in countries such as Slovenia, Latvia, and Greece.

³⁶ When the absolute level of deposits is lower across the household population, the holding limit is less binding, and households are thus able to convert a larger share of their household deposits into digital euro.

Figure 4 Magnitude of deposit outflows varies considerably

(A) **Marginally impacted institutions**

Deposit outflows as share of bank liabilities
(10th percentile)

(B) **Highly impacted institutions**

Deposit outflows as share of bank liabilities
(90th percentile)

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	0.0%	0.0%	0.1%	0.1%	20%	0.3%	0.7%	1.3%	1.9%
40%	0.0%	0.1%	0.2%	0.2%	40%	0.7%	1.3%	2.5%	3.7%
60%	0.1%	0.1%	0.2%	0.3%	60%	1.0%	1.9%	3.7%	5.4%
80%	0.1%	0.2%	0.3%	0.4%	80%	1.3%	2.5%	4.8%	7.0%
100%	0.1%	0.2%	0.4%	0.5%	100%	1.6%	3.1%	5.9%	8.7%

Note: Estimates represent the deposit outflow over liabilities for each individual bank. Banks without household deposits are not considered.

Source: Copenhagen Economics Balance Sheet Model

2.4.3 Aggregate funding needs for commercial banks

Given the outflows of deposits, commercial banks need to adjust their balance sheets to ensure adequate buffers. As previously discussed, this will likely be achieved through increased long-term wholesale funding³⁷ to maintain a sufficient level of high-quality liquid assets (HQLA) without further reducing liquidity, which short-term financing would.

Panel A of Figure 5 displays the aggregate additional long-term wholesale funding required to restore the LCR to the level prior to the deposit outflow. The funding need is less than the deposit outflow due to the transition from deposits to long-term funding, resulting in a reduced estimated net outflow (LCR denominator) and consequently, a decreased required level of HQLA level (LCR numerator). See Appendix C for details.

In the severe scenario, the additional funding need amounts to just shy of 700 billion euro. Compared to the existing stock of debt securities issued by euro area banks, this implies an expansion of the bank-issued debt securities market of around 20%, as shown in Panel B of Figure 5.

³⁷ Keeping the implementation LCR-neutral requires reestablishing adequate HQLA without decreasing liquidity. This follows BIS (2021) and is chosen as long-term wholesale funding (such as senior preferred bonds) increases the funding base without harming short term liquidity. See Appendix C for further discussion of relevant regulatory ratios.

Figure 5 Required funding needs for commercial banks**(A) Additional long-term funding need**

Billion euro

(B) Expansion of debt securities required

Funding need as share of existing stock of bank-issued debt securities

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	27	53	103	152	20%	0.8%	1.6%	3.1%	4.5%
40%	53	103	201	292	40%	1.6%	3.1%	6.0%	8.7%
60%	78	152	292	427	60%	2.3%	4.5%	8.7%	12.7%
80%	103	201	383	556	80%	3.1%	6.0%	11.4%	16.6%
100%	128	247	471	681	100%	3.8%	7.4%	14.1%	20.3%

Note: Estimates cover the required funding need in an LCR-neutral adjustment to the implementation of a digital euro. Panel A is measured in billion EUR, while Panel B shows the funding need relative to the existing stock of debt securities issued by banks.

Source: Copenhagen Economics Balance Sheet Model

2.4.4 Differences within funding needs across banks

To assess the amount of long-term wholesale funding required on an individual bank-level, we measure the funding need to the existing stock of issued debt in bank liabilities. Due to differences in business models across banks, we find that the relative amount by which debt issuance must increase varies greatly across the euro area banks. For the least affected banks, shown in Panel A in Figure 6 below, the additional debt issuance needed would not be above roughly 4% of their current debt issuance even in the most severe scenario.

For the most heavily affected banks, however, even moderate uptake scenarios could be difficult to accommodate by purely increasing debt issuance. As shown in Panel B of Figure 6 below, a holding limit of 1,000 euro may easily require above ten percent of banks to more than double their current level of debt issuance, while the most severe scenario implies a five-fold increase in debt issuance, which would require substantial changes to the structure of the bank. Given the magnitude of the required changes for some banks³⁸, this introduces extraordinary risks in times of financial stress, where scarcity of funding increases. The magnitude of funding appears so large and unevenly spread that some banks will be unable to obtain funding.

³⁸ For our analysis, we rely on the size criteria of the SSM Regulation size criteria and define all banks with assets of less than 30 bn. Euro as “smaller banks”, as compared to larger (systemic significant) banks. The impact on banks do not critically depend on the determined size, however, but smaller banks are on average more exposed to deposit outflows.

Figure 6 Some banks face substantial increases in debt issuance

(A) **Marginally impacted institutions**

Required increase in debt issuance
(10th percentile)

(B) **Highly impacted institutions**

Required increase in debt issuance
(90th percentile)

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	0.2%	0.3%	0.6%	0.9%	20%	16%	31%	59%	88%
40%	0.3%	0.6%	1.2%	1.8%	40%	31%	59%	116%	169%
60%	0.5%	0.9%	1.8%	2.6%	60%	45%	88%	169%	244%
80%	0.6%	1.2%	2.3%	3.4%	80%	59%	116%	219%	320%
100%	0.8%	1.5%	2.9%	4.2%	100%	73%	144%	269%	395%

Note: Estimates show the funding need relative to the existing stock of debt securities issued by each individual bank. Banks without household deposits, or without existing debt security issuance, are removed.

Source: Copenhagen Economics Balance Sheet Model

2.4.5 Effects on banks' costs and net interest income levels

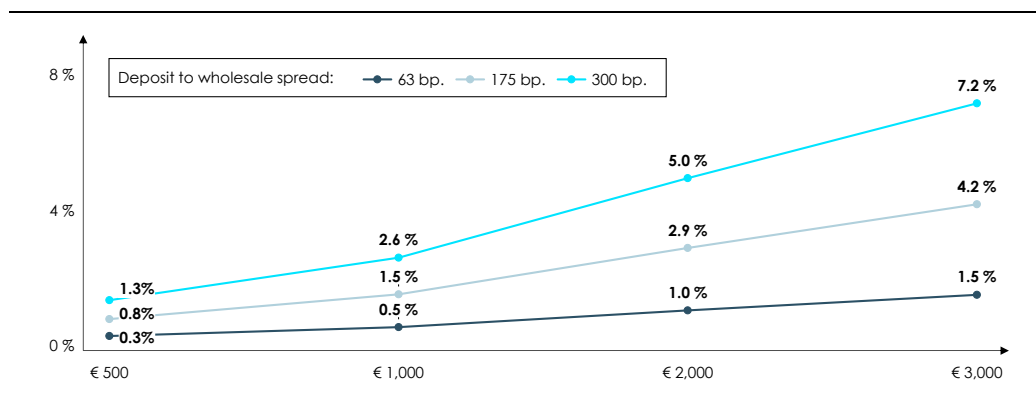
As discussed previously, relying on market funding to replace displaced deposits implies an increase in cost of funding. In the following, we rely on parameter estimates used by BIS (2021) for the average spread between retail deposits and long-term wholesale funding: 63 basis points under benign conditions, and 300 basis points under unfavourable financial circumstances. In addition, we consider a mid-level estimate of 175 basis points.

Given our estimated deposit outflow presented above, a holding limit of 3,000 euro implies a decrease in NII of 7.2% across the euro zone commercial banking market, assuming a 300 basis points spread between household deposits and long-term wholesale funding. The lower band estimate given a funding spread of 65 basis points is roughly a decrease in the NII of 1.5%.

It is important to note that the outflow of deposits do not at the same time reduce the costs that banks have in obtaining the deposits in terms of branch networks, IT systems or employee compensation. These are largely fixed short term, such that the impact on net interest income of a sudden deposit outflow can largely be measured by the difference in rates, which will exceed the spread reported by BIS of 300 basis points. Even in the long term, it is not clear that banks costs will be reduced significantly as deposits shift to central banks: customers are not leaving the banks, the central banks will just be other banks in which they have a deposit for the wide majority of customers. Consequently, largely unchanged infrastructure costs will have to be borne by a reduced deposit base.

Figure 7
NII decrease under various financing cost scenarios

Average decrease in NII (%)



Note: Assumes full adjustment on liability side of banks. The scenarios are based 100% uptake, and hence the most severe scenario for each holding limit, why results should be interpreted as upper bounds. Current net interest income is based on profit and loss statements from first half of 2022. The X-axis is not continuous, but rather shows the impact across the four holding limits considered in this study.

Source: Copenhagen Economics Balance Sheet Model

If the cost spread between wholesale funding and household deposit funding exceeds the 300 basis points scenario, banks do incur additional costs. This applies either if financial market environments develop unfavourably, or to the extent individual banks are unable to obtain funding at this rate. This may be the case for smaller banks who have limited access to debt markets. As shown in Figure 8 below, every additional 100 basis point increase in funding spread to the overall market results in an additional reduction in the NII of 2.4% of the initial level, in a 3,000 euro holding limit scenario with full uptake.

Figure 8
NII sensitivity to funding spread given deposit outflow

Decrease in average NII (%) per 100 bp. increase in funding spread

Holding limit: €500	Holding limit: €1,000	Holding limit: €2,000	Holding limit: €3,000
-0.45%	-0.87%	-1.65%	-2.39%

Note: Assumes full adjustment on liability side of banks. The scenarios are based 100% uptake, and hence the most severe scenario for each holding limit. Estimated effects are linear.

Source: Copenhagen Economics Balance Sheet Model

2.4.6 Deposit outflow and NII impact among smaller banks

In our sample, we find that the impact on smaller banks is disproportionately large. Our model encompasses granular data on 13 explicitly modelled banks³⁹ that fall below the size criteria in the SSM Framework Regulation of 30 billion euro of assets.⁴⁰ These 13 banks are clustered in a few countries with small economies or small financial sectors and are thus not necessarily representative of all small banks, but they do offer some insight into the differences in impact across types of banks.

Smaller banks are generally more reliant on household deposits, and hence, the impact of a deposit outflow is greater. As per Table 2, deposit outflows amount to 7.1% of total liabilities across the 13 smaller banks in our sample, more than twice the aggregate outflow across all banks.

At approximately 50% and 30% for smaller and all banks, respectively, the difference in reliance on household deposits only partly explains the disparity in deposit outflow between banks of different sizes. Customers of the smaller banks in our sample are less frequently able to exhaust the holding limit of the digital euro and hold fewer bank deposits above a given holding limit due to lower absolute levels of bank deposits, meaning that for a given holding limit, smaller banks retain less of their deposits. This effect is more substantial at higher holding limits, indicating that as the holding limit increases, the disparity in impact between smaller and larger banks becomes more pronounced.

