June 2025

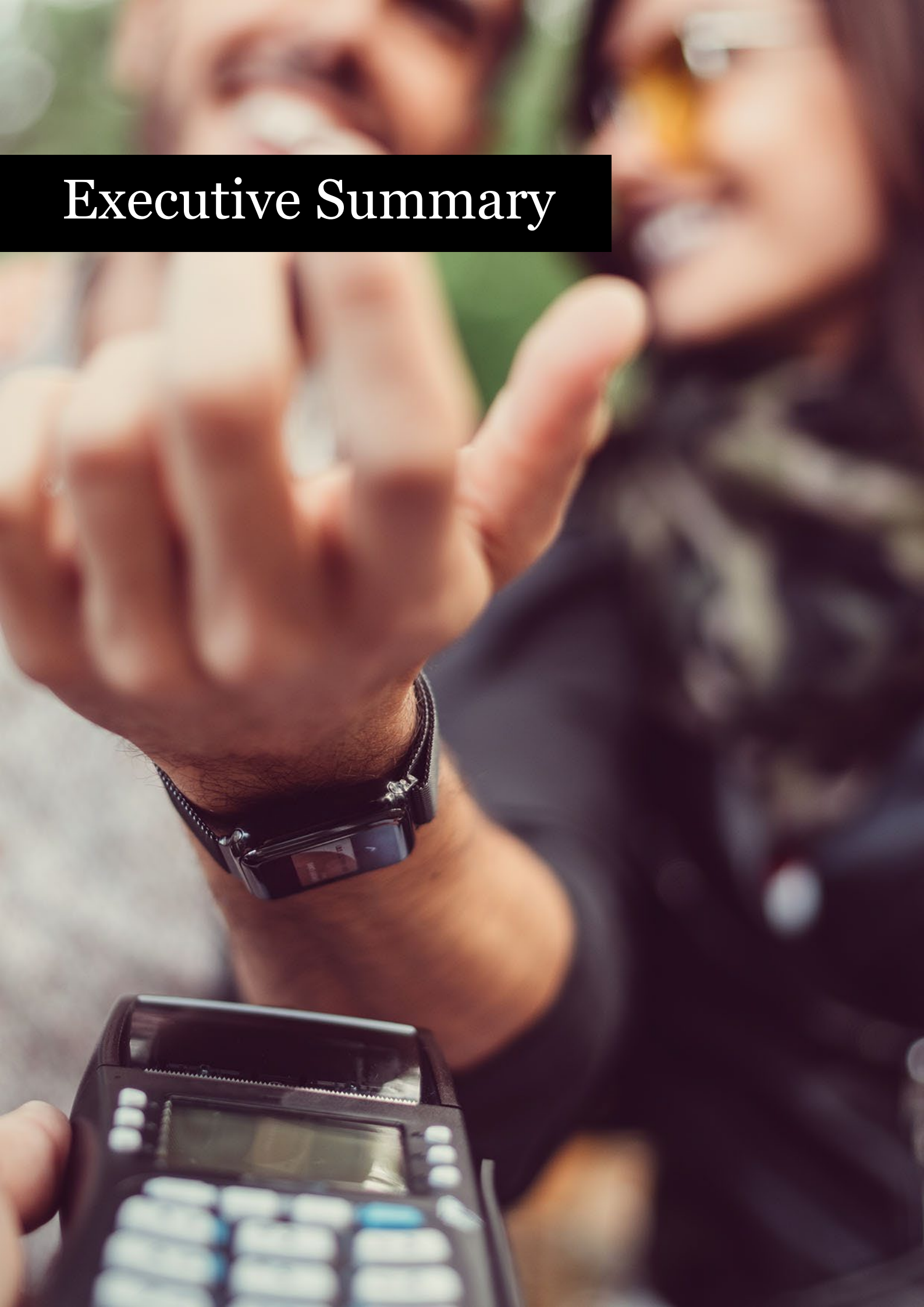
Digital Euro Cost Study

From concept to implementation: evaluating some economic implications of the digital euro for European retail banks

pwc

Commissioned by the European Association of Co-operative Banks (EACB), the European Banking Federation (EBF) and the European Savings and Retail Banking Group (ESBG)

Executive Summary



Background

Through the retail digital euro initiative, the European Central Bank (ECB) aims to provide a European electronic means of payment accessible and accepted in all euro area countries.[1] The ECB furthermore seeks to alleviate dependence on non-European players in payments. The digital euro is to be offered to euro area citizens as a payment option, free for basic use, with pan-European reach for peer-to-peer and point of sale (both in store and online) transactions, complementing cash and ensuring the continued legal tender status of physical currency, while promoting public money transactions in an increasingly digitalised economy. Additionally, it aspires to future-proof the euro against evolving financial technologies and potential competition from foreign digital means of payment. At the same time, for the ECB to be able to implement the project, a regulatory framework is needed; this is why the European Commission has proposed a regulation for the digital euro, which is now under scrutiny by the co-legislators.

While the digital euro project as presented by the ECB may portray a number of advantages, several concerns have arisen, ranging from safeguarding financial stability and the lending capacity of banks to avoiding crowding out home-grown solutions, stifling private innovation and ensuring a viable investment and business model for the digital euro. The scope of the initiative is extensive and ambitious, entailing a significant demand on resources for banks both in terms of financial and human capital.

The objective of this Digital Euro Cost Study is to provide a fact-based assessment of investment and resource requirements of the introduction of the digital euro for retail banks within the euro area, should the decision be taken to proceed with its issuance. Commissioned by the European Credit Sector Associations (ECSAs), namely the European Association of Co-operative Banks (EACB), the European Banking Federation (EBF) and the European Savings and Retail Banking Group (ESBG), the study was conducted by PricewaterhouseCoopers (hereafter only referred to as PwC).

Purpose of this document

> This study aims to provide an initial estimation on parts of the costs banks might face if they need to implement the Digital Euro based on the current understanding of its design.

It delves into the complexities of the digital euro introduction by analysing a sample of 19 European banks or banking groups, hereafter referred to only as “banks”. It focuses on the material change cost drivers and key implementation challenges, such as heterogeneous IT landscapes, operational complexities and impact on full-time equivalents (FTEs). This report aims to contribute to the debate among stakeholders by formulating fact-based observations.

[1] Based on “FAQs on the digital euro”, European Central Bank, 2023

Scope

The study at hand examines change costs associated with the issuance and distribution of the digital euro and the technology to process digital euro payments including automated teller machine (ATM) and point of sale (POS) terminal and e-commerce infrastructure. Costs related to the payment processing at the merchant domain were not considered.

> "Change costs" refer only to the expenses of introducing the digital euro over a period of four years. It excludes running costs or future change costs beyond this period.

The cost estimation was based on the best understanding of the digital euro's potential design, as per the current version of the Digital Euro Scheme Rulebook (V0.8a), which is still work in progress. For example, the offline and multiple account features, which remain under consideration were not included in the scope of the quantitative estimates as the requirements for these functionalities were not sufficiently detailed for a quantitative assessment when the study was conducted. The change costs identified should therefore be considered as a first approximation of the minimum expected change costs of this limited design.

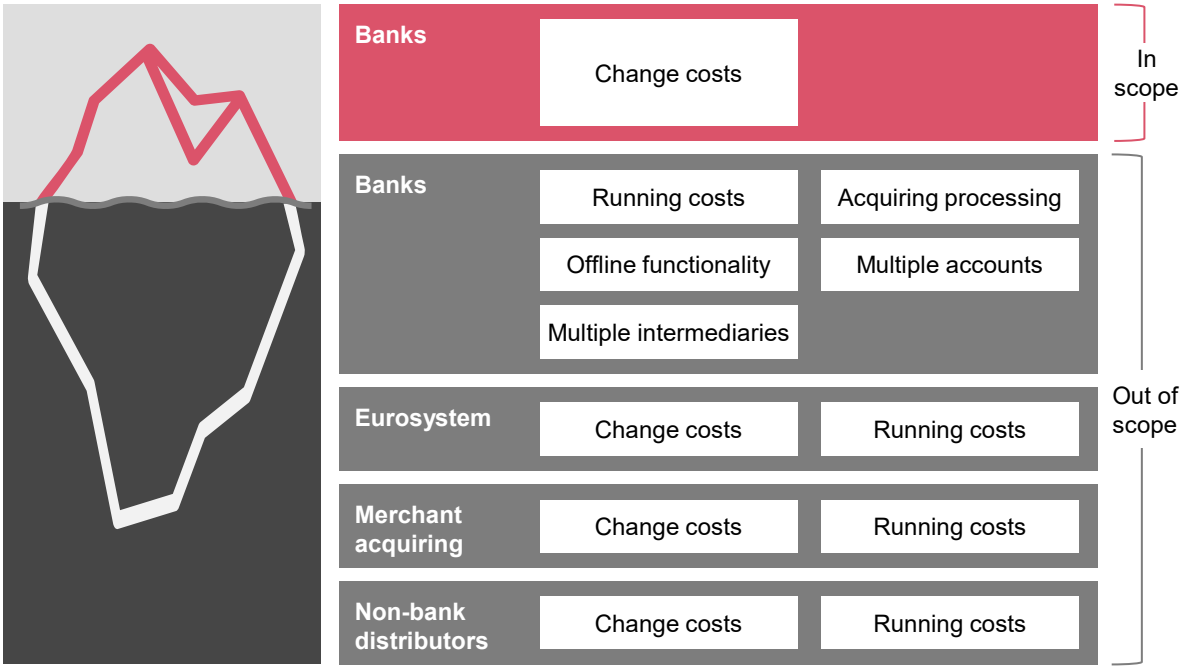


Figure 1 Scope of the Digital Euro Cost Study compared to total market (schematic)

Figure 2 Extrapolation of introduction costs to the euro area (PwC estimate)

Approach

The study was conducted using data from a sample of 19 banks and banking groups from different sizes, regions and business models. It is based on a survey conducted between August and December 2024, reported early 2025. The study was based on a "black box" approach where the estimates of the participating banks were collected in a **fully anonymised way**.

The study utilised a model developed by PwC to structure the estimates for major digital euro cost drivers across three layers:

1. **Commercial layer** focuses on the go-to-market approach and customer relationships;
2. **Technical layer** covers technology and infrastructure including (mobile) banking applications, physical card, ATMs, branch networks, POS terminals, as well as functionalities the rulebook lists as liquidity and access management;
3. **Operational layer** takes a closer look at core back-office processes, such as fee calculation, reporting, and payment statistics, to support the seamless integration of the digital euro.

