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University
of Venice

Laurea Magistrale in
ECONOMIA E FINANZA

Final Thesis

**DIGITAL TRANSFORMATION OF FINANCE AND ITS
ECONOMIC IMPLICATIONS IN EUROPE**

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Matriculation Number 882808

Academic Year

2025 / 2026

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INTRODUCTION

The financial