As a result of the greater deposit outflow among the smaller banks in our sample, the refinancing need is also higher for smaller banks, leading to higher financing costs and, ultimately, a larger impact on the NII. While the aggregate impact on the NII is approximately 7% across all banks, smaller banks are estimated to take a hit of upwards of 13% of NII, as shown in the last row of Table 2. Both effects assume a funding spread of 300 basis points, but in the likely scenario that smaller banks are unable to issue debt or access wholesale funding at this cost, the cost to smaller banks will increase further.

Due to the larger impact on smaller banks, and their increased likelihood of being unable to increase long-term funding, some small banks may face a real risk to sustain operations in case of financial stress, in particular if funding dries up. These tail-risks must be considered given their potential detrimental impact on the financial system as a whole.

³⁹ The remainder of smaller banks are included as a top-down residual banking sector. See Appendix B for details.

⁴⁰ These banks are generally included as they are “one of the three most significant banks established in a particular country”, see e.g. <https://www.bankingsupervision.europa.eu/banking/list/criteria/html/index.en.html>.

Table 2
Impact for smaller banks

	SMALLER BANKS	ALL BANKS
Deposit outflow as share of total liabilities	7.1%	2.9%
Deposit outflow as share of household deposit	14.3%	9.9%
Household deposits as share of liabilities	49.6%	28.9%
Impact on NII in severe case and 300 bp. spread	-13.0%	-7.2%

Note: "Smaller banks" refer to all banks in our sample with total assets of less than 30 bn. euro. The sample is unbalanced and does not contain information across countries and will thus only generalise to the extent a given small bank possesses the same characteristics as the banks included in our subsample. The results consider a scenario with a €3,000 holding limit and 100% uptake, which would be likely in times of market stress. For the impact on NII, we consider a funding spread of 3% between lost deposits and wholesale funding.

Source: Copenhagen Economics Balance Sheet Model

2.4.7 Implications for financial stability

The introduction of a digital euro poses potential risks to the euro area's financial stability, with estimates pointing to an outflow of up to 739 billion euro from commercial banks. Our results indicate that some banks, especially in countries such as Slovenia, Latvia, and Greece, with heavy reliance on household deposits, could face significant challenges in large uptake scenarios.

To mitigate deposit outflows, banks would need to notably increase their long-term funding, requiring an expansion of debt issuance by up to 20% overall. In severe scenarios, refinancing needs imply some banks to quintuple their current debt issuance, which is unlikely to materialise, leading to adjustments on the asset side, shifting capital allocation, and significant economic impacts for consumers. Additionally, a shift to long-term market funding could substantially decrease the NII for banks by as much as 7.2% or more, depending on the spread between wholesale funding and household deposits.

Collectively, our results indicate that in normal times, an introduction of a digital euro with a 1,000-3,000 euro holding limit will impact profitability and funding structures of banks, resulting in less stable funding bases. In times of financial stress, the potential combination of sudden deposit outflows and scarce availability of wholesale funding appears incompatible with the existing business models for several banks, as liquidity needs will far exceed available reserves. This will disproportionately hit smaller banks in countries with high reliance on household deposits.

CHAPTER 3

THE DIGITAL EURO AND CONSUMER WELFARE

In this chapter, we evaluate the effects that a digital euro could have on consumer welfare by considering the potential benefits of launching a digital euro, as well as the associated costs. The potential benefits of launching a digital euro are considered by assessing whether and how a digital euro could achieve its intended objectives (3.1). The costs are assessed by identifying the costs that a digital euro would bring for financial institutions, PSPs, and merchants, and describe how these could ultimately spill over to consumers and the economy (3.2).

3.1 POTENTIAL BENEFITS FOR CONSUMER WELFARE

In this Section, we assess whether and how a digital euro could achieve each of its three main intended objectives, namely to (1) preserve the digital euro's role as a monetary anchor and maintain financial stability (3.1.1), (2) promote innovation and competition in payments (3.1.2) and (3) promote financial inclusion (3.1.3).

3.1.1 Possibility to preserve the euro's role as a monetary anchor and maintain financial stability

As per Objective 1, the digital euro is intended to ensure that the euro remains a monetary anchor, while maintaining financial stability. This objective first indicates that current trust in the central bank's ability to convert private money into central bank money is insufficient to ensure confidence in private money, which the ECB allures to by stating that “*While banks could continue to hold central bank money in the form of reserves, this may not prove sufficient to fully preserve the monetary anchor role of central bank money*”.⁴¹

Second, if one accepts this statement, one needs to consider the digital euro's possibility to maintain (and improve) the euro's role as a monetary anchor. Following the ECB's reasoning, this depends on one primary factor: the level of adoption, especially in a steady state of the financial environment. The higher the level of adoption of the digital euro, the larger is the share of central bank money that is used by end consumers, assuming that the majority of the digital euro would replace commercial bank money such as deposits (and not cash). At the same time, there is a direct trade-off of digital euro replacing commercial bank money which increases the risk of reduced financial stability.

As explained in 1.3, the level of adoption depends on two main factors: holding limit and demand.⁴² While the holding limit sets the upper bound for the level of adoption of a digital euro, the ECB notes that “*If the currency is not demanded by the public, the mere announcement that the central bank would make it available would not be enough to preserve its role in the economy*”.⁴³

⁴¹ Speech by Christine Lagarde, Fabio Panetta, Member of the Executive Board of the ECB, at the Elcano Royal Institute, Madrid, 5 November 2021, “*Central bank digital currencies: a monetary anchor for digital innovation*”, available at <https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp211105~08781cb638.en.html>

⁴² In this context we treat the adoption of a digital euro as a stock – i.e. we do not consider short-term flows of transactions. See footnote 20.

⁴³ https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220218_1~938e881b13.en.html

The *holding limit* is set in the European Commission's proposal but is to be determined by the ECB. A limit of 3,000 euro has been used as a possible limit in several key studies and is also the upper bound we use in our assessment.⁴⁴ With a holding limit of 3,000 euro, the maximum adoption of digital euro would correspond to 2.9% of liabilities of the entire euro area commercial-banking sector, and as such a fairly low share if put in relation to total liabilities.⁴⁵

Furthermore, it is not likely that *demand* would lead to a 100% utilization of the holding limit, or 100% of available deposits if lower, across all individuals in the euro area. But it will, on average, be somewhere between 0-100% of the holding limit. Different design features of the digital euro drive the demand in opposite directions, and it is therefore difficult to estimate what share of the holding limit that is most likely to be used on average. Where a design feature such as free use for basic functionalities ought to have a positive impact on demand, the fact that the digital euro will not yield any interest limits the use of the digital euro as a store of value,⁴⁶ and thereby ought to mainly be seen as a means of payment, not considering behaviour in crisis times. Overall, this means that with a 3,000 euro holding limit adoption of the digital euro can be estimated to correspond to somewhere between 0.1% and 2.9% of the liabilities of the euro area's commercial-banking sector, assuming at least 10% utilization of the holding limit on average.

With respect to using the digital euro as a *store of value*, this possibility should first be restricted via a holding limit, which, as explained, is critical to maintain financial stability. Second, a digital euro could be seen as a relevant store of value if it is perceived as less risky than bank deposits. However, the holding limit of 3,000 euro as considered in this report is significantly below the deposit guarantees from EU insurance schemes, which typically cover deposits up to around 100,000 euro. Given the zero remuneration of a digital euro, a shift from a remunerated euro deposit to a non-remunerated digital euro would likely only occur if there were a lack of trust in regulators and authorities making good deposit guarantees. It is noteworthy that the ECB is inadvertently casting doubts over the insurance schemes, risking triggering a *self-fulfilling prophecy*. While seeking to strengthen trust in the financial system, it may be perceived as doing its exact opposite. As such, the function of the digital euro as a store of value seems limited in steady state financial environment.

More fundamentally, we would also suggest that the ability of central banks to pursue monetary policy focused on price stability and stable growth is not impeded by the dwindling role of cash in the economy. The primary levers for central banks are short-term policy rates for banks deposits and borrowing setting a band for short money market rates and open market operations as central banks buy and sell securities to impact wider interest rates across the maturity spectrum. The ECB has provided no evidence that the potency of these instruments is being lowered by the lowered demand for cash.

By implication it also suggests that adding a digital euro to the toolbox will not improve the ability of ECB to conduct monetary policy. Indeed, the remuneration of the digital euro is supposed to be fixed and not linked to movements in policy rates.

⁴⁴ See e.g. ECB (2022a) and JRC (2023).

⁴⁵ As we note in Chapter 2, this figure only portrays the results on an aggregate level. While this is what is relevant from a monetary-anchor perspective, effects for individual banks and countries are still relevant to consider from a financial-stability perspective, as we do in Chapter 2.

⁴⁶ Cf. the European Commission's proposal.

With respect to using the digital euro as an *investment*, this is not relevant with the current design, as the digital euro will not accrue any interest. As such, the function of the digital euro as an investment is not relevant.

With respect to using the digital euro as a *means of payment*, this would be the function where a digital euro could fill a purpose. If the digital euro is designed in a way that is easy to use and where basic functionalities are offered for free, it could become an attractive means of payment for transactions below the holding limit. Long-term holdings would be more likely to remain with commercial banks, given e.g. the non-remuneration of digital euro.

In conclusion, we suggest that the digital euro's possibility to support the euro's role as a monetary anchor is limited if financial stability is to be protected, and with the current design features. Particularly, out of the three functions of a currency as described earlier in this report (store of value, investment, means of payment), with its current design, the digital euro will mainly address the last function, but not the other two.

3.1.2 Impact on competition and innovation

As per Objective 2, the digital euro is intended to promote innovation and competition in the payment market. For the launch of a digital euro to positively impact competition in the payment market, there needs to be a current (or expected) lack of competition in the euro area (e.g. lack of entry, or innovation and sustained high barriers to expansion and difficulty in scaling across countries).

In addition to a current lack of competition in the payment market, this is only a relevant objective for the digital euro, if at least some of the (potential) current issues stemming from a lack of innovation and competition can be expected to be remediated with a digital euro.

However, market dynamics and regulatory developments strongly suggest that there is limited scope for the digital euro to improve competition and innovation. The payment services sector has experienced major developments underscoring the increasing competition in this space. The proliferation of new services and providers enabled by digital technologies are some of the key developments compatible with increasing competition. This has been translating into a growing adoption of mobile wallets, mobile payments, and account-based instant payments (including peer-to-peer). This is also acknowledged by the ECB and the European Commission.⁴⁷⁻⁴⁸

Increasing digitisation coupled with regulatory frameworks pushing for market openness (e.g. PSD2⁴⁹) led to a growing variety of services and providers and a decline in the use of cash.⁵⁰

⁴⁷ See ECB (2021). According to the ECB, “digitalisation, changing consumer habits and legislative action are profoundly changing retail payments. Increasingly, electronic retail payments are being transformed from basic payment services provided by domestic banks to strongly commercialised payment solutions”.