Overall, more than 40 cost positions were estimated by each bank complemented by qualitative information where participants could provide additional explanations to their estimates. These comments were used to contextualise the estimates and derive the concluding remarks of the study.

Key findings

> The survey shows that the change costs for banks in the study panel (alone) amount to more than 2 billion euro, excluding offline, multiple accounts and merchant acquiring.[2]

The cost estimate depends largely on the size of the banks together with other characteristics such as their structure (centralised or decentralised), with average change cost estimated at 110 million euro per bank, excluding offline, multiple accounts and merchant acquiring (i.e., the cost for the processing of payments). In line with the scope of this study, this figure represents

[2] Note: To enhance readability, the overall sum of costs as well as the averages have been rounded and are presented as approximate values. The estimates are intended to convey the overall scale and distribution of costs.

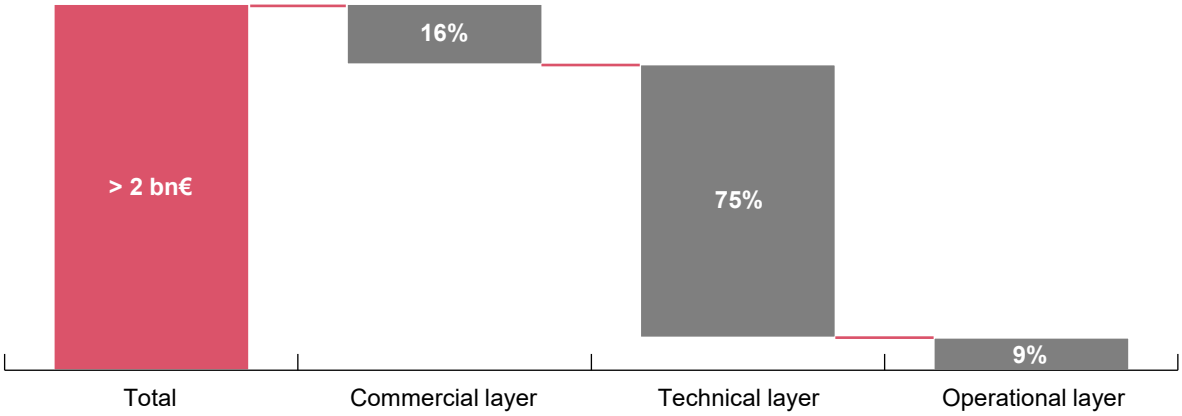


Figure 3 Distribution of costs across the PwC Payment Layer Model

only a part of the total costs to be covered for the introduction of the digital euro. If the results of this study are extrapolated to the entire euro area, the total change cost for banks in the euro area could amount to 18 billion euro.

Main cost drivers relate to technical adjustments (e.g., intermediary applications, interfaces and ATM infrastructure), which account for around 75% of the estimated total costs of participating banks (> 1.5 billion euro). Additionally, the introduction of the digital euro will not only entail considerable financial resources but also significant deployment of personnel from across various areas of expertise. On average, respondents assume that almost 46% of the resources with relevant skills would be tied up per year – some banks assume even higher capacities – which would materially limit the innovative ability of the banks.[3]

Discussion

Based on the cost and resource estimates, the study highlights significant concerns over the financial and operational viability of the digital euro in its current form for retail banks in the euro area. While this study does not address the value proposition itself, it is intended to form the first pillar of a full cost-benefit analysis that is needed before reaching key design decisions on the digital euro. This should be followed by a fact-based discussion about the scope of the digital euro, considering the available financial and human resources of banks.

[3] Based on: “Banking in 2030 – How will the current global trends, especially AI, shape the post-COVID19 pandemic future of the European banking industry and its employees?”, Arix Research, 2024

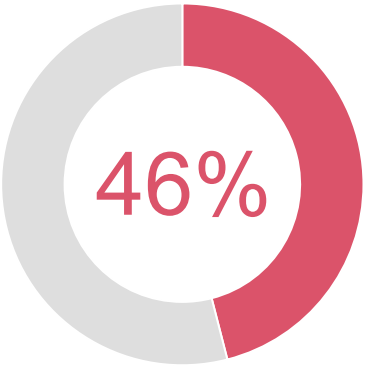


Figure 4 **Estimated average share of resources with relevant skills required to implement the digital euro as reported by respondents**

Conclusion

The current proposal for the introduction of the digital euro, based on version 0.8a of the Digital Euro Scheme Rulebook, requires significant financial commitments from financial institutions with limited prospects for cost recovery.

On the basis of the study, PwC has derived several key takeaways in terms of competitiveness, synergies and efficiency gains, as briefly outlined below:

- **High financial burden**: The study estimates that minimum expected change costs for introducing the digital euro would cost each bank an average of 110 million euro, excluding offline, multiple accounts and merchant acquiring (i.e., the cost for the processing of payments), with the total cost of implementation for participating banks amounting to more than 2 billion euro.
- **Extrapolation to the euro area**: When extrapolating to the entire euro area, the total cost could amount to 18 billion euro.[4]
- **Significant operational and competitive challenges**: The study highlights major financial, resource, and operational hurdles for banks, limiting their capacity for innovation. Particularly in the long-term when running costs have to be considered as well.
- **Cost-efficiency and sustainability**: To ensure long-term viability, and considering the broad impact of the digital euro, the total cost must be significantly reduced. Leveraging existing infrastructure and industry standards will enhance efficiency and avoid conflicts with private-sector initiatives. A thorough cost-benefit analysis is essential for design development and targeted implementation, alongside a fair compensation model to offset investment burdens and maintain competitiveness in innovation by the European banking sector.

[4] Considering an additional scenario where the offline and multiple accounts functionalities, and multiple intermediaries are included in the design (~40%) and possibly lower synergies (~20%) could occur, change costs may be as high as 30 billion euro.

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Introduction to the Digital Euro Cost Study

1

Background: The study was commissioned by the three European Credit Sector Associations, namely the European Association of Cooperative Banks (EACB), European Banking Federation (EBF) and the European Savings and Retail Banking Group (ESBG) (collectively referred to as ECSAs) and conducted by PricewaterhouseCoopers (hereafter only referred to as PwC).

Objective: The study sets out to offer key stakeholders – banks, ECB, the European Commission, the co-legislators – factual quantitative and qualitative insights into the cost impact of the potential introduction of the digital euro as an important factor in related decision-making. It broadens the perspective beyond internal assessments and provides observations on the challenges of a potential implementation to provide a constructive contribution to the dialogue between the aforementioned stakeholders.

The following chapters provide a guide through the multiple facets of the digital euro's introduction. The report begins with an overview of the market context and background to the study, in chapter 2. Chapter 3 outlines the general approach and specific assumptions of the study. Chapter 4 proceeds to examine the financial impact of the introduction of the digital euro on European banks highlighting technical, commercial and operational implications of the digital euro and associated key cost drivers. Chapter 5 provides insights into the consequences of the digital euro illustrating key observations from the study, supplemented by final conclusions in chapter 6.

Market context and study background

2

Uncertainties regarding the Digital Euro Scheme Rulebook: Potential concerns are related to macroeconomic challenges, competition, business models for intermediaries, data privacy, and operational issues. The rulebook encompasses considerable functional complexity (e.g., offline functionality, etc.) in order to enable the digital euro to address all conceivable use cases – be it online transactions, offline payments, or in-branch top-ups – across various form factors.

Unintended consequences of the introduction of the digital euro: Doubts have been expressed whether the digital euro provided by the Eurosystem could end up benefitting non-EU players. Especially global technology companies could simply integrate the digital euro into their ecosystems, which would inadvertently strengthen their position vis-à-vis EU players.

Overlap with private sector payment solutions: The European payment landscape contains many different national and international payment solutions. The functional scope of these solutions often overlaps, and the digital euro would increase this overlap and potentially compete with other regional or local payment solutions.

Limited ability to innovate: In addition to the introduction of the digital euro, European banks are faced with considerable ongoing regulatory compliance and the implementation of multiple regulatory initiatives. With digital euro on top, banks will face a capacity bottleneck in both financial and human resources limiting their ability to innovate.

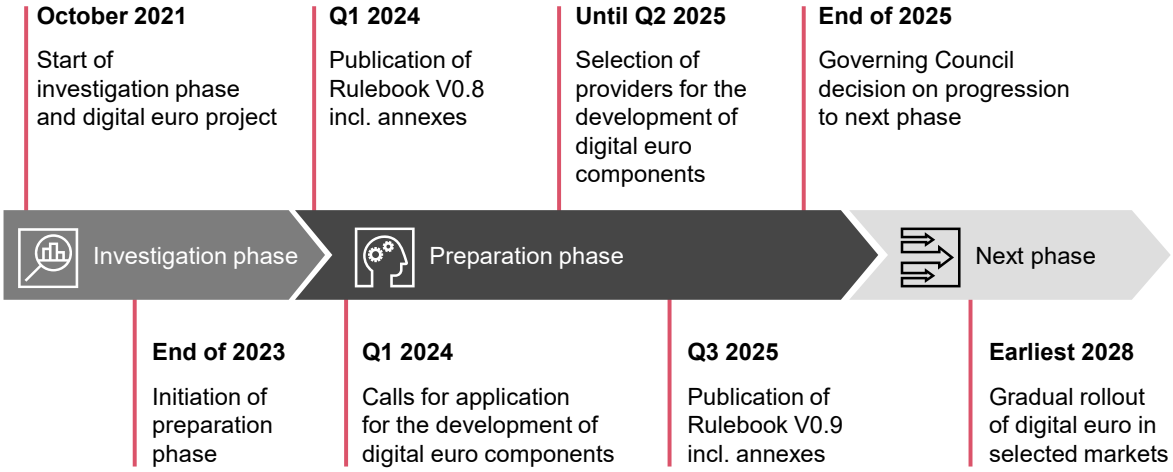

Figure 5 High-level expected timeline of the digital euro project as envisioned by ECB (illustrative)

Digital euro project

The digital euro project comprises several key phases. Following the publication of the ECB Digital Euro Report in October 2020, the investigation phase started in October 2021 and concluded in October 2023. It focused on exploring design options and distribution models and established various platforms with stakeholders, including EU policymakers and market participants, to assess how a digital euro could function effectively within the existing financial ecosystem.[5]

In December 2023 the ECB published version 0.8a of the rulebook which provides a high-level outline for the digital euro and provided the basis for this study. An updated version of the rulebook is expected to be released mid-2025, which may introduce further cost implications. The ECB intends to make a decision on the continuation of the project by the end of the year.

Observations from the banking industry

ECB's digital euro proposals have been analysed in detail by the European banking sector. Several key concerns were articulated including those related to macroeconomic challenges, competitiveness, business model for intermediaries, privacy and possible unintended consequences and last, but not least, potential impacts on bank liquidity, lending capacity and financial stability.[6]

The question of whether sovereignty in payments can be achieved through private sector payment means has been frequently raised, especially in light of existing European initiatives,

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[5] PwC illustration based on "Timeline and progress on a digital euro", European Central Bank, 2024

[6] Please see among others: "Effects of a digital euro on financial stability and consumer welfare", Copenhagen Economics, 2023; "The digital euro - implications for the European banking sector", Volker Brühl, 2024; "A digital euro beyond impulse", Centre for European Policy Studies, 2023; "Vision on a Digital Euro Ecosystem", European Banking Federation, 2023

which aim to expand across the EU (e.g. EuroPA, and the European Payment Initiative, EPI). The mandatory acceptance of the digital euro would create overlap or competition with existing private-sector offerings (e.g. among others Bizum, MB Way, girocard), potentially stifling existing innovation and affecting the competitive landscape. This may undermine European-led initiatives in payment solutions and limit the development of new, locally-driven alternatives.[7]

Additionally, the introduction of the digital euro could inadvertently benefit non-European actors, particularly large tech companies, which are expected to integrate the digital euro into their platforms, such as wallets and e-commerce services, strengthening their position vis-à-vis EU players.[8]

This would position these foreign platforms as the primary consumer interface, thereby, undermining the ECB's objective of achieving strategic autonomy in payments. The business model for intermediaries, such as banks and payment service providers (PSPs), is another important aspect. Intermediaries would need to invest in infrastructure and compliance measures, such as Know-Your-Customer (KYC) and Anti-Money Laundering (AML) requirements, to facilitate the digital euro's distribution. The banking community has called for clarity on how data will be managed and shared to maintain trust among consumers and stakeholders in order to allow for the completion of effective KYC and AML procedures. In addition, clear mechanisms for compensating intermediaries for these tasks are necessary to ensure their continued engagement and viability. Moreover, banks need to cater for elaborate funding and defunding capabilities, for which a clear mechanism for compensation is also necessary, especially in a scenario where digital euro users can fund and defund at any intermediary in the euro area irrespective of an existing customer relationship.

Furthermore, there are concerns that the digital euro will significantly overlap with existing payment solutions, both in terms of use and geographical reach,[9] that already include use cases such as real-time wallet-based payments, digital value-added services as well as protection for consumers and merchants.

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[7] See among others: "EBF contribution to the ongoing debate on a Central Bank Digital Euro, How does a digital euro fit the payments landscape", European Banking Federation, 2021

[8] See among others: "Digital euro and competition issues", EACB, 2024, "Digital Euro; Digital Euro Policy Brief", Centres for European Policy, 2023

[9] See among others: "A digital euro beyond impulse", Centre for European Policy Studies, 2023; "EBF contribution to the ongoing debate on a Central Bank Digital Euro, How does a digital euro fit the payments landscape", European Banking Federation, 2021

Study design and panel

3

Study focus: The study examines change costs over a period of 4 years associated with the issuing and distribution of the digital euro and technology to process digital euro payments including ATM and POS terminal and e-commerce infrastructure. Costs for the merchant acquiring (i.e., the cost for the processing of payments) and costs for other market participants were not considered.

Selection of participants: 19 retail banks and banking groups from the euro area were included based on size, region, and business model for broad representation. 17 of the 19 participating banks provided estimates for their home market, two participants for the euro area, which was accounted for in the extrapolation approach.

Assumptions: To minimise the scope for interpretation and thus generate a uniform basis for estimation, the participants were provided with clarifying assumptions in addition to the rulebook.

PwC Payment Layer Model: The model provides a standardised framework for cost estimation, comprising commercial, technical, and operational layers.

Study methodology: A black box approach was used to ensure the anonymity of the participating banks, both in terms of qualitative and quantitative data.

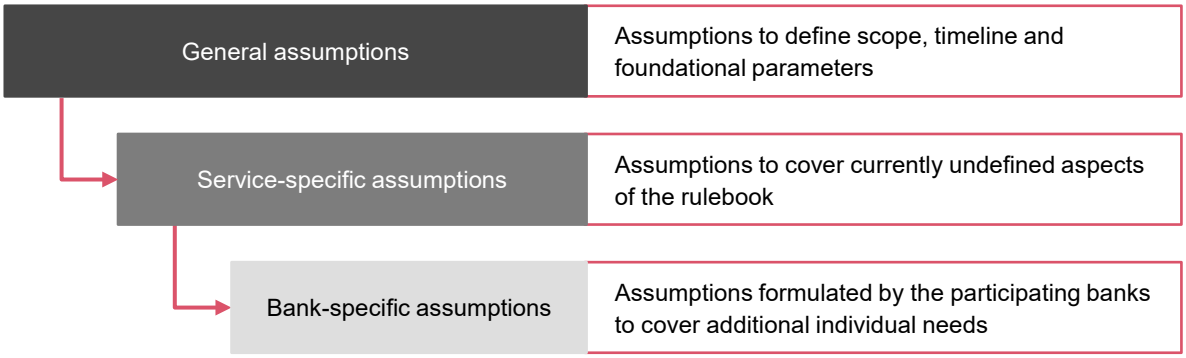


Figure 6 Levels of assumptions

This Digital Euro Cost Study represents an initial step in sizing the financial implications of the digital euro's introduction. It is based on a survey conducted between August and December 2024, reported early 2025. It should be noted that while the study perimeter covers a four-year period, the participants of the study expect that the actual implementation of the digital euro will take even longer. The study did not examine costs of non-bank market participants such as, but not limited to, non-bank PSPs, merchants, and technology providers.

Study design

Accompanying to the estimation framework, three levels of underlying assumptions were formulated to complement requirements of the rulebook that lacked sufficient detail. This includes general assumptions which were established to create a common framework for all participants. Within this context, it was assumed that the digital euro would be account-based to leverage existing expertise and infrastructure. The study also focused on online use cases for peer-to-peer (P2P) and peer-to-business (P2B), including government transactions, as these are central to ongoing discussions by the ECB. Offline and multiple account functionalities, as described in the rulebook and accompanying technical notes, have not been estimated quantitatively but considered qualitatively due to their immanent complexity and vague requirements.[10]

The individual services of the PwC Payment Layer Model (see figure 7) were further detailed with an additional layer of assumptions, referred to as service-specific assumptions, to address the yet-to-be-defined aspects of the Digital Euro Scheme Rulebook V0.8a. These assumptions are based on previous project experience and serve to establish a general direction for the services as needed. In addition to the general and service-specific assumptions, the participating banks were asked to make and document internal assumptions to reflect their specific needs and organisational structures.

The digital euro requirements were mapped to the PwC Payment Layer Model which was utilised as a uniform framework to guide the cost estimation within the participating banks. This framework is divided into the three layers (i.e. commercial, technical, and operational) capturing major digital euro services.

[10] Based on "Technical note on the provision of multiple digital euro accounts to individual end users", European Central Bank, 2024

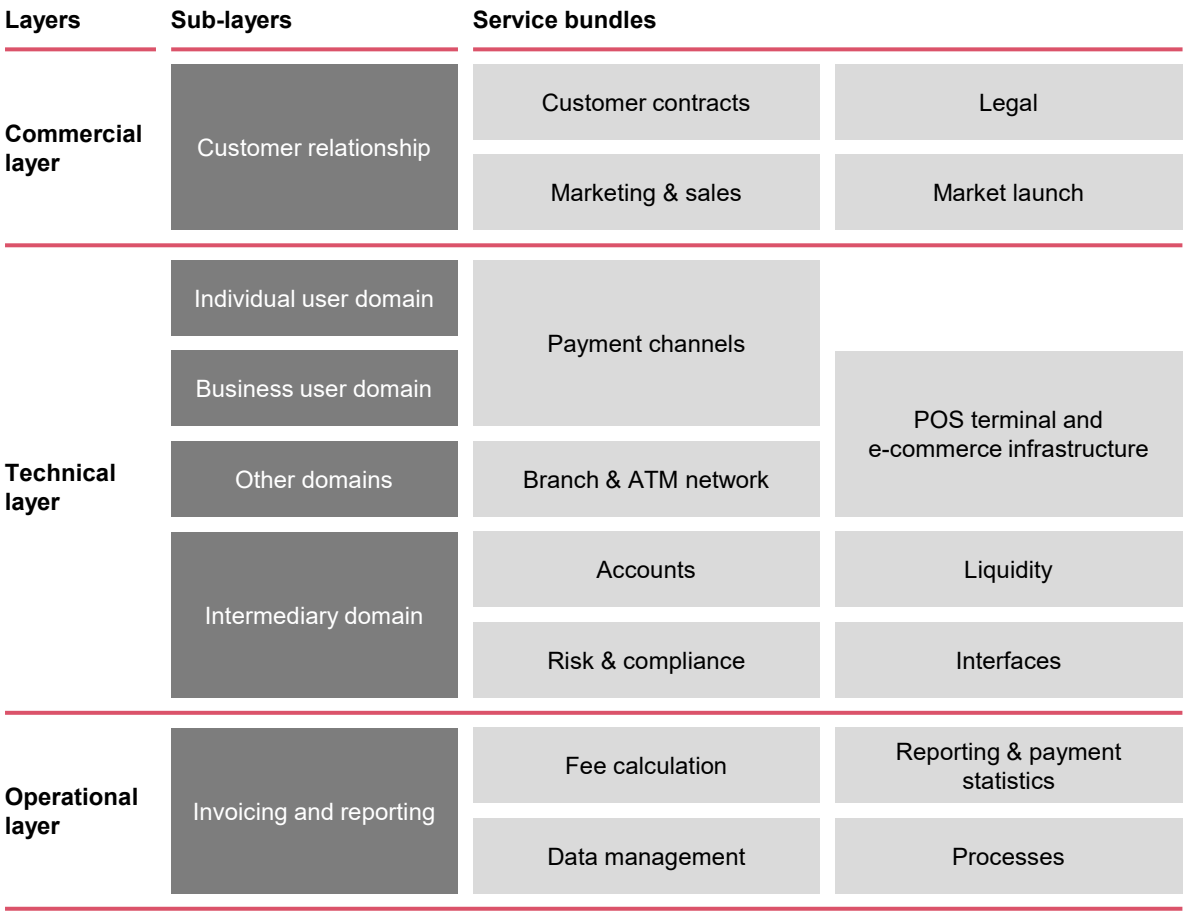


Figure 7 Aggregated view of the PwC Payment Layer Model

The study employed a black box approach to ensure that cost estimates remained untraceable to individual banks. Although the participating banks were known, the online tool's access links were distributed anonymously, preventing any party, including PwC and the ECSAs, from identifying the submitting bank. To maintain confidentiality, all qualitative information entered in the free-text fields of the tool was anonymised, and any design elements that could reveal a participant's identity were excluded. This approach was consistently upheld in all meetings with the study participants, to ensure that participant-specific information was not shared.