⁴⁸ The European Commission acknowledges that in recent years, “(...) the retail payment services market underwent significant changes largely related to the increasing use of cards and other digital means of payment, the decreasing use of cash and the growing presence of new players and services, including digital wallets and contactless payments”.

⁴⁹ Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015, on payment services in the internal market – the revised Payment Services Directive (PSD2).

⁵⁰ See ECB (2022b). Consumers' payment habits show that cashless payment methods are substituting cash across payment types (e.g. POS and P2P). This decline in the use of cash was largely driven by the increase in the use of cards and mobile apps, with the latter more than tripling its share in POS and P2P payments between 2019 and 2022.

Indeed, the European Commission notes PSD2's role in fostering innovation, competition, and the entry of new players and services ultimately leading to more choices for consumers.⁵¹

Increased choice for consumers has similarly benefited from lower barriers to switching, to which the digital euro will bring no clear novelty. Mandatory services to allow consumers to switch bank accounts exist across the EU since the introduction of the Payment Accounts Directive (PAD).⁵² The PAD has been successful in making switching easier to increase competition, as noted by the European Commission.⁵³ The argument that the digital euro portability feature will be significant to improve competition is thus not consistent with the European Commission's assessment that ease of switching has already been improved via the PAD.

Competition has also intensified as barriers precluding providers from expanding across the European single market are decreasing. The increasing number of providers and services has resulted in increased variety in the EU. As PSPs increasingly supply their services across the EU, available choices for consumers and merchants extend beyond national borders, intensifying competition.⁵⁴ The European Commission has also recognised this phenomenon in several antitrust cases related to payment services.⁵⁵ The European Commission also acknowledges these developments as advances towards a more competitive single European market.⁵⁶

Moreover, conditions for competition will likely improve as other instruments and ongoing policy initiatives are designed to address existing barriers, see Box 2 below. Competition concerns in EU payments remain despite the increasingly dynamic market. These range from non-harmonised regulatory regimes to high concentration around international card schemes and limited interoperability.⁵⁷

Several policy initiatives that do not depend on the launch of a digital euro are underway to tackle existing barriers to competition. Concretely, initiatives seek to harmonise regulatory frameworks and push for the availability of instant payments and open banking infrastructures. If those initiatives are believed to be effective in pursuing the intended goals, it is unclear how will the digital euro be a relevant tool in promoting competition.

Considering these, we cannot conclude that there is insufficient competition in the payment market.⁵⁸ Therefore, the first condition for the digital euro to significantly affect competition and

⁵¹ See e.g. European Commission (2023c).

⁵² Directive 2014/92/EU of the European Parliament and of the Council of 23 July 2014, on the comparability of fees related to payment accounts, payment account switching and access to payment accounts with basic features.

⁵³ Report from the Commission to the European Parliament and the Council on the application of Directive 2014/92/EU, see pp. 11-12. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0249>.

⁵⁴ See Kantar Public (2022). Regarding merchants' sourcing decisions, "(...) when it comes to the payment solution provider, the country in which the provider is based seemed not to be an issue [for merchants]".

⁵⁵ See e.g. European Commission (2021). The European Commission has notably considered that different relevant markets across the payments value chain are likely pan-European in their geographical scope (e.g. e-commerce merchant acquiring, acquiring processing).

⁵⁶ See European Commission (2023c): "the retail payment services market underwent significant changes largely related to the increasing use of cards and digital means of payment, the decreasing use of cash and the growing presence of new players and services, including digital wallets and contactless payments".

⁵⁷ The European Commission acknowledges "(...) effectively different regulatory conditions in Member States because of different interpretation of the rules (...)" hindered PSD2's efficacy in promoting competition.

⁵⁸ Assessing whether competition is functioning well in a market (i.e. whether there is sufficient competition in a market) requires a thorough market competition analysis. Our conclusion is the result of a high-level assessment of market dynamics and economic conditions for competition.

innovation in payments does not hold. Equally, the ECB did not put forward material evidence of a potential lack of competition nor the expected impact of the digital euro on it.

Box 2 Ongoing policy initiatives to foster competition in EU payments

The European Commission has been working on several policy initiatives to increase competition in payment services in the EU. These initiatives include:

Instant Payments Regulation (IPR)

The IPR aims to make instant payments available to all in the EU. Instant payments are considered more convenient and efficient than traditional payment methods (e.g. standard credit transfers and payment cards). The IPR will require banks to offer instant payment services at low fees. The ECB has considered the full deployment of instant payments the second major goal of its retail payments strategy.

Directive on payment services and electronic money services

The proposed Directive aims to address some of the challenges that have arisen since the PSD2 was adopted, such as the rise of new payment technologies, the need to protect consumers from fraud, and the need to ensure the resilience of the payment systems.

Payment services regulation

The PSR aims to increase competition in the payment services market by strengthening measures to combat payment fraud, allowing non-bank PSPs access to all EU payment systems, increasing the efficiency, transparency and choice of payment instruments, facilitating the provision of card, internet and mobile payment services across borders within the EU, and helping innovative payment services to reach a broader market.

Digital Markets Act (DMA)

The DMA includes provisions that are specifically aimed at increasing competition in the payment services market, such as requiring large platforms to allow customers to use other payment providers when making purchases on their platforms.

Other initiatives

The European Commission is also supporting the development of new payment technologies, such as instant payments and blockchain-based payments. These technologies have the potential to further increase competition in the payment services market and make it easier for consumers to make payments.

Source: Copenhagen Economics based on legal texts and proposals of the European Commission

Most of the use cases of the digital euro for payments are already covered by existing solutions, which further limits its potential benefits. Several digital payment solutions already provide POS, online, and P2P payments via technologies such as contactless (NFC), QR codes, or proxy/alias. Moreover, such solutions extend beyond payment cards, to include account-to-account payments and instant payments.⁵⁹

⁵⁹ An instant payment is a credit transfer which arrives on the payee's account within ten seconds of the sending of a payment order by the payer.

New services (including value-added services) could be developed using existing infrastructures without the digital euro. Whilst the digital euro may ease cross-border payments and supply an offline digital payment option to consumers, it is unclear whether such features require a digital euro. Similarly, there is no indication that potential value-added services using the digital euro could not be developed over existing solutions.

There is little evidence that the digital euro will supply a more convenient or preferred payment method compared to those already available.

First, data shows an increasing adoption of digital solutions suggesting that market participants are catering to consumers' needs. According to the ECB, between 2019 and 2022, the share of POS and P2P payments using mobile apps more than tripled in the EU.⁶⁰ In the same period, the number of online payments tripled while the variety of digital payment methods increased.⁶¹

Second, these trends are consistent with a “*strong preference for payment methods that are convenient, fast, easy to use and widely accepted at least domestically*”. It is yet to be demonstrated that the digital euro will be superior to existing solutions in these dimensions.⁶²

Third, merchants reported accepting a wide range of payment methods, including mobile application payments, with the advantages of digital payment methods being transaction speed, reliability, and ease of use both for customers and merchants. When presented with the concept of the digital euro, merchants were at best neutral to the idea.⁶³

Moreover, the proposed compensation model arbitrarily links the price cap of the digital euro to existing payment methods, which can harm innovation as PSPs can be forced to supply services at a loss. Contrary to its intended goals, the price cap may discourage digital euro services' active distribution and development. This risk results from the suggested cap on fees. The proposed rules prevent PSPs from charging merchants more for digital euro services than other “*comparable means of payment*”, even if digital euro services are more costly.

If existing services are more cost-efficient, price regulation can result in losses for PSPs and fewer incentives to innovate (e.g. to deploy new services based on digital euro). Moreover, competitive pressure may leave PSPs with little choice not to supply those services.⁶⁴

Finally, limiting the use of the digital euro as a store of value can hinder take-up, reducing potential benefits for competition. In principle, the waterfall/reverse waterfall mechanisms ensure that the holding limit will not restrict the use of digital euro (online) payments. However, any limits to the overall use of the digital euro can hinder its adoption and consumers' willingness to use it,

⁶⁰ (ECB, 2022b)

⁶¹ (ECB, 2022b)

⁶² See (ECB, 2022b). The legal tender status of the digital euro would ensure virtually every merchant would accept it. Albeit lower, cashless payment methods also have a high coverage. According to the ECB, “*in the euro area it was possible to pay with non-cash instruments in 81% of transactions in 2022*”.

⁶³ https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.sl.pdf

⁶⁴ Acquiring service providers can have little freedom not to provide digital euro services if merchants procure acquiring services of multiple schemes as a bundle. When merchants prefer single homing, removing digital euro acquiring services from their portfolio could result in a significant loss of revenue for acquirers.

including for payments. This limitation will be greater if some consumers do not easily understand how waterfall/reverse waterfall mechanisms work.

The above suggests that three main reasons suggest the digital euro may not significantly improve innovation and competition in the payment market. *First*, the market is becoming increasingly competitive without the digital euro, which will be accentuated by other policies designed to reduce barriers in payments. *Second*, it is unclear what added value the digital euro will bring compared to the existing payment solutions. *Third*, the proposed compensation model and price regulation create risks discouraging service providers from promoting digital euro payments and innovative services.

3.1.3 Effects on financial inclusion

The emergence and increased reliance on digital solutions in the payment market has created a need to actively address financial exclusion, since, as the European Commission explains, “*digital means of payments may not specifically cater for vulnerable groups of the society or may not be suitable in some rural or remote areas without a (stable) communication network*”.⁶⁵ To increase financial inclusion, the digital euro is thereby aimed to provide a digital solution which can cater to people with disabilities and limited digital skills. For the digital euro to improve financial inclusion relative to these people, it would therefore need to be easier to use than current digital payment solutions, but also easy enough for these people to both want to and be able to utilise them and prefer them over existing non-digital solutions such as cash. Furthermore, to address connectivity issues, it would need to provide offline solutions, at least for certain transactions.

Additionally, the digital euro is intended to be launched in a way to accommodate people who wish to remain unbanked. People who voluntarily decide to stay unbanked can be assumed to do so due to a lack of trust in the banking system. As such, for a digital euro to be perceived as a relevant option for these people, it needs to be associated with higher trust than other digital solutions and be at least as attractive as non-digital options.

The importance and societal benefits of enhancing financial inclusion is widely acknowledged and an important objective for many policymakers.⁶⁶ At the same time, the euro area faces a relatively low financial exclusion, which has declined significantly in the last couple of years. In 2021, financial exclusion (defined as unbanked adults) was 3.6% in Europe, less than half compared to the 8.2% in 2017⁶⁷, and significantly below the worldwide average of 24% in 2021.⁶⁸

According to a study on new digital payment methods made by Kantar Public on behalf of the ECB⁶⁹, there are three main reasons for why people in the euro area are unbanked, underbanked, or offline.

- **Unfavourable life circumstances** (primary reason), such as no steady income, not in charge of own finances or personal bankruptcy;

⁶⁵ Proposed regulation on the establishment of the digital euro.