After the finalisation of the data submission phase, the collected data was thoroughly analysed. Taking into consideration any qualitative information, the received data was cleaned and benchmarked. Data points that could not be explained on the basis of the qualitative information were scrutinised and participants were given the option to provide additional information anonymously through a pre-defined process. At the conclusion of the data analysis phase over 790 data points were collected, analysed, and benchmarked. More than 90% of the provided data was considered as high quality, meaning that the combination of the provided quantitative and qualitative information sufficed to infer sound interpretations of the data. In the remaining segment of less than 10% of cases, additional steps (e.g., data cleansing, information requests or exclusion of computational errors) were necessary. These additional steps improved the data quality further, resulting in an overall data quality of around 99% when considering the additional qualitative information.

Study sample and distribution

In order to ensure a comprehensive understanding of the change costs which could arise if the digital euro is introduced the participants were selected based on several criteria to ensure a fair representation in terms of market, geography and bank profile. As a result, a sample of 19 retail banks from across the euro area was selected based on three criteria: size, region, and bank type. To maintain participant anonymity, these criteria were structured into clusters. For example, instead of collecting exact total asset values, banks were asked to select a pre-defined asset range. This approach ensured that no individual bank could be identified, even when all three criteria were analysed together.

Bank size

It was ensured that banks of different sizes were introduced to the study panel. The banks were clustered into four size brackets based on their total assets (< 30 billion euro, 30-100 billion euro, 100 billion euro-1 trillion euro, > 1 trillion euro).

Bank type

Lastly the banks also provided information on their bank type by selecting one of the following options from the dropdown menu in the online tool. The selection was based on the association the bank belongs to: ESBG members were asked to select “savings bank”, EACB members were asked to select: “cooperative bank” and EBF members were asked to select the option “commercial/retail bank”.

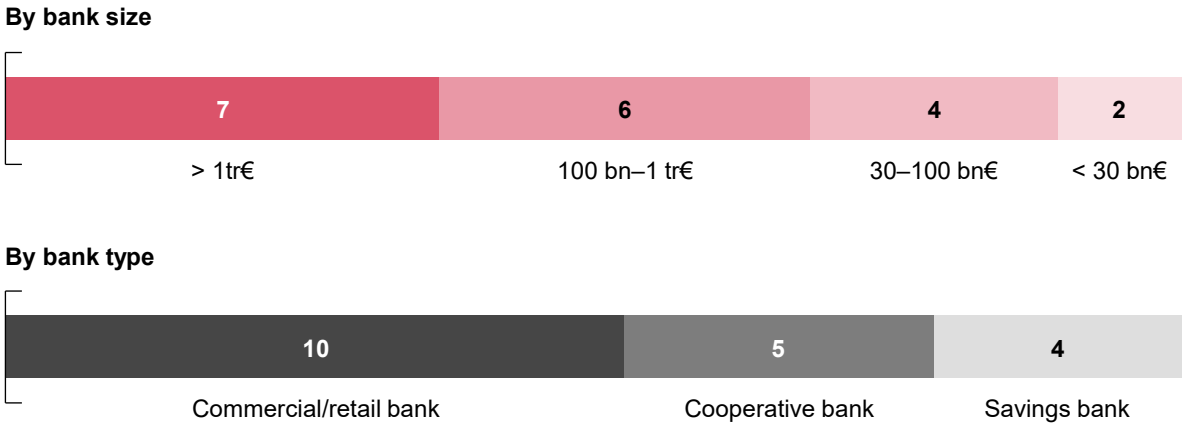


Figure 8 Distribution of study panel by clusters

Key findings

4

Cost estimate for introduction of digital euro: The study participants' aggregated submissions estimate the total cost of introducing the digital euro at over 2 billion euro, excluding offline, multiple accounts and merchant acquiring. On average, the cost per bank is 110 million euro.

Extrapolation to the euro area: When extrapolating to the entire euro area, the total cost could amount to 18 billion euro.

Notable differences by business model and bank structure: Cost estimates varied significantly depending on the structure of the bank (centralised or decentralised) as well as the extent of branch and ATM networks.

Technical requirements as main cost driver: Technical requirements account for around 75% of the total estimated costs (> 1.5 billion euro).

Relevant skills: Respondents estimated that the implementation of the digital euro would tie up approximately 46% of their resources with relevant skills.

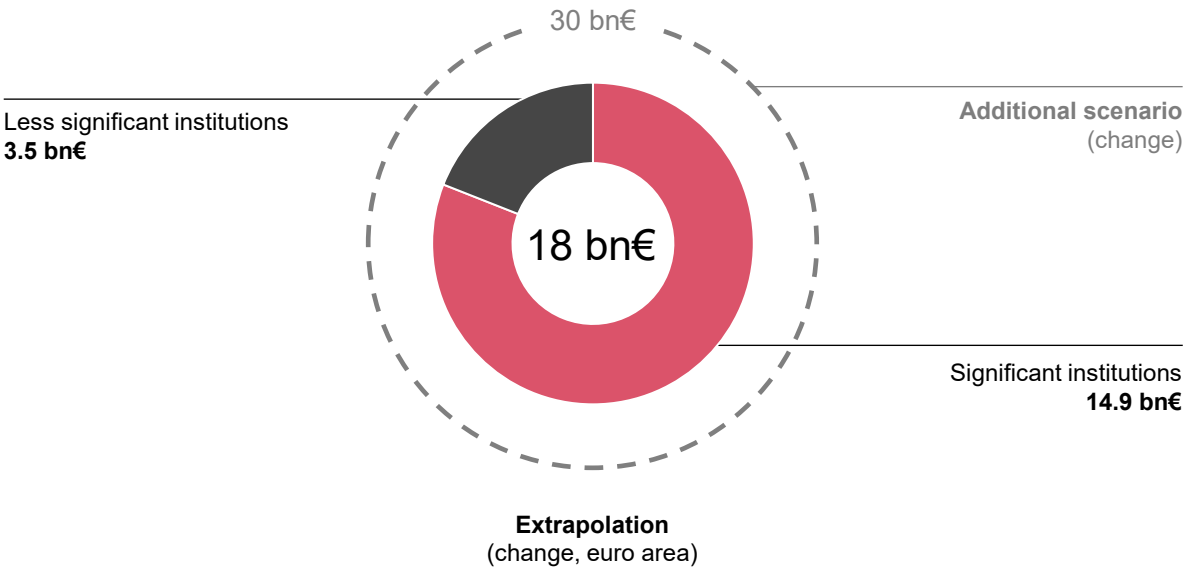


Figure 9 Extrapolation of introduction costs to the euro area and additional scenario (PwC estimate)

Overarching study results

On average, the costs of introducing the digital euro were estimated at 110 million euro whereas the total costs amount to more than 2 billion euro.[11]

To size the overall impact on the euro area, these costs were extrapolated using a top-down approach based on ECB's Single Supervisory Mechanism (SSM) framework.

The SSM forms the basis for the ECB's regulatory supervision and includes 661 significant institutions (SIs) and 2,244 less significant institutions (LSIs). Assuming that the retail banks listed therein are at the forefront of the introduction of the digital euro, the SSM framework provides a suitable basis for extrapolation.[12, 13] The extrapolation uses different estimation parameters to calculate the costs for SIs and LSIs. These values are based on the averages provided by banks in the study within different size brackets. Banks without a retail business were not included, so that the extrapolation covers a total of 212 SIs and 1,891 LSIs. In addition to the extrapolation, it was estimated what could be the costs in a scenario where the offline and multiple accounts functionalities, and multiple intermediaries are included in the design (~40%) and possibly lower synergies would occur (~20%). This was based on additional qualitative information provided by study participants. The scenario was indicative and could be considered as an additional point for reflection.

[11] Note: To enhance readability, the overall sum of costs as well as the averages have been rounded and are presented as approximate values. The estimates are intended to convey the overall scale and distribution of costs.
[12] It should be noted that the SSM framework does not represent all retail banks in the euro area. In 2023, there were 5,304 credit institutions in the euro area.
[13] For details about the extrapolation approach, please refer to the attachments.

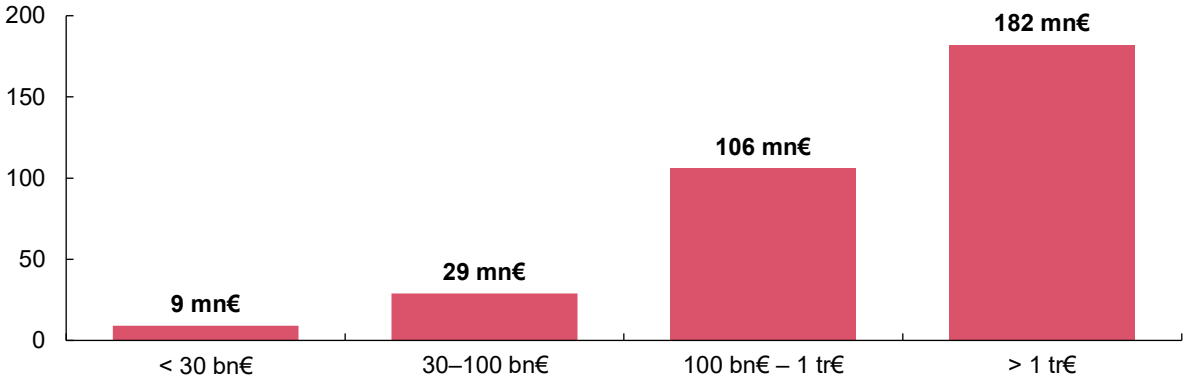


Figure 10 Average total estimate by bank size (rounded, n=19)

> Overall, the extrapolated costs for credit institutions in the euro area due to the introduction of the digital euro could amount to 18 billion using the outlined methodology. In addition to the extrapolation, the indicative scenario leads to change costs that could be as high as 30 billion euro.