⁶⁶ See e.g. <https://www.bis.org/ifc/publ/ifcb460.pdf> and <https://documents1.worldbank.org/curated/en/806481470154477031/pdf/Payment-Aspects-of-Financial-Inclusion.pdf>

⁶⁷ <https://www.wsbi-esbg.org/number-of-unbanked-adult-eu-citizens-more-than-halved-in-the-last-four-years/>

⁶⁸ <https://www.unsgsa.org/financial-inclusion>

⁶⁹ https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf

- **Emotional barriers**, such as a distrust in banks and reluctance to use internet and digital banking tools; and
- **Functional barriers**, i.e. a lack of technical skills.

Relatedly, other research shows that in addition to financial reasons (being unemployed or with lower income) financial exclusion is more common among older and less educated people.⁷⁰

These financially excluded individuals use cash as their main payment method, as it is perceived as the most accessible, trustworthy, and convenient payment method. For the offline population, cash is also preferred due to concerns regarding privacy, security, and safety of other payment methods.⁷¹

For a digital euro to improve financial inclusion in the euro area, it needs to improve the underlying reasons for people who are either unwilling or unable to be a part of the financial system.

For the first and largest group of people (unfavourable life circumstances), a digital euro would not have any direct effect on their situation and would thereby not remediate this reason for financial exclusion. As such, one could expect that even with a digital euro there would still be a share of the population which would remain financially excluded as their need for a digital solution remains low.

For the remaining two groups of people (with emotional and functional barriers), a digital euro could though be expected to improve financial exclusion, if it is able to incorporate design features that reduce the barriers.

Based on qualitative interviews with individuals in the euro area, Kantar Public identifies four key features that would be required for a digital euro (or another digital solution) to be seen as a relevant option and could drive adoption among financially excluded people⁷²:

1. **Easy to use**, i.e. no technological skills required, an easy onboarding process and a possibility to use offline without internet connection.
2. **Robust customer support**, and preferably face-to-face support. For some people, complementary tutorials (in addition to face-to-face support) and backing from banking system is important.
3. **Secure**, i.e. personal information needs to be kept secured. This feature was particularly important for people who currently distrust banks.
4. **Free of charge**, or low associated fees, and no maintenance costs. For some individuals, this would ideally be complemented with an option of short-term borrowing for certain amounts in periods of financial difficulty.

In essence, Kantar Public finds that these financially excluded people generally want a solution which acts like cash as much as possible, with potential value-adding features such as additional security in the form of a possibility for protection in case of loss/theft or the short-term credit feature.

⁷⁰ <https://www.bis.org/ifc/publ/ifcb460.pdf>

⁷¹ https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf

⁷² https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf

The key features demanded by the financially excluded population and the request for a digital euro to be advantageous compared to already existing payment methods drives two main questions. First, while a digital euro may fulfil some of the design features requested by the financially excluded population, why could these criteria not just as well be fulfilled via existing payment methods from private PSPs? Second, given the financially excluded population's strong preference for cash, and a fear that a digital euro would contribute cause cash to disappear, if a digital euro is designed to as close as possible mimic cash, what incentive would these people have to transition from cash to a digital euro? We elaborate on these two questions below.

The European Commission's proposal for a digital euro claims that a digital euro will improve financial inclusion by providing universal access to payment accounts with basic features to all individuals. As such, it intends to address key feature 1 by being accessible and offer a smooth and simple onboarding. However, the proposal specifically states that the digital euro design is "*inspired by the approach adopted under Directive (EU) 2014/92 (Payment Accounts Directive)*", i.e. a directive for non-digital euro payment accounts.

The proposal further states that "*[t]he digital euro will be offered following a similar approach, but with the required adaptations, to ensure universal access to basic digital euro payment services*". As such, it is not clear how a digital euro goes beyond what existing payment accounts can already offer. Furthermore, under "Easy to use", financially excluded people wish to use a solution for which *no* technological skills are required and where *offline* solutions are possible. While a digital euro may be able to provide a solution which is simpler than current digital payment methods, and with offline solutions being possible for certain limited transactions, it is unclear how this would be more appealing than continuing to use cash, which is these people's current preferred choice, and which can be done without any technological skills and fully offline.

With basic features of a digital euro to be provided free of charge, one can also question the likelihood that it would be provided along with substantial customer support, particularly face-to-face support, which is already limited and declining for other payment methods via e.g. commercial banks, who close physical offices to operate more efficient business models.⁷³

It is possible that a digital euro would be perceived as a more secure option than current digital payment methods. The reasons are that it is provided by the central bank (with the option of using a public body rather than a private PSP as an intermediary) and the proposal includes measures to strive for e.g. privacy and data protection. As such, a digital euro may be a more attractive option than e.g. commercial bank deposits. However, without value-added features such as the example of protection in case of loss mentioned above, there is little to no incentive to select a digital euro over cash for people who remain financially excluded due to a distrust in the banking system. Similarly, people with a reluctance to use the internet and digital banking tools would likely also continue to select cash as their preferred payment method.

While the basic features of a digital euro account are to be provided free of charge, this could, at best, put a digital euro at par with cash. Furthermore, it is not clear to what extent payment

⁷³ The number of bank branches in the euro area has been steadily declining since 2008. According to the ECB, EU structural financial indicators reporting to the end of 2022 show "*further decline in the number of bank offices in the EU, averaging 5.39% across Member States. Decreases were observed in 25 of the 27 countries, ranging from -0.98% to -21.54%*". <https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr230601~1a54c64d97.en.html>

methods need to be provided *free of charge*, or whether it is sufficient that it is provided at *low* fees. If the latter, this could also be incentivised for other already existing digital payment methods via e.g. the competition-enhancing measures described in the previous Section. Additionally, in its current form, a digital euro does not offer any possibilities for short-term borrowing, unlike other payment methods such as credit cards.

In addition, even if the digital euro is designed in a way that the financially excluded population is requesting, the study by Kantar Public notes that there is a “*general lack of interest*” and “*reluctance*” towards new digital payment methods. This is due to low interest and a low perceived need for such solutions. Relatedly, a large extent did not perceive a need for a digital currency as long as cash can be used, and there was a fear that the introduction of a digital euro would phase out cash.

As a conclusion, we find it highly uncertain to what extent a digital euro would improve financial inclusion. *First*, already without a digital euro, financial exclusion is relatively low in the euro area and has decreased significantly in the last few years. *Second*, for the financially excluded population, there is a general low demand due to low interest and a low perceived need for a digital euro, particularly compared to continuing to use cash. *Third*, while certain design features of the digital euro could and intend to cater to the demands of the financially excluded population, many of these features can be achieved through already existing digital solutions.

Overall, designing a solution which resembles cash to the extent possible may be the best chance of motivating these people to use the digital euro and improve financial exclusion. A digital euro which is largely seen as a substitute to cash by the broader population would also limit the impact on financial stability, as a replacement from cash to digital euro would not affect commercial banks’ ability to withstand shocks. At the same time, a replacement from cash to digital euro would not have any effect on maintaining the euro’s role as a monetary anchor, as such a solution only replaces one form of central bank money with another.

3.2 COSTS FOR CONSUMER WELFARE

In this Section, and taking into account that the digital euro is a complex project with still many unknown factors in its implementation, we approach some of the costs it would bring for financial institutions, PSPs and merchants (3.2.1). For a full deep dive on the digital euro infrastructure and related cost assessments, a separate study would be necessary. We also look into how these could ultimately spill over to consumers via higher prices and restricted access to lending (3.2.2). Subsequently, we explain how higher lending rates could affect economic growth in the EU (3.2.3) and the effect such increased lending rates for consumers could have on GDP (3.2.4).

3.2.1 Costs for commercial banks, PSPs, merchants, and the ECB

Introducing the digital euro creates costs for financial institutions, PSPs, and merchants. As costs will ultimately spill over to consumers, these need to be factored in when assessing the introduction of a digital euro.

The digital euro will have potentially high costs for payment service providers, worsened by an incomplete compensation model. Direct costs of supplying the digital euro include one-off and recurring costs. These costs comprise setting up and maintaining IT systems, providing in-person customer support, developing front-end interfaces, and complying with fraud management, anti-

money laundering (AML), and dispute settlement requirements, see Table 3. Indirect costs include lost revenues in payment services.

The proposed compensation model heightens this cost. As previously explained, PSPs will face a transactional price cap for inter-PSP fees and merchant service charges linked to alternative payment methods' costs. This can ultimately force PSPs to provide basic digital euro services at a loss, precluding them from covering transactional costs and recouping initial investments.

Commercial banks' costs are aggravated by more expensive funding and a larger scope for lost revenue in banking services. *First*, the cost of funding will increase as banks seek to replace the funds lost in the outflow of deposits at a higher cost. Opposite to other PSPs, this is a key driver in financial institutions' business models. *Second*, financial institutions can suffer a larger loss of revenues. Since the digital euro allows users to make payments above the holding limit,⁷⁴ potentially crowded out payments will include those traditionally provided by banks, such as high-value credit transfers. Moreover, the more payments (especially high-value payments) completed with digital euros, the more likely will a higher outflow of deposits be.⁷⁵ On top of lost transactional revenues in payment services, consumers may substitute other traditional banking services for digital euro services (e.g. current accounts), which furthers the scope of lost revenues for banks compared to other PSPs.

Merchants will also bear significant costs in setting up systems and POS capable of accepting the digital euro, with estimated one-off costs ranging from 1 to 16.7 billion euro.⁷⁶ These costs relate to substituting POS terminals and software. The European Commission further estimates additional recurring costs with maintenance and licensing of 860 million euro, as merchants will likely need to keep the current payment methods options. Moreover, depending on market dynamics, additional costs on PSPs might be passed on to merchants.⁷⁷

Lastly, the Eurosystem will bear the costs of setting up and running the digital euro scheme. While no estimates have been provided, these costs include developing and managing the network and settlement infrastructure, marketing the digital euro, scheme management and monitoring scheme compliance.⁷⁸ In addition, the ECB will bear the costs of ongoing price monitoring and enforcing price caps.

⁷⁴ The waterfall and reverse waterfall mechanisms allow payments with a value above the holding limit, see footnote 12.

⁷⁵ Even if consumers keep a maximum amount of digital euros (e.g. as a store of value), significant demand for the digital euro as a payment wallet can lead to an overall outflow of deposits higher than that that would occur if everyone exhausted the holding limit. In such a scenario, the total displacement of deposits would include the value of individual payments beyond the holding occurring at any point in time.

⁷⁶ According to the European Commission's impact assessment, estimated potential one-off costs (i) range between EUR 0.8 and 14 billion for merchants already accepting electronic payments and (ii) are about EUR 2.7 billion for merchants not accepting electronic payments, see pp. 53-54.

⁷⁷ The passthrough to merchants can occur despite price caps via e.g. cross-subsidisation.

⁷⁸ ECB fourth progress report.

Table 3
Overview of direct and indirect financial costs of the digital euro

STAKEHOLDER	ADDITIONAL COSTS OF THE DIGITAL EURO
Commercial banks	<ul style="list-style-type: none"> • Additional funding costs (up to 20.6 billion euro)⁷⁹ • Lost income/fees in banking and payment services
PSPs (including commercial banks)	<ul style="list-style-type: none"> • Infrastructure (e.g. IT connections to the ECB) • Compliance costs and expanding business processes (e.g. developing customer interfaces, fraud management, screening and AML, dispute settlement) • Customer support • Lost income in payment services <p>The European Commission estimates a total one-off cost of 3.6 to 6.8 billion euro, recognising that there are large uncertainties in the design choices with impacts on costs. Moreover, the European Commission notes that it is not possible to estimate recurring costs.</p>
Merchants	<p>For merchants currently accepting electronic payments</p> <ul style="list-style-type: none"> • POS hardware and software costs between 0.5 and 14 billion euro ⁸⁰ • Recurring maintenance/license costs annual running costs of about 0.7 billion euro <p>For merchants not yet accepting electronic payments</p> <ul style="list-style-type: none"> • One-off cost between 0.5 and 2.7 billion euro ⁸¹ • Recurring maintenance/license costs annual running costs of about 160 million euro
Eurosystem	<ul style="list-style-type: none"> • Developing and managing the network and settlement infrastructure • Scheme management • Settlement processing • Monitoring scheme compliance • Monitoring markets prices and price-regulation enforcement • Marketing the digital euro

Source: European Commission; Copenhagen Economics

3.2.2 Spillover costs to consumers

The additional costs to the system brought by the digital euro can ultimately spill over to consumers via three channels.

First, merchants will seek to protect margins by passing additional costs to consumers. This would result in higher prices on retail products. Harm to consumers is aggravated as the passthrough would also include at least part of the direct costs imposed on PSPs (3.6 to 6.8 billion euro). The more homogeneous the additional costs on merchants and PSPs, the more likely are merchants to pass higher costs on to consumers.^{82,83}

Second, consumers could be hurt by higher lending rates or reduced credit supply. These are likely consequences of banks' adjustments to higher funding costs coupled with lost revenues and

⁷⁹ Upper bound of additional funding costs, considering (i) a 3,000 euro holding limit; (ii) full utilization of the digital euro and (iii) a 300 basis points cost spread between wholesale funding and deposit-based funding.

⁸⁰ Lower and upper bounds of the different estimation methods considered in the European Commission's impact assessment exercise, in a scenario where all merchants must accept digital euro payments. See European Commission (2023b).

⁸¹ Idem

⁸² If additional costs affect competing merchants similarly, relative competitive advantages remain unaffected (i.e. prices increase in the same proportion for all) and passing costs onto consumers does not necessarily change pricing incentives.

⁸³ Depending on the final implementation of the compensation model and the costs the ECB considers in calculating price caps, the passthrough of costs from PSP to merchants can be somewhat homogeneous across providers.

heightened liquidity risk and financial instability. Following the introduction of the digital euro and an outflow of deposits, banks adjust by relying on more expensive sources of funding or adjusting their asset portfolio. As we show further down in this chapter, both options can harm consumers.

Third, if the ECB operates the digital euro at a loss, it reduces the ECB's profits and is ultimately a cost to consumers. Indeed, part of the Eurosystem's profits is generally distributed to the corresponding national governments. Therefore, a reduction in profits must be accounted for as a financial cost to citizens.

3.2.3 Effects of higher interest rates

The impacts of the digital euro on banks will force balance-sheet adjustments which could lead to higher interest rates and a lower supply of credit. An outflow of deposits will force banks to adjust their balance sheets. In an asset-side adjustment, banks may choose to cut credit supply. Empirical studies suggest this might be the case in an environment of funding stress and rising funding costs (e.g. when alternative funding sources are not available at acceptable prices).⁸⁴ In a liability-side adjustment, banks will seek to avoid losses passing on to consumers at least part of the additional cost of funding. This would result in increasing charges and lending rates.

Higher lending rates increase the cost of debt and reduce households' disposable income through higher interest payments on existing debt. This results in lower household consumption in the economy, which is worsened under tight household budgets. Reduction in credit extension is likely to affect individual borrowers differently. Low-income households with limited ability to reduce consumption in the short term will be especially harmed. Additionally, higher prices (interest rates) could exclude some consumers from the credit market altogether.

Moreover, it can lead to a decline in investments in the economy. An increase in lending rates forcibly requires that financed investments yield higher returns to be equally profitable. Higher financing costs can reduce overall investment as some otherwise investments become unprofitable. Likewise, a cut in credit supply leads to lower corporate investments, especially among smaller firms as they are more bank-dependent in their financing.⁸⁵ Overall, the remaining funding will be more concentrated on riskier projects, which can further reduce banks' willingness to lend.

Notably, the digital euro will remove funds from the banking system, hindering banks' role in facilitating productive investments in the economy. As banks suffer an outflow of deposits, their financial intermediation role will be weakened, and the economy deprived of relevant funding. The deposit multiplier effect further aggravates the negative impact on the economy. Reducing access to credit could hinder achieving other national or EU-wide public policy objectives that rely heavily on the financial intermediation role of banks (e.g. the green transition).⁸⁶ Overall, society at large could experience a slowdown in economic activity and reduced GDP, see Box 3.

⁸⁴ See, e.g. Duquerroy et al. (2022), De Jonghe et al. (2019), Cooperman et al. (2023) and Damar et al. (2019).

⁸⁵ See, e.g. Volk (2023), Alfaro et al. (2021) and Amiti and Weinstein (2018)

⁸⁶ The EU green transition agenda relies on banks playing a pivotal role by providing credit to sustainable activities to channel financial resources towards environmentally sustainable projects and initiatives (e.g. through investments in renewable energy, green infrastructure, green renovations, and other eco-friendly endeavours), thereby accelerating the shift towards a low-carbon economy.

Box 3 Potential impacts of higher lending rates on the economy

The interaction of the abovementioned economic dynamics triggered by an increase in lending rates may produce the following general effects on the economy:



Lower demand for consumer and business products and services

Lower consumer demand on the household side translates back to the firm level via lower demand for consumer goods and services, whereas lower propensity to invest or the urge to cut expenses among some firms reduces business product or service demand at the firm level.¹



Wage cuts and employment losses further reduce household consumption

Cutting expenses and foregone investments may well relate back to the labour force within a company, resulting in wage cuts or employment losses and constraints in terms of new hires.² This relates back to the household level through the cash-flow channel as wage cuts and employment losses seriously impact household disposable income which again leads to lower consumption expenditures.



Lower total factor productivity and reduced economic activity

On a broader scale, reduced or a more costly corporate credit supply may harm total factor productivity in the economy. Evidence from Italy shows that firms constrained in their credit supply acquire less inputs and produce less output compared to their competitors.³ Constrained corporate credit supply has also been associated with a lower market valuation for respective firms and lower export volumes.⁴ Hence, negative credit supply shocks propagate through companies' supply – and trade credit chains growth ultimately harming general economic activity.



Rising income inequality and slower economic growth

Lastly, income inequality may rise at the household- and firm level. Low-income households and smaller/younger firms are affected the most if credit is costly or not available at all. OECD research finds rising income inequality to affect economic growth among OECD countries negatively. More precisely, the gap between low-income households and the rest of the population is an obstacle to growth.⁵

Source: Copenhagen Economics

Notes:

1 – <https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230419~09fe9b3295.en.html>

2 – <https://onlinelibrary.wiley.com/doi/epdf/10.1111/ecin.12989>

3 – <https://www.imf.org/en/Publications/WP/Issues/2019/05/17/Credit-Supply-and-Productivity-Growth-46894> 4 – <https://onlinelibrary.wiley.com/doi/epdf/10.1111/ecin.12989>

5 – https://www.oecd-ilibrary.org/docserver/5jxjncwxv6j-en.pdf?expires=1690548848&id=id&ac_cname=guest&checksum=0CA27EC67912A44787ECFECF306C677C

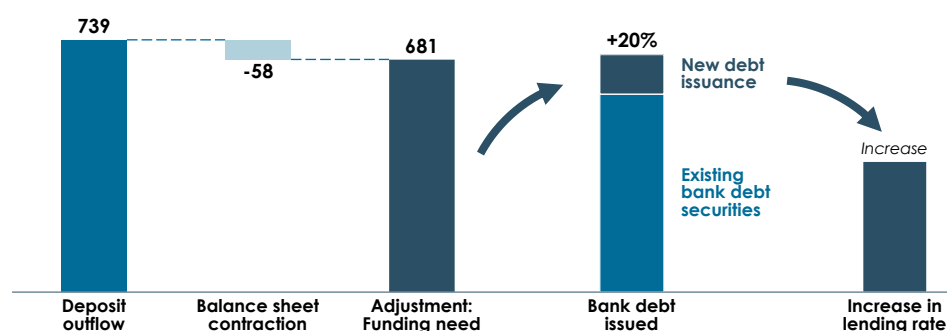
3.2.4 Effects of higher interest rates for consumers on GDP

Increasing costs of funding may result in an increase in lending rates charged by commercial banks to consumers. This mechanism would occur in four steps. *First*, there would be an outflow of deposits from commercial banks to the digital euro. *Second*, banks would need to source new

(wholesale) funding to achieve the same liquidity levels. *Third*, the adjustment in funding composition would bring a spread (i.e. increase) in the cost of funding between household deposits and wholesale funding sources. *Fourth*, this increase in costs of funding could then lead to an increase in lending rates to cover the banks' increased funding costs.

Figure 9
Illustrative example: Consumer impact from deposit outflow

Bn. euro / pct



Note: Scenario with €3,000 holding limit and 100% uptake. Assumes funding cost for additional debt issuance at 3.0% for all banks and full pass-through of costs to existing stock of loans. Data as of June 30th, 2022. The pass-through rate of costs, and hence the change in lending rate will depend on the magnitude of costs the, ability for banks to change rates, the competitive landscape, and the reaction of consumers to an increase in lending rates.

Source: Copenhagen Economics Balance Sheet Model

In Chapter 2 we showed the *first* and the *second* steps. For simplicity we replicate these results in Figure 10, below. *First*, we estimated an outflow of deposits of up to 739 billion euro in the most severe scenario (100 percent uptake of the digital euro and a 3,000 euro holding limit).⁸⁷ *Second*, we determined the amount of funding banks would need to source to maintain adequate liquidity buffers, which can be of up to 681 billion euro.⁸⁸

⁸⁷ See Section 2.4.1.

⁸⁸ See Section 2.4.2. The required funding to achieve a liquidity coverage ratio (LCR) equal to that before the outflow of deposits towards the digital euro.