On top of the estimated change costs, the implementation is associated with a considerable demand for specialists and IT experts. The respondents assume that ~46% of available human resources with relevant skills from various bank departments (e.g., retail and business users, authorisation, interfaces, liquidity management) must be allocated in full for the introduction of the digital euro for a period of four years.

Considering that the introduction of the digital euro will be mandatory, it is to be assumed that the banks will simultaneously carry out a massive expansion of their workforce, which will place additional pressure on their budgets.

When analysing the quantitative data provided by the study participants, it showed a connection between a bank's size and its cost estimate. Larger banks estimated significantly higher costs on average than their smaller counterparts (see Figure 10). Please note that all averages mentioned here and thereafter are calculated based on the number of responses received, this may differ from n=19. The analysis of the quantitative and qualitative information revealed that costs are also affected by the bank's business model and structure. Banking groups with a decentralised structure where the individual banks operate mostly independently have estimated significantly higher costs for services that require higher coordination efforts (e.g., contract modifications, process adaptations) than centralised banks. Additionally, the business model played a role especially when it came to the change costs in the modifications necessary to the ATM and POS terminal infrastructure. Costs varied significantly depending on whether a bank distributes ATMs and POS terminals themselves or if these services are outsourced.

When comparing the cost estimates by bank type (commercial bank/private client bank, savings bank, co-operative bank), there are no significant differences.

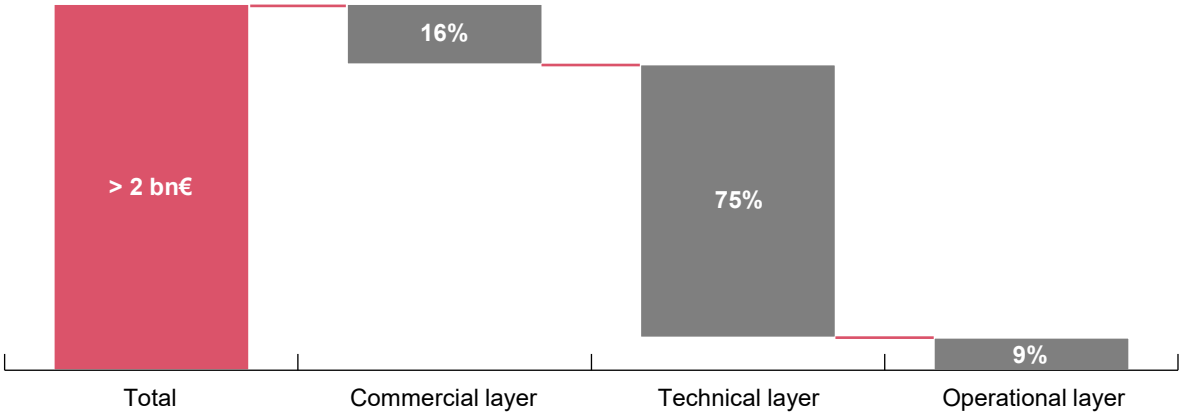


Figure 11 Distribution of costs within the PwC Payment Layer Model

Another perspective on the costs can be obtained by examining their distribution across the three layers of the PwC Payment Layer Model. The analysis shows that the technical requirements account for the majority of the effort, averaging 75% of the estimated costs (see figure 11). When looking at the main cost drivers by average estimates, the majority of these services originate in the technical layer. Only the necessary processes adaptations, contract modifications and marketing investments were services outside of the technical layer.

Summary of results

The bank-internal discussions with the subject matter experts showed various uncertainties regarding the digital euro introduction. Within the meeting formats, participants were able to ask questions regarding the digital euro requirements to ensure a mutual understanding (bank-internal specifics and strategic choices were not part of these meetings).

Note: The averages shown in the visual and mentioned in the text are based on the actual number of submitted estimates for each service. This means the average may differ from n=19, which was used to calculate the overall cost estimates.

When taking a look at the results provided by the study participants, several key complexities and cost drivers can be identified. The following section provides a brief summary of the qualitative information that helps contextualise the quantitative cost estimates presented in the figure below.

Layers	Sub-layers	Service bundles (average costs)			
Commercial layer	Customer relationship	Customer contracts	5 mn€	Legal	2 mn€
		Marketing & sales	7 mn€	Market launch	4 mn€
Technical layer	Individual user domain	Payment channels	23 mn€	POS terminal and e-commerce infrastructure	17 mn€
	Business user domain				
	Other domains	Branch & ATM network	11 mn€		
	Intermediary domain	Accounts	15 mn€	Liquidity	9 mn€
		Risk & compliance	7 mn€	Interfaces	12 mn€
Operational layer	Invoicing and reporting	Fee calculation	2 mn€	Reporting & payment statistics	2 mn€
		Data management	2 mn€	Processes	6 mn€

Figure 12 Aggregated view of the PwC Payment Layer Model (average costs per service bundle, presented costs may not sum precisely due to rounding and variations in methodology)

Technical layer

Accounting for 75% of the total estimated costs, the technical layer encompasses several key areas, including the adaptation of payment channels (mobile applications, web frontends, physical cards), POS infrastructure for payment acceptance (POS terminals, payment pages, e-/m-commerce), interfaces (authorisation backend, digital euro access gateway, digital euro issuer hub and necessary interfaces), and branch and ATM networks. Additionally, banking functions such as account management and liquidity management, as well as, risk and compliance functions (i.e. fraud, risk and dispute management) must be re-examined to meet the demands of the digital euro.

The overhaul of mobile applications is considered a significant effort, with an average cost estimate close to 10 million euro. Web-based frontends are estimated to require lower effort, with average change costs of approximately 3 million euro for individual users and 1-2 million euro for business users.

The integration of the digital euro into existing mobile and web frontends is preferred over relying on the ECB's centrally provided Digital Euro App. The connection to the Digital Euro App is estimated to cost an average of 3 million euro without offering any functional advantage over integration into existing apps. The physical digital euro card is supposed to be usable in all use cases (POS, e-commerce, P2P). The establishment of the issuing infrastructure for the physical card is estimated 6 million euro per bank on average, marking it as one of the most substantial single-service cost projections. It should be kept in mind that this estimate only refers to the change costs, additional running costs for issuing will add to the overall costs.

The adaptation of POS terminal infrastructure is influenced by several factors, including the number of terminals, outsourcing, terminal ownership, and technical maturity. The cost estimates for adapting POS terminals range from 2.5 million euro to nearly 30 million euro, depending on the extent of necessary hardware replacements. The average costs for modifying digital payment solutions for payment pages and e/m-commerce are estimated to be close to 7 million euro.

The distribution of the digital euro through intermediaries' branch and ATM networks presents additional complexity. The average cost for adapting ATM infrastructure is estimated to be around 9 million euro. For the adaptation of the branches, participants estimated an average of 2.7 million euro, with a significant variance depending on the extent of the branch network. The funding and defunding processes for the digital euro require significant changes to banks' internal IT infrastructure, with average change costs for each estimated at 2-3 million euro. The implementation of the waterfall functionality, which ensures the holding limit is enforced, is expected to require an average investment of 3-4 million euro.

When looking at the necessary interface to connect to the Digital Euro Service Platform. Intermediaries would need to connect to the digital euro access gateway, serving as a single access point for all digital euro services. The creation of these interfaces was estimated to cost around 4 million euro on average. Internal interfaces connecting backend systems with frontends are estimated to cost an average of 2-3 million euro. Changes to risk and compliance functions, including payment authorisation, fraud prevention, and dispute management, are crucial for ensuring secure and efficient transactions. The average costs for addressing changes to central authorisation components amount to between 3 and 4 million euro. Additional costs were estimated for fraud prevention systems (average 5 million euro) and dispute management (2 million euro).

The establishment of a fraud management system for the digital euro is estimated to cost around 5 million euro. The costs for dispute management modifications range from 1-3 million euro, with an overall average of 2 million euro. The introduction of the digital euro presents a significant challenge for banks, requiring substantial investments in technical infrastructure, payment channels, and compliance systems. The complexity of integrating the digital euro into existing systems, coupled with the need for new functionalities and compliance measures, underscores the importance of careful planning and resource allocation.

Commercial layer

Within the commercial layer, it was seen that the costs for basic marketing activities as well as the modification of customer contracts are significant cost items. Regarding marketing and sales, responses showed divergence in the banks' role expectations: some institutions assumed that the ECB would handle awareness-raising through advertisements and general campaigns and, as a result, saw less marketing effort on their side. The corresponding cost estimates for marketing and sales were below 2 million euro. In contrast, several banks planned their own, larger, independent marketing campaigns for private customers and merchants, including external support from consultants and specialised agencies, resulting in a cost range between 10 and 30 million euro.

For the modification of contracts, the responses indicated a connection between costs and bank size as well as the organisational structure. Participants estimated the average cost of reviewing, adapting, and formalising changes to customer contracts at around 5 million euro. When looking at the sum of estimates, customer contracts account for around 5% of the total costs estimated. There were significant variances due to differences in size and organisational structure (e.g., number of customers, digital euro-relevant products, activity radius). Larger decentralised institutions estimated significantly higher costs than their smaller counterparts.

Operational layer

In the operational layer, study participants identified several key complexities and cost drivers related to the implementation of the digital euro. Adjustments to back-office functions, such as fee calculations and reporting processes, are necessary for the digital euro's implementation, with notable costs associated with these adaptations. For example, the adaptation of billing and fee calculation systems is a significant cost item, with estimates averaging 2 million euro. Additionally, the uncertainty about permissible fee levels and potential "cannibalisation" were expressed in the qualitative information provided.