Figure 10 Outflow of deposits and resulting funding needs for commercial banks

(A) **Aggregate deposit outflow**

(B) **Additional long-term funding need**

Deposit outflow in billion euro

Billion euro

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	29	58	112	165	27	53	103	152	
40%	58	112	218	317	53	103	201	292	
60%	85	165	317	464	78	152	292	427	
80%	112	218	416	603	103	201	383	556	
100%	139	268	511	739	128	247	471	681	

Note: Estimates in Panel B cover the required funding need in an LCR-neutral adjustment to the implementation of a digital euro.

Source: Copenhagen Economics

Replenishing liquidity will entail additional costs because wholesale funding is more expensive for commercial banks than household deposits. We consider two spreads of 63, and 300 basis points to represent two scenarios of funding environment: (A) favourable conditions and (B) unfavourable conditions, respectively, providing lower and upper bound estimates.⁸⁹

Considering the above, in a severe scenario (of high demand for the digital euro) we estimate that sourcing the necessary funding will entail an additional annual cost between 4.6 and 20.4 billion euro depending on the funding environment, see Figure 11. If instead of 3,000 euro, the holding limit is set at 500 euro, then the range of additional annual funding costs is reduced to between 0.8 and 3.8 billion euro.

Figure 11 Additional aggregate funding costs in different funding environments

(A) **Favourable conditions - 63 bp spread**

(B) **Unfavourable conditions - 300 bp spread**

Additional yearly costs in billion euro

Additional yearly costs in billion euro

Uptake	Holding limit				Uptake	Holding limit			
	€ 500	€ 1,000	€ 2,000	€ 3,000		€ 500	€ 1,000	€ 2,000	€ 3,000
20%	0.2	0.3	0.6	1.0	0.8	1.6	3.1	4.6	
40%	0.3	0.6	1.3	1.8	1.6	3.1	6.0	8.8	
60%	0.5	1.0	1.8	2.7	2.3	4.6	8.8	12.8	
80%	0.6	1.3	2.4	3.5	3.1	6.0	11.5	16.7	
100%	0.8	1.6	3.0	4.3	3.8	7.4	14.1	20.4	

Note: Spreads follow parameter values from BIS (2021).

Source: Copenhagen Economics Balance Sheet Model and BIS (2021).

The additional funding costs for banks will result in higher lending rates as banks eventually restore the lending margin to competitively sustainable levels. Due to the lasting higher level of costs, this permanently increases the cost of borrowing. This increase in borrowing costs endure through business cycles and is thus not comparable to traditional interest rate hikes which aim to

⁸⁹ We rely on parameter estimates used by BIS (2021) for the average spread between retail deposits and long-term wholesale funding: 63 basis points under benign conditions, and 300 basis points under unfavourable financial circumstances.

affect economic activity in the short term. Rather, the increase in borrowing costs introduces a lasting negative impact on the allocation of capital between borrowers and lenders.

As described in Box 3, higher cost of borrowing has a contractionary impact on economic activity. To assess the long-run impact on economic growth, we rely on BIS (2021c) which presents a collection of cost simulations from the introduction of the Basel III regulation. Specifically, we use the estimated long-run impact on GDP from the introduction of the LCR regulation⁹⁰, as these models (i) work through an increase in the spread of lending rates, and (ii) are designed to assess the impact of LCR, resembling the LCR-induced bank adjustment we model, as described in Chapter 2.

To establish an upper and lower bound on the impact from increased lending rates to long-run GDP, we rely on two separate estimates, both presented in BIS (2021c). The model simulation used for our lower bound estimate⁹¹ estimates that an LCR-induced increase in lending rates of 5 basis points corresponds to a decline in GDP of 0.04%. For our upper-bound, we rely on simulations from the euro area specific “3D model”,⁹² which finds that an LCR-induced increase in lending rates of 6 basis points leads to a decline in GDP of 0.14%.

Under the common assumption that these effects scale linearly for small changes in parameter values, we estimate that the permanent GDP impact of an increase in lending rates following an LCR-induced adjustment lies in the range of 0.01%-0.02% decrease per basis-point increase in lending rates. Assuming that the cost increases for banks is passed onto consumers symmetrically, we estimate that GDP could decrease permanently following the introduction of a digital euro by 0.12% to 0.34%, with a mid-point estimate of 0.23%, in a severe uptake scenario and a high lending rate spread.⁹³

As costs are directly impacted by the chosen holding limit, it is evident that choosing lower holding limits may greatly reduce the adverse impact on lending interest rates. This relationship suggests that a low holding limit should be preferred to limit the potential adverse economic effects of funding costs on interest rates and the overall economy.

⁹⁰ See Table 8 in BIS (2021c): *Assessing the impact of Basel III: Evidence from macroeconomic models: literature review and simulations*.

⁹¹ BIS refers to this model simulation as “Norway (Cost approach)”, as the model as it relies on the NEMO model developed by the central bank of Norway.

⁹² BIS refers to this model as “Euro area 3D (cost approach). This is a macroeconomic encompassing three layers of default, developed and extended by researchers at a range of European central banks, including the ECB. See BIS (2021c) for details.

⁹³ This estimate is based on a holding limit of 3,000 euro, 100% uptake and a funding spread of 300 basis points, which yields an average increase in lending rates across all consumers of 14.5 basis points.

CHAPTER 4

CONCLUSION

In this report, we have considered the effects that a digital euro could have on financial stability and consumer welfare, particularly in light of the intended objectives of introducing it. This focus does not in any way indicate that other expected impacts on banks, such as from the investments/costs side and the erosion of existing revenue streams, are less significant or adequately tackled. The digital euro is a project of high complexity and as such, more studies will be needed to deep dive into its different anticipated impacts.

Our overall evaluation from the financial stability and consumer welfare viewpoints is that it is not clear what financial sector challenges the digital euro will solve and that, depending on its final design and holding limits, it may impact financial stability appreciably.

As explained in Chapter 1, we argue that the effects on financial stability are primarily driven by the level of adoption of a digital euro, which in turn heavily depends on two parameters, *holding limit* and *the demand for the digital euro*.

In Chapter 2, we emphasise that in order to assess effects on financial stability, and given the uncertainties surrounding the digital euro, it is essential to focus on the effects in times of market stress, where users are more likely to hold digital euro up to the allowed limit and where liquidity risks can be aggravated. Moreover, even in steadier states of the financial system, where the uptake of the digital euro may be less pronounced, the risk to financial stability is not entirely avoided. If the initial adoption of the digital euro is moderate and leads to many dormant digital euro wallets, it increases the scope for sudden shifts in deposits during economic distress.

Our results show that the introduction of a digital euro with a 3,000 euro holding limit could lead to an outflow of up to 739 billion euro from commercial banks. Banks would need to mitigate this outflow by increasing their long-term funding by up to an amount equivalent to a 20% expansion of debt issuance. Additionally, a shift to wholesale funding could substantially decrease the NII for banks by as much as 7.2%, impacting their performance and operations.

In addition, we find asymmetrical impacts across countries, markets, and banks of different sizes. We conclude that the resilience of banks more heavily reliant on deposits will be threatened given an unanticipated high or sudden demand for a digital euro. For more heavily impacted banks, refinancing needs can amount to up to five times their current debt issuance, which would leave them vulnerable to wholesale funding dry ups. We cannot rule out that such refinancing may not be possible for all banks, which further underlines the risks that a digital euro would pose to financial stability. Relatedly, the impact on smaller banks is disproportionately large. Even if we assume that these banks would be able to refinance their funding needs (which may not be the case), we find that the smaller banks in our sample could face a decrease in NII of up to 13.0%, almost twice as large as the aggregate decrease across all banks (7.2%).

As our results in Chapter 3 show, there is not a clear way in which a digital euro would fulfil its intended objectives and increase consumer welfare.

First, the digital euro's possibility to maintain the euro's role as a monetary anchor is limited if financial stability is to be protected, given the current design features (e.g. holding limit and zero remuneration). Unless financial stability is sacrificed, the digital euro will mainly address the role of means of payment, having a reduced impact on the monetary anchor role of the euro.

Second, the digital euro is unlikely to significantly promote competition and innovation in payments. Its added value compared to the existing payment solutions is unclear and the proposed compensation model and price regulation create risks potentially discouraging service providers from further innovating in this area. Furthermore, the market is becoming increasingly competitive even without the digital euro, further limiting its possibilities and need to improve competition and innovation.

Third, we find it highly uncertain to what extent a digital euro would improve financial inclusion in the EU. For the financially excluded population, a general low demand is expected due to low interest and a low perceived need of a digital euro, particularly compared to continuing to use cash. Additionally, while certain design features of the digital euro could and intend to cater to demands of the financially excluded population, many of these features can be achieved through already existing digital solutions.

Fourth, introducing the digital euro creates a set of additional initial and recurring costs for financial institutions, PSPs, and merchants. These costs could at least partly spill over to consumers via increased lending rates and restricted access to lending. The increased lending rates could have a lasting impact on investment decisions and economic activity, and lead to a permanent reduction in GDP of 0.12-0.34%. Furthermore, additional costs such as overarching infrastructure costs, maintenance and compliance costs, and loss of revenue in payment and other banking services must be thoroughly accounted for when assessing the effects of launching a digital euro. These additional costs can trigger further transmission mechanisms leading to reduced consumption and investment, potentially hindering overall economic activity in the EU.

Overall, we find limited evidence that the digital euro, under its currently proposed implementation, will realise all the benefits and value-added stated as its objectives. Moreover, it would entail higher costs for the financial system, with potential spillover effects to consumers, and could have a negative effect on financial stability, particularly in times of market stress.

Should policymakers choose to implement the digital euro, it is critical to ensure a viable business model from the start and to set an adequate holding limit. Our analysis suggests that setting a zero or low holding limit with a robust governance around it would mitigate risks to financial stability without necessarily reducing effectiveness in achieving other objectives as the digital euro could still be used for payment transactions, even at a zero holding limit.⁹⁴ Lower holding limits – including a possible zero holding limit – would likewise reduce the risk of adverse impact on lending interest rates and thus overall economic activity. As an example, setting a holding limit of 500 euro rather than 3,000 euro would decrease the required balance-sheet adjustment for commercial banks by more than 80%, significantly reducing the potential impact on financial stability.

⁹⁴ Notably, for online payments.

Moreover, the implementation of the digital euro should be coupled with a transition period long enough for banks, PSPs, and merchants to adapt to the expected operational and financial impacts.

Finally, we recommend an additional thorough quantification of other costs and financial effects that remain largely unknown but will likely be significant to the overall impact of the digital euro, such as (i) the costs of setting up and maintaining the digital euro infrastructure; and (ii) the extent of the erosion of existing revenue streams.

If launched, the digital euro marks an enduring shift in the financial landscape. It is in the interest of both the public and the private sectors, and of society at large, to assess its viability and implications on all possible angles well in advance to clearly identify its added value and robustly mitigate its risks.

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APPENDIX A

**DEVELOPMENT OF THE DIGITAL EURO'S
OBJECTIVES****Box A.1 Development of the digital euro's objectives**

In 2020, the ECB published a report identifying a broad set of objectives.⁹⁵ These included the role of the digital euro in:

- (i) facilitating monetary policy transmission (e.g. via interest rates);
- (ii) providing an alternative to the lending options offered by large banks; and
- (iii) providing real-time data on economic activities.

However, in 2022, during the investigation phase, the ECB published the “*key objectives of the digital euro*”. There, the ECB identifies a set of key policy objectives that are overarching across the ECB's progress reports on the investigation into the digital euro. These key objectives identified by the ECB are:

- (i) ensuring that citizens can continue to trust in the monetary anchor behind their digital payments;
- (ii) protecting the strategic autonomy of European payments and monetary sovereignty; and
- (iii) helping to avoid market dominance, improve the efficiency of the payment system and foster innovation in the private sector.

According to the European Commission's proposed regulation for introducing the digital euro, its general objective is to “*ensure that central bank money with the status of legal tender remains available to the general public, while offering a state-of-the-art and cost-efficient payment means, ensuring a high level of privacy in digital payments, maintaining financial stability and promoting accessibility and financial inclusion*”.

The proposal further gives insight into the intended benefits of the digital euro in two ways. First, the impact assessment considers the two following objectives:

- (i) “*reinforcing the euro's monetary anchor in the digital age*”; and
- (ii) “*strengthening the EU's open strategic autonomy by increasing the euro's competitiveness vis-à-vis other currencies, third country CBDCs and other privately issued means of payment not denominated in euro*”.

Second, the European Commission identifies the principles that should guide the design, introduction, and use of the digital euro. According to these principles, the digital euro aims at

- (i) safeguarding monetary and financial stability;
 - (ii) promoting innovation and competition in the payment system;
 - (iii) enabling cross-border payments;
 - (iv) helping the digital economy; and
- protecting consumers and ensuring financial inclusion.

⁹⁵ ECB (2020)

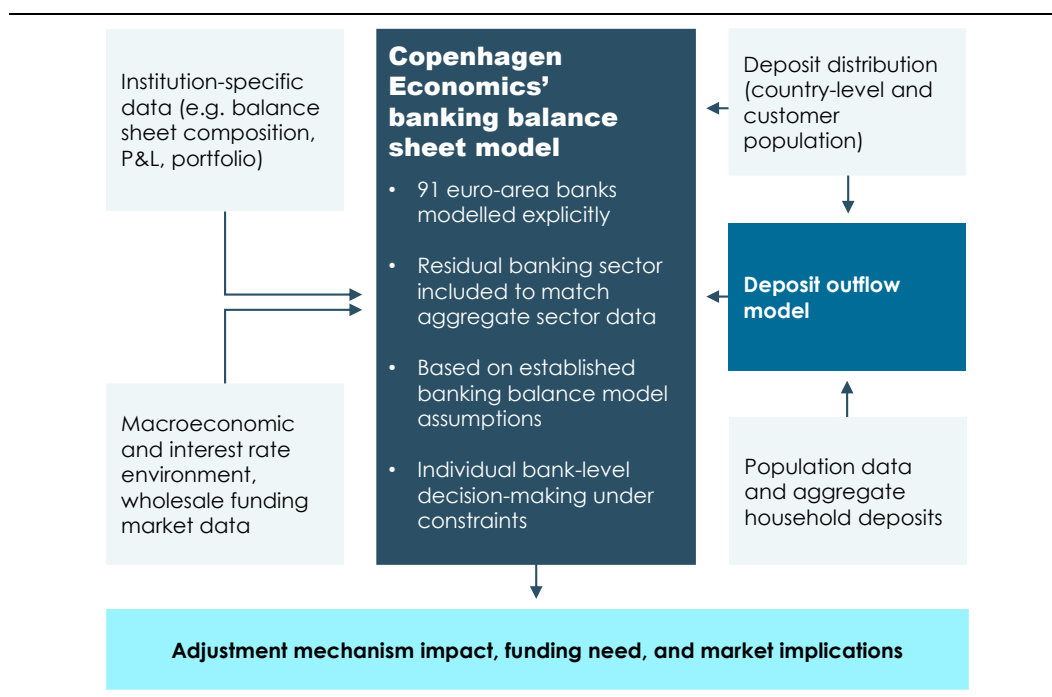
APPENDIX B

MODELLING EXERCISE

This Appendix describes the two interconnected models used for estimating deposit outflows and subsequent adjustments by individual banks to ultimately estimate the potential impact of the digital euro on financial stability. We also provide a brief account of the data sources.

Both models take a bottom-up approach, focusing either on individual bank balance sheets or the distribution of household deposits within each member state in the euro area. These models draw from publicly available data and proprietary data obtained for this research, consolidated by members of the European Banking Federation (EBF). See Figure B.1 for an illustration of the modelling approach.

Figure B.1
Illustration of modelling approach

**DATA FOUNDATION**

Our modelling exercise relies on three main data pillars to simulate deposit outflows and balance sheet adjustments:

- EBA Transparency Exercise Data
- Disaggregate country-level data provided by EBF and its members
- Other publicly available data (from ECB and EBA)

EBA Transparency Exercise Data

The primary component of our balance sheet modelling stems from the latest EBA Transparency Exercise, released in December 2022. This exercise provides data up to June 30, 2022, which forms our reference point. For euro area banks included in the EBA Transparency Exercise, this enables us to extract data on both the asset and liability side for each bank.

For each bank, we construct the complete liability side. This comprises the full funding base, most notably including household deposits, deposits from other sources, and debt issuances. For assets, our focus is on the loan portfolio, its composition, and central bank reserve holdings. Additionally, we extract data on interest income and expenditure to determine the net interest income (NII), calculated as the difference between these two figures. All flow values (e.g. interest income) are annualized from the half-year data available as of June 30, 2022⁹⁶.

In total, we utilize data from 91 major banks situated in a member state within the euro area, with assets approximating 25 trillion and household deposits close to 7 trillion. For the rest of the banking sector, which mainly includes smaller banks, we rely on an average value among smaller banks included in the dataset and data assumptions on the structure as provided by EBF.

For more details on the EBA Transparency Exercise's data, please refer to Copenhagen Economics (2022) or EBA.

Country-level data provided by EBF

In addition to the EBA's publicly available data, we obtain country-specific data from several EBF members. This data focuses on the distribution of deposits among customers and funding costs. It helps us populate our balance sheet model with a “residual bank” as a proxy for the banks not covered by the EBA Transparency Exercise. In addition, we rely on deposit distributions to estimate deposit outflows. This proprietary data is shared in confidentiality with Copenhagen Economics.

When possible, this data is provided disaggregated into “smaller” and “larger” institutions, which generally corresponds to whether banks are considered a significant institution under the ECB. When national aggregates are submitted, we construct a residual measure for “smaller institutions” by subtracting data from the EBA Transparency Exercise from the aggregate levels.

If data for specific member states is absent, we use alternative data that most closely mirrors the household deposit ratio of the concerned country. The timeframe for this data spans from July 2022 to March 2023, and we have made no adjustments for these variations.

Other publicly available data

To supplement the data from the EBA Transparency Exercise and substantiate data assumptions of non-covered banks, we rely on the EBA Risk Assessment Report and the accompanying Risk Dashboard, which includes a much broader set of banks. We define the data included in the EBA Risk Dashboard as the relevant banking universe and use the difference between total level of household deposits recorded in EBA Risk Dashboard and the EBA Transparency Exercise as a measure of banks not covered by the Transparency Exercise.

⁹⁶ This applies to all banks in the data set, except one, for which the fiscal year does not follow the calendar year.

To supplement data obtained from EBF members on deposit distributions, we use the Net Wealth distribution from the ECB Household Finance and Consumption Survey, wave 2021, scaled to match the average deposit level per person, and to be qualitatively in line with distributions shared by EBF members. The use of household deposits rather than individual deposit levels is chosen to be consistent with the ECB's proposal, which specifies that holding limits of an individual can be shared among households.

Finally, we use aggregate euro area household deposits in all deposit-taking monetary financial institutions for the distribution of deposits among countries, also sourced from the ECB⁹⁷, but scaled down to match the aggregate euro area household deposit level considered in our study. We combine this with the number of inhabitants above the age of 15 in each euro area country to obtain an estimate for the average level of holdings per customer in each country.

Data limitations due to aggregation

As EBA Transparency data is aggregated at a group level, banks may hold a significant portion of their household deposits outside the country they are registered in. However, the ECB HCFS-based estimation of deposit distributions only contemplates in-country household deposits. We have not adjusted for this in our model, relying on the implicit assumption that characteristics of foreign customers align with those in a bank's home country.

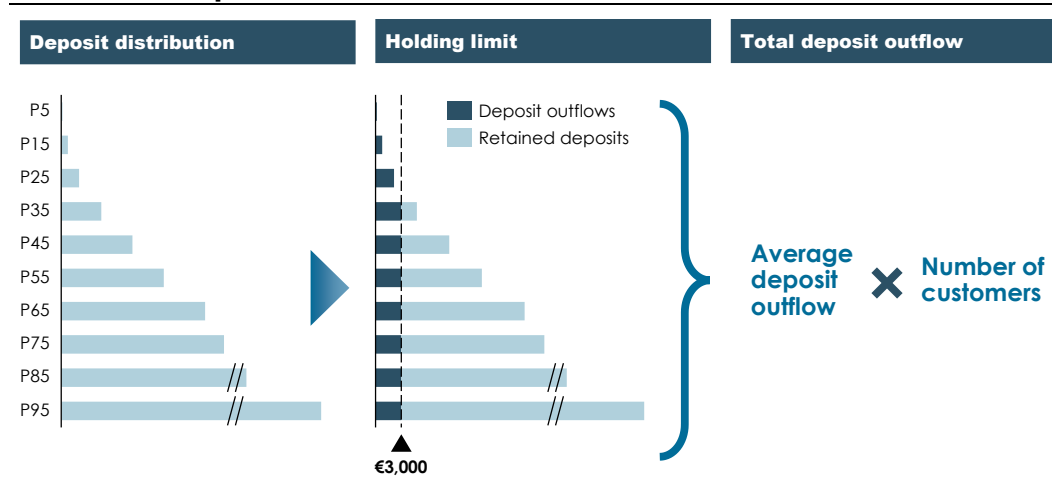
DEPOSIT OUTFLOW MODEL

We estimate the deposit outflows for each country and for smaller and larger institutions, respectively, through the following steps:

1. Estimate deposit distribution
2. Calculate average outflow per person for given holding limit
3. Derive deposit outflow for each individual bank

⁹⁷ See the MFI Balance Sheets Report by ECB: <https://sdw.ecb.europa.eu/reports.do?node=1000005718>

Figure B.2
Illustration of deposit outflow model



Note: Deposit distribution is illustrative only.