Process adaptations include redesigning internal customer support processes across platforms like self-service sites, call centres, and branches, along with adjusting client and employee-facing processes such as onboarding and offboarding. Updating information resources, such as knowledge bases and internal procedures for compliance reasons, is also necessary. Cost estimates for these processes vary significantly based on bank size and organisational structure, the average comes down to 6 million euro.

Observations

5

General observation: The financial impact of the digital euro poses a serious challenge on banks in the euro area given that significant investments for upgrading IT systems, infrastructure and processes (110 million euro in change costs per bank on average) will be required for redundant use cases. On top of that, respondents anticipate dedicating 46% (and some even more) of skilled resources to the digital euro implementation. When extrapolating the estimated change costs to the euro area, the total implementation costs of the digital euro could reach 18 billion euro. Considering an additional scenario where the offline and multiple accounts functionalities, and multiple intermediaries are included in the design and possibly lower synergies could occur, change costs could be as high as 30 billion euro.

Mobile banking applications: Banks can integrate digital euro functionalities into their own mobile applications however the current design as stated in the rulebook V0.8a foresees that that all must connect to the ECB's Digital Euro App. Larger banks may prefer to use their own apps to tailor the user experience. In contrast, smaller institutions might opt to rely solely on the central Digital Euro App to reduce costs and resource demands.

ATM infrastructure: Banks interpreted digital euro requirements differently for ATMs, leading to uncertainty. If the digital euro is introduced in its current design, participants saw it as important to align ATM upgrades with natural replacement cycles and focus on local customer preferences for form factors like near-field communication (NFC) or QR code.

Branches: The digital euro's design envisions a role for bank branches in onboarding, offboarding, funding, and defunding, in order to strengthen financial inclusion. While many banks are streamlining branch networks in response to digitalisation and cost pressures. It was emphasised that, should the digital euro be introduced, its implementation should align with evolving market trends and digital-first strategies.

Physical card: The long-term necessity of a physical digital euro card is questioned due to the continuous rise of digital payments and wallet-based solutions. At least, the card should use existing card infrastructure and align with existing card products to minimise complexity and costs.

POS infrastructure: Acceptance of the digital euro in stores is crucial. The rulebook should allow banks to decide which form factors to use at the POS to account for local market preferences and aligning hardware upgrades with natural replacement cycles to manage costs.

Additional observations: Within the study context the offline and multiple accounts functionalities were also discussed. However, not quantitatively estimated due to in-complete requirements. A thorough cost-benefit analysis is critical before any decision is made.

Observations from the study

During the data collection phase, several issues required further discussion in order to reach a common understanding of the requirements, which are summarised as key topics in the following section.

Mobile banking applications

The ECB envisages a central application for basic digital euro services, the “Digital Euro App”. Alternatively, intermediaries may integrate the digital euro services into their own environments through a software development kit (SDK).

Adapting the mobile banking apps to incorporate the digital euro functionalities, requires significant investments. The main tangible benefits of integration lie in building on existing user experiences, which can streamline frontend implementation and support a more intuitive adoption of the digital euro, particularly in markets with more advanced digital payment solutions. In the course of the study, it has been discussed whether the integration of digital euro functionalities could increase customer interaction in the app. In principle, value-added services can be linked to digital euro use cases with cross-selling potential, however the digital euro is unlikely to lead to new transactions, but rather to a shift from other payment methods.

In general, banks should have the freedom to choose whether to integrate the digital euro functionality into their own apps or to use the app provided by the ECB with benefits for smaller institutions. However, concerns have been raised whether the use of Digital Euro App may interfere with existing customer relationships of the banks.[14]

ATM infrastructure

From the digital euro rulebook, it is not clear whether all ATMs operated by intermediaries need to be able to work with both form factors, NFC and QR code, defined in the rulebook. As a result, the qualitative information has shown that banks interpreted the requirements differently. Among the banks that operate ATMs, some assumed that all of their ATMs would need to facilitate funding and defunding via QR code and NFC while others assumed a limited number of ATMs would need to be able to do so. In general, the ATMs were a hot topic during assessment phase and the requirements need to be clarified. Especially in times of declining trends in the number of ATMs (–5.5% compound annual growth rate (CAGR) 2019–2022)[15] and usage (–5.9% CAGR 2019–2022)[16], there is an opportunity to optimise these investments by focusing on local market preferences and needs.

[14] Please refer to “EBF response to the European Commission’s targeted consultation on a digital euro”, European Banking Federation, 2022
[15] PwC analysis based on “ECB Data Portal”, European Central Bank, 2024
[16] PwC analysis based on “ECB Data Portal”, European Central Bank, 2024

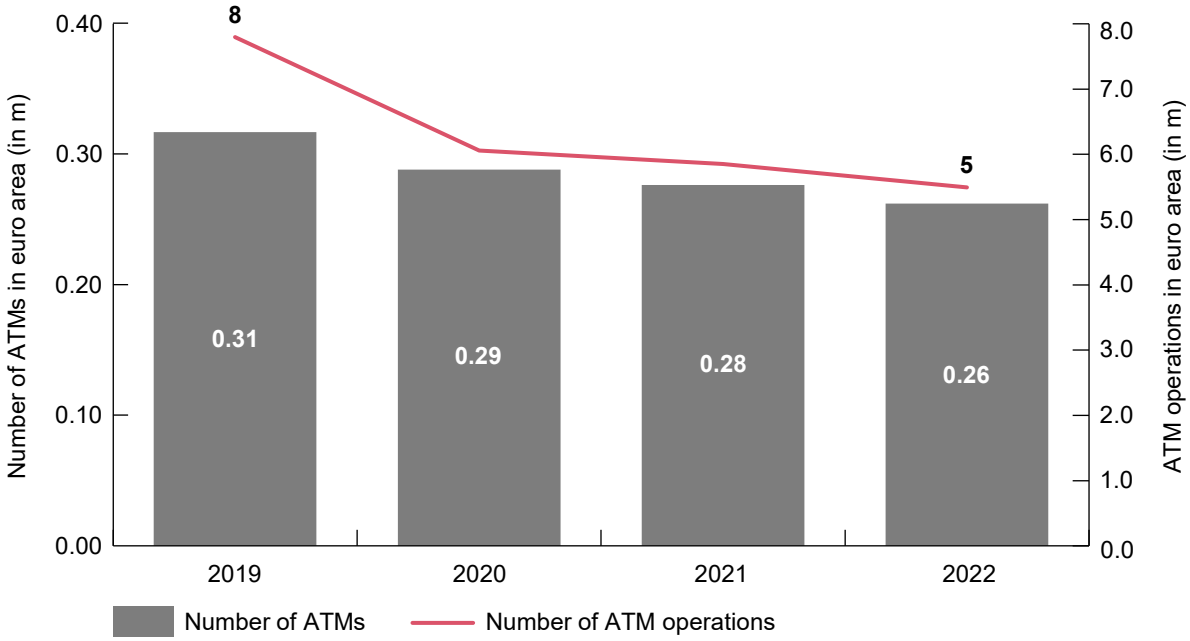


Figure 13 Development of ATM coverage and usage in the euro area (PwC calculation based on ECB Data Portal)

During the study it was also discussed whether ATMs could not just be replaced and made ready for the digital euro in line with their natural replacement cycles. This way intermediaries could optimise the modification efforts and not face unplanned investments due to earlier replacement/modification of their ATM fleet.

Branches

Over the past decades, there has been a declining trend in the number of bank branches. As operational costs continue to rise and demand for online services increases, many banks are reassessing the viability of maintaining extensive branch networks.[17] The combination of these factors, has led to a strategic shift towards optimising branch locations and functions, ensuring that each branch offers maximum reach, value and efficiency. As a result, the euro area has seen a decline in bank branches 106,000 branches in 2023, which corresponds to 30 per 100,000 inhabitants in contrast to 186,000 branches and 58 per 100,000 inhabitants in 2008.[18] By consolidating resources and focusing on high-impact areas, banks can better manage costs while still providing essential services to their customers.

This development is in contrast with the requirements of the Digital Euro Rulebook, where branches are an access point for customers to on-/offboard to the digital euro environment but also for funding and defunding their digital euro wallets. Multiple study participants with a large network of branches have questioned the feasibility of these requirements, especially regarding funding and defunding.

[17] See: “The changing landscape of bank offices in the euro area”, European Central Bank 2024
[18] Based on “The changing landscape of bank offices in the euro area”, European Central Bank 2024

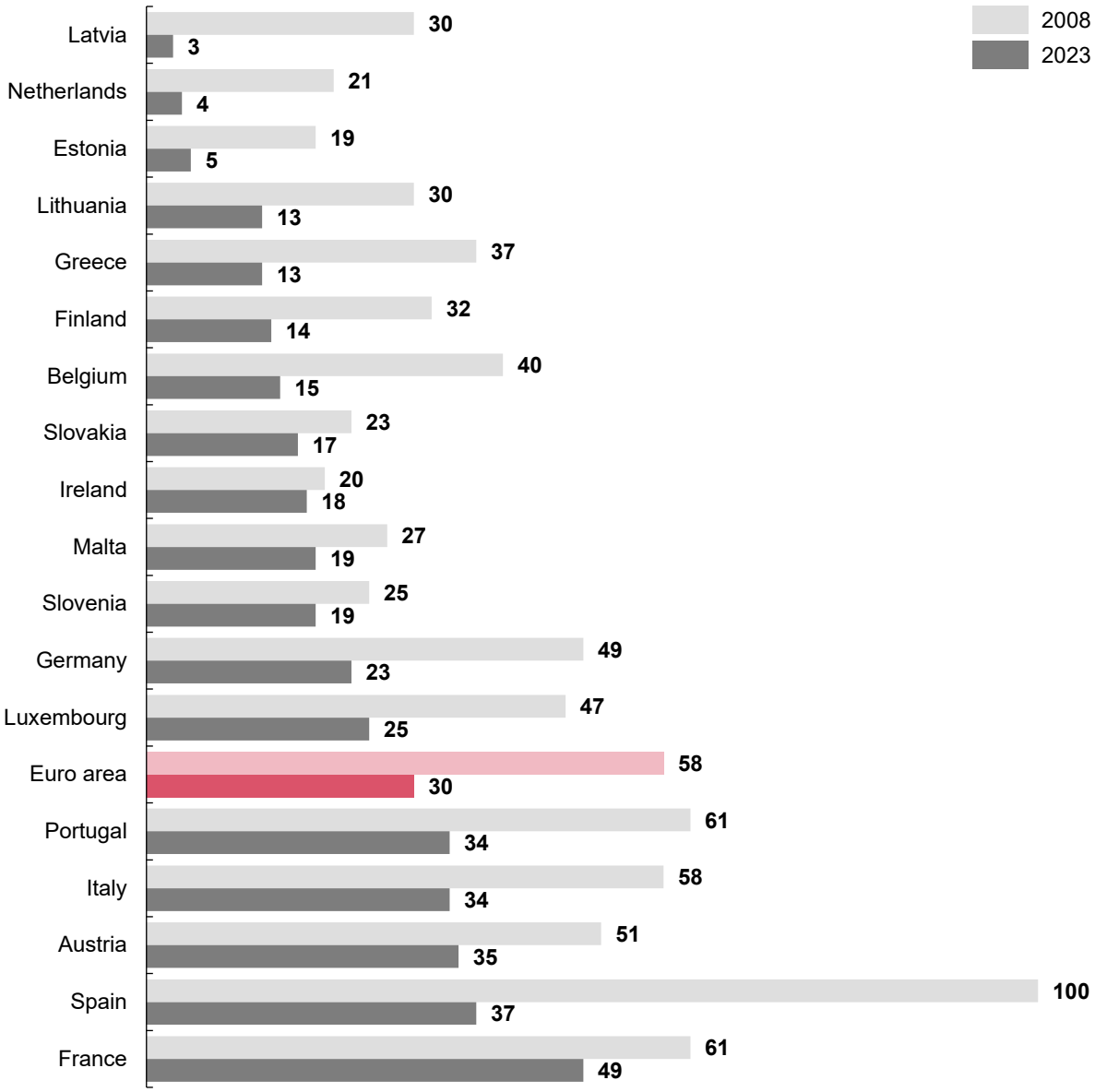


Figure 14 Development of branch networks in selected euro area countries (branches per 100k inhabitants, based on ECB Data Portal)

Physical card

The ECB foresees the physical digital euro card as a way of facilitating the digital euro's role in promoting financial inclusion. Across Europe the usage of non-cash payment methods has been increasing rapidly, based on the latest "SPACE" Study by ECB[19]. One of the drivers of this growth have been wallet-based solutions, especially at the POS, where they are expected to grow at a staggering rate of 24% CAGR until 2027.[20] It is expected that this growth will be possible at the expense of cash and physical card-based payments.

[19] Based on "Study on the payment attitudes of consumers in the euro area (SPACE)", European Central Bank, 2024
[20] Based on "Global Payment Report 2024", FIS, 2024

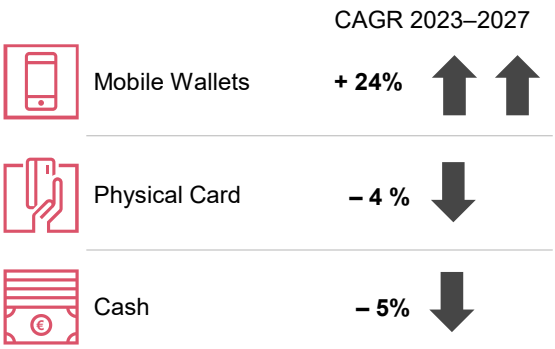


Figure 15 **Expected growth rates of relevant payment methods (based on FIS Global Payment Report 2024)**

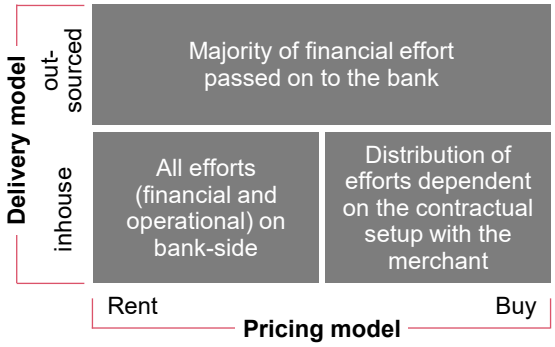


Figure 16 **High-level overview of POS terminal business models in Europe (PwC analysis)**

It is likely that the digital euro card will serve as a transitional product, with most users eventually integrating it into their mobile wallets. Given this trajectory, the long-term value of investing in physical cards becomes questionable.

POS infrastructure

A key factor for the high variance of the estimations of banks operating POS-infrastructure, can be attributed to the varying composition of POS markets in Europe that include different delivery (inhouse vs. outsourced) and pricing models (rent vs. buy, see figure 16).

One of the primary cost drivers identified is hardware modification, which is tied to the number of terminals a bank operates. The study results have shown that the costs differ depending on the customer preferences regarding form factors (QR code or NFC) across the euro area as well as distribution and pricing models.

Additional observations

The following section discusses important additional observations drawn from the qualitative results and discussions with the study participants.

Offline functionality

The offline functionality could not be reliably estimated due to the incomplete requirements compared to other functions described in supplementary digital euro documents published by the ECB.[21] However, a qualitative assessment of the offline functionality allows conclusions to be drawn about the complexity and resulting costs.

The offline feature is intended for P2P and POS use cases, enabling payments without mobile or network connectivity, improving privacy, and mimicking the speed and simplicity of cash. To

[21] See “State of play on offline digital euro”, European Central Bank, 2024, “Rulebook Development FAQs”, European Central Bank, 2023

conduct offline transactions, users must first “fund” digital euro onto their offline wallets, where they face limits on usage time and transaction volume. Upon reconnection, the balance of the offline wallet is reconciled with the digital euro account. Individuals are restricted to one offline wallet, while businesses can hold multiple.

Technically, the offline functionality of the digital euro is designed to work much like a physical cash wallet. Offline transactions occur between two devices in close proximity, with authorisation and settlement executed on each party’s local storage device. As a bearer instrument, funds stored offline are unrecoverable if lost or stolen and reside locally on smart devices or physical cards. Analogous to its physical cash counterpart, transactions with offline digital euro are envisioned to provide similar levels of privacy, confidentiality and anonymity to payer and payee, exponentially adding to the complexity. While the ECB has acknowledged this complexity, it is essential to provide clarity on the requirements, consumer value and ways of implementation before deciding to move forward.[22]

Multiple account functionality

The multiple account functionality would allow users to hold more than one digital euro account with the same or different intermediaries. The reconciliation of different digital euro accounts involving multiple intermediaries presents several technical challenges. Coordinating individual holding limits across multiple accounts and devices requires precise oversight by intermediaries and users, who must ensure that total holding limits remain within ECB-defined thresholds. Moreover, both intermediaries and users will have to complete multiple know-your-customer (KYC) checks and adjustments, complicating both the backend processes and the user journey. Altogether this would lead to unprecedented levels of coordination, data sharing, and reconciliation among European financial institutions.

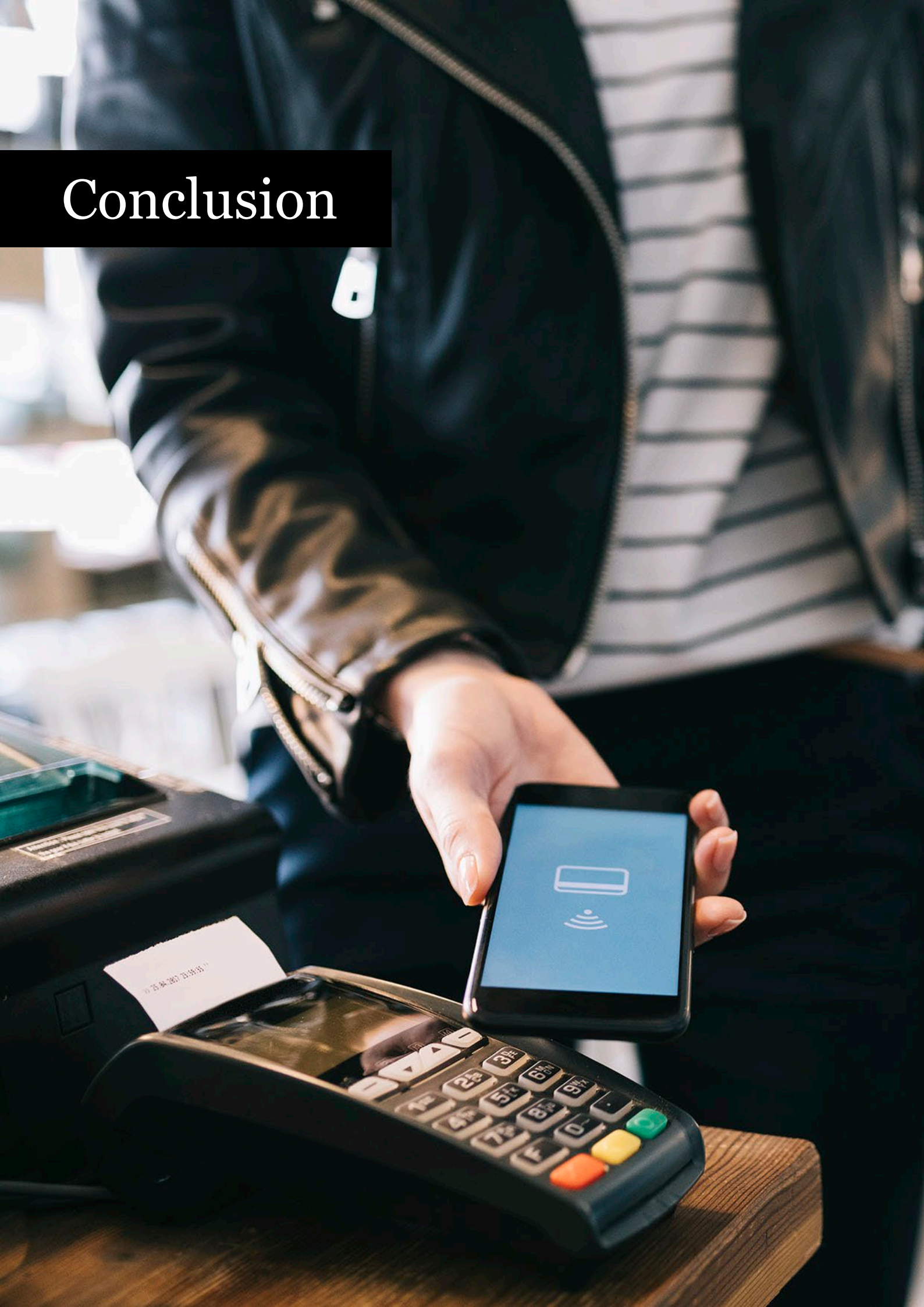
Multiple intermediaries

The ECB envisions a “virtually intermediary agnostic” account setup which allows users to onboard, fund, and defund with any intermediary in the euro area, and even use different intermediaries for their digital euro and linked commercial bank accounts. While this flexibility complements the offline and multiple account capabilities, it also introduces additional layers of complexity, with increased demands on coordination and communication.