The distribution of deposits is generally not readily available but is important to consider for a meaningful estimation of deposit outflows, as it impacts the number of customers for whom a holding limit will bind. For this reason, we obtain this data from members of the EBF as described above. When unavailable, we rely on the distribution of household Net Wealth from ECB HCFS, scaled uniformly to match average deposit levels.

Step 1: We estimate the in-decile deposit holding as the average between the deposits of the previous and current decile plus 15% to account for the heavily right-skewed distribution. We use zero for the lower bound and estimate the upper bound by assuming that the difference between the 9th and 10th decile is equal to 250% of the difference in deposit holdings between the 8th and 9th decile. Finally, we scale the distribution such that the aggregate level of deposits among the population – when following our estimated distribution – corresponds to the aggregate level of deposits in the aggregate data.

Step 2: Based on our estimated distribution and a given holding level, the maximum outflow in each decile is determined by the lesser of the estimated deposit holding and the given digital euro holding limit. For groups with substantial deposit holdings (such as the 9th decile in any country) the holding limits we examine are consistently binding. However, for groups with more modest deposits, the actual deposit outflow may be below the holding limit, leading to an average level of deposit outflows smaller than the holding limit.

Step 3: Given the average deposit outflow per person for each country and each type of financial institution, we estimate the total deposit outflow as the implied number of customers, multiplied by average deposit outflow. The number of customers is induced by the level of deposit holdings and average deposits per (adult) person. This ensures that the outflow is spread proportionally among banks, according to level of household deposits, to account for the fact the customers can spread their digital euro holdings among different banks or fund their digital wallet from all their available deposits in any commercial bank.

BALANCE SHEET MODEL

For the simulation of adjustment channels, banking funding needs, and impact on the current portfolio and banking business model, we apply an adapted version of our Banking Balance Sheet Model, as described i.e. in Copenhagen Economics (2019) and Copenhagen Economics (2022). The modelling rests upon 4 steps:

1. Establish existing funding base and asset portfolio
2. Shock banks by individually estimated deposit outflow
3. Simulate LCR-neutral adjustment to balance sheet
4. Assess financial impact on banks

Step 1: Existing funding base and asset portfolio

For each bank, we construct the existing balance sheet. For liabilities, we consider the entire funding base. On the asset side, we explicitly include central bank reserves and loans and allowances, while collapsing all other assets to a single residual asset.

We construct residual banks by adopting balance sheet characteristics from “smaller institutions” within each country, as categorised by data submitted by members of EBF. The size of residual banks is determined by the difference between total household deposits in EBA Transparency Exercise and EBA Risk Dashboard, as described above. Given the importance of household deposits in the modelling exercise, we use this as measure as our sole target, introducing small discrepancies in other targets (e.g. total assets), for which we make no correction.

Step 2: Shock banks by deposit outflow

We shock each bank by a simultaneous outflow of deposits as estimated in our deposit outflow model described above. In an interim modelling step, this is countered by a reduction in cash reserves for the balance sheets of banks to match, leading to severe breaches of liquidity and reserve requirements. Hence, our model adjusts each individual balance sheets under a set of constraints, chosen to keep financial stability broadly unharmed. Namely, we make the following assumptions and restrictions:

- Sustain banking portfolios (static asset side, except for reserves)
- Keep reserves above minimum levels
- Ensure LCR-neutral adjustments

Specifically, we focus on the LCR as the relevant liquidity measure as it is a shorter-term measure ensuring that banks hold enough high-quality liquid assets to meet short-term obligations during stress scenarios, preventing liquidity crises and safeguarding financial stability in the face of a deposit outflow.

Step 3: Simulated adjustment

Given the need for additional reserves, our model applies a reduced-form LCR-neutral asset acquisition rule described in Appendix C. This requires knowledge of the level of the LCR before the outflow but is unaffected by the existing composition of the LCR (i.e. knowledge of the actual High-quality liquid assets and Estimated Net Cash Outflows are not required), which simplifies the analysis considerably, as it mitigates the need for normalising individual components of the LCR.

For any bank with a deposit outflow, the adjustment leads to a slight contraction of the balance sheet through lower levels of reserve holdings, reflecting the lower level of customer deposits.

Note that our simulation is based on data from June 30th, 2022, where excess reserve holdings with ECB were plentiful. For this reason, reserve requirements generally do not bind. Since then, excess reserves have effectively vanished⁹⁸. Hence, the adjustment may underestimate effects for banks in today's environment.

Given the preference to maintain portfolios and LCR, banks generally refer to (secured or unsecured) long-term wholesale funding in our modelling, like the scenario considered by BIS (2021). To the extent long-term funding from the ECB is available, banks may also turn to such funding, but we do not consider a permanent increase central bank funding a likely scenario.

In the report, we measure the required wholesale funding against existing debt issuance, as a system-wide shock (such as a launch of a digital euro) requires additional funds injected to the financial system. Funding options, such as wholesale deposits or interbank-lending, do not add funding to the financial system, but rather distribute existing funding, which does not mitigate a system-wide shock.

In practice, smaller banks with less ability to access wholesale funding may channel their funding needs through interbank lending, essentially requiring larger banks to issue debt on their behalf. Under normal financial circumstances, this enables the treatment of the debt issuance need as a system-wide aggregate, as presented in Figure 5. Note that this will not hold in times of financial uncertainty, increasing risks for, in particular, smaller banks. For this reason, we highlight the discrepancy in funding needs among banks in Figure 6.

Step 4: Assessment of impacts

The increased need of funding leads to increased cost of funding, as wholesale funding is generally more expensive than household deposits. In this model, we assume a marginal cost of displaced household deposits of zero, as interest rates on overnight deposits are still near-zero for most countries, and since banks still must maintain deposit facilities for households for deposits in excess of the holding of digital euro.

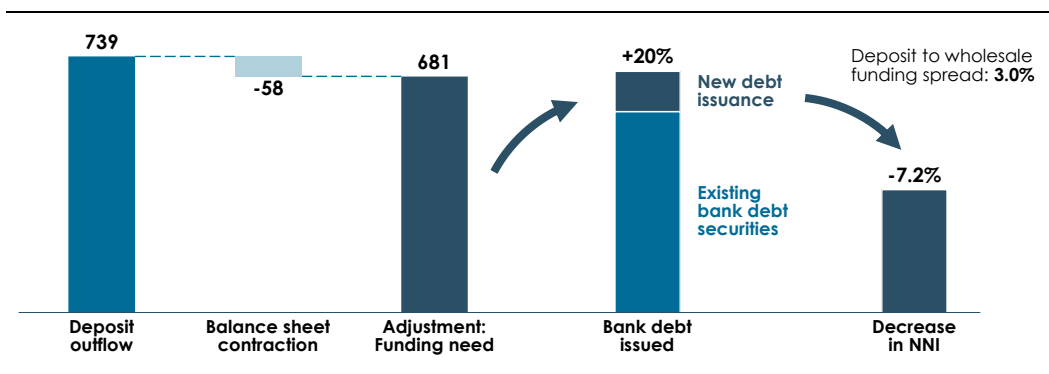
For the cost of wholesale funding, we rely on modelling by BIS (2021), in which the spread between retail deposits and wholesale funding is reported as 0.63% under “benign conditions”. For stress conditions, BIS report 3%. These the parameters are used as our core lower and upper bound values, which we apply uniformly across banks to estimate the increased funding need for each of our scenarios, resulting in a general increase in funding costs.

⁹⁸ https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=117.BSI.M.U2.N.R.LRE.X.1.A1.3000.Z01.E

To demonstrate the magnitude of increase in funding costs, we relate it to (i) existing net interest income (NII), and (ii) the required increase in loan interest rates to meet increased costs. This represents either of two extremes, in which banks take the entire adjustment (NII decrease), or when banks fully pass on costs to consumers (loan rate increase).

Note that the balance sheet model is reduced to assess the impact of changes to the balance sheet, and thus does not capture any other costs to banks (e.g. lost transaction revenues, as discussed in Chapter 3 of this report).

Figure B.3
Illustration of model results in severe case
Billion euro / per cent



Note: Scenario with €3,000 holding limit and 100% uptake. Assumes funding cost for additional debt issuance at 3.0%. Data as of June 30th, 2022.

Source: Copenhagen Economics Banking Balance Sheet Model

APPENDIX C

**FUNDING NEED UNDER AN LCR-NEUTRAL
ADJUSTMENT TO A DEPOSIT OUTFLOW**

When a bank loses deposits, it becomes less liquid. To reestablish liquidity, the bank must acquire additional liquid assets, which requires additional funding, for the portfolio to remain static. This Annex describes how this adjustment may look, and to which extent additional assets must be acquired, based on the assumption that banks make all adjustments on the liability side, and that they prefer to keep the Liquidity Coverage Ratio unchanged after an outflow of deposits. This adjustment framework generally follows BIS (2021) but is adapted to the euro area context.

The Liquidity Coverage Ratio measures a bank's stock of highly liquid assets to a potential loss of short-term funding. Concretely, it is calculated as the ratio between high-quality liquid assets (HQLA) and the estimated net cash outflow over a 30-day stress period (NCO). Prior to an outflow of deposits, it is thus written as

$$LCR_{pre} = \frac{HQLA}{NCO}$$

An outflow of household deposits impacts both the numerator and denominator of this ratio. HQLA decreases one-to-one with deposit outflows, as the outflow of deposits draws down bank reserves. The NCO is only decreased with five percent of the deposit outflow, however, as household deposits are regarded as a very stable source of funding, and thus assigned a low weight (of five percent) in the estimation of the net cash outflow over a 30-day stress period.

By defining the total amount of deposit outflows as DO , and a potential acquisition of additional HQLA by ΔA , the LCR following a deposit outflow can be written as

$$LCR_{post} = \frac{HQLA - DO + \Delta A}{NCO - (0.05 \cdot DO)}$$

For the LCR to remain unchanged following an outflow of deposits, it is required that

$$LCR_{pre} = LCR_{post} \Leftrightarrow \frac{HQLA}{NCO} = \frac{HQLA - DO + \Delta A}{NCO - (0.05 \cdot DO)}$$

Isolating for ΔA , the need for acquiring additional HQLA, we find

$$\frac{HQLA}{NCO} = \frac{HQLA - DO + \Delta A}{NCO - (0.05 \cdot DO)} \Rightarrow \Delta A = (1 - 0.05 \cdot LCR_{pre})DO$$

This implies that a bank must increase HQLA to match the outflow of deposits, less a factor of five percent of the initial LCR ratio. Given an initial LCR of e.g. 150%, the bank would thus have to acquire new HQLA worth $(1 - 0.05 \cdot 150\%) = 92.5\%$ of the deposit outflow, to reestablish the LCR.

This ultimately leads to a funding need of corresponding size, which must be financed by long-term funding as to not decrease the LCR further.