A recent study on the consumer preferences in banking, puts the benefits of being able to hold accounts with different intermediaries into question. Based on a representative study across Europe more than 70% of consumers across all age groups do not hold accounts at more than two banking service providers.[23] This raises the question, whether the added value is really in proportion to the additional effort.

[22] See “State of play on offline digital euro”, European Central Bank, 2024
[23] Based on “Global Thought Leadership Consumer Preferences in Banking”, PwC, 2024

Conclusion



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Key takeaways from the study

High financial burden: The study estimates that minimum expected change costs for introducing the digital euro would cost each bank an average of 110 million euro, excluding offline, multiple accounts and merchant acquiring, with the total cost of implementation amounting to more than 2 billion euro for the participating banks excluding offline, multiple accounts and merchant acquiring.

Extrapolation to the euro area: When extrapolating to the entire euro area, the total cost could amount to 18 billion euro.[24]

Significant operational and competitive challenges: The study highlights major financial, resource, and operational hurdles for banks, limiting their capacity for their own innovation. Particularly in the long-term when considering running costs.

Cost-efficiency and sustainability: To ensure long-term viability and considering the broad impact of the digital euro, the total cost must be significantly reduced. Leveraging existing infrastructure and industry standards will enhance efficiency and avoid conflicts with private-sector initiatives. A thorough cost-benefit analysis is essential for targeted implementation, alongside a fair compensation model to offset investment burdens and maintain competitiveness in the European banking sector.

[24] Considering an additional scenario where the offline and multiple accounts functionalities, and multiple intermediaries are included in the design (~40%) and possibly lower synergies (~20%) could occur, change costs may be as high as 30 billion euro.

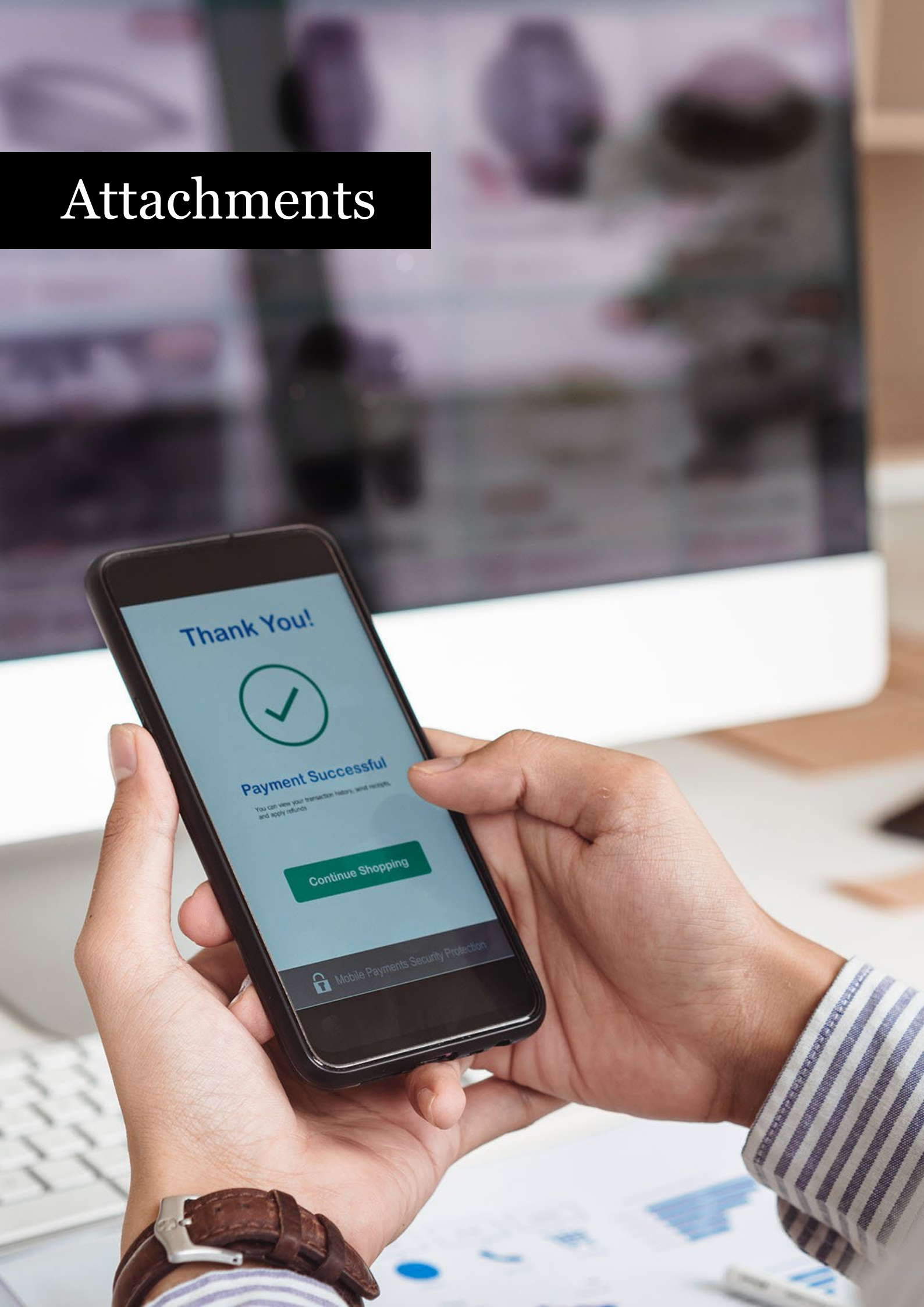
The digital euro project is entering a key phase, with the next iteration of the rulebook (version 0.9) expected in Q2 2025 and the ECB Governing Council to decide on the continuation of the project in Q4 of the year.

Market participants will have to make substantial investments to introduce the digital euro – without distinct prospects of recouping their investments and confidence that the proposed implementation approach is suitable to achieve proportionate benefits. At the same time, the implementation of the digital euro may hinder banks' capacity for innovation. This is a result of the mandatory introduction of the digital euro as it will require the allocation of resources over an extended period of time, thereby limiting the availability of these resources for innovative activities pertaining to other products and services offered by banks to their customers. Consequently, banks' competitiveness is likely to be considerably diminished during the initial years of the digital euro's adoption. This issue is further compounded by the fact that non-bank PSPs are not mandated to distribute the digital euro, which enables them to partake in the associated value at a reduced cost. It is therefore crucial to assess the potential unintended consequences of the design of the digital euro. A key question is whether it could lower barriers to entry for global payment providers and tech companies, potentially disadvantaging local players, payment systems and intermediaries.

As part of the EU's competitiveness agenda, the digital euro should be subject to a competitiveness assessment, with a particular focus on cost and price competitiveness, as well as the impact on the competitive position of European institutions vis-à-vis international players. Such an assessment should ensure that new regulations and measures do not undermine the viability of the EU economy.

In addition to financial factors, the analysis of decision makers should also include the strategic and political objectives of the digital euro. In the current role model, intermediaries are mandated to play a key role in its adoption and seamless integration into existing payment systems and will be facing an immense financial and operational burden. Their involvement will be crucial to addressing consumer needs and ensuring a smooth user experience. Especially since the success of the digital euro will depend on its acceptance by consumers, businesses and the market. To encourage adoption, it is essential to develop a practical, user-friendly framework that meets market expectations and offers a clear value proposition.

Attachments



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Extrapolation approach

The extrapolation of the costs of introducing the digital euro in the euro area is meant to provide a first approximation for the total change cost of the digital euro in the euro area (€ 18bn). It is based on the "List of Supervised Entities", cut-off date 30 November 2024.[25] Using this list as a starting point, significant (SI) and less significant institutions (LSI) were grouped to consider factors such as group structure – i.e., whether digital euro-related costs are borne by the entity itself, by the parent company or the central entity of a group – and only banks with retail business activity (e.g., accounts, cards, payments).

The extrapolation considers distinct characteristics of SIs and LSIs. Among the SIs, some were observed to be significantly larger on average than others, leading to the assumption of lower average costs for the latter. It was also assumed that some SIs are technically dependent on their parent company and can therefore leverage greater synergies, which was reflected in the use of a higher synergy factor. For the LSIs lower average costs were assumed to account for their generally smaller size compared to the SIs. The LSIs were further grouped into categories with different synergy factors depending on the extent to which they can use infrastructure from another entities (e.g., parent company or central provider). It was observed that some LSIs are completely integrated into a banking group and receive all infrastructure from another entity and as a result will not face any costs from the digital euro implementation.

In addition to the extrapolation, it was estimated what could be the costs in a scenario where the offline and multiple accounts functionalities, and multiple intermediaries are included in the design (~40%) and possibly lower synergies could occur (~20%). This was based on additional qualitative information provided by study participants. The scenario was indicative and could be considered an additional point for reflection.

[25] Based on "List of supervised entities", European Central Bank 2024

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List of abbreviations

AML	Anti-Money Laundering
ATM	Automated teller machine
CAGR	Compound annual growth rate
EACB	European Association of Cooperative Banks
EBF	European Banking Federation
ECB	European Central Bank
ECSA	European Credit Sector Associations
EPI	European Payment Initiative (product name wero)
ESBG	European Savings and Retail Banking Group
KYC	Know-Your-Customer
LSI	Less Significant Institutions
NFC	Near-field communication
P2B	Peer-to-business
P2P	Peer-to-peer
POS	Point-of-sale
PSP	Payment service providers
SDK	Software development kit
SI	Significant Institution

Digital Euro Cost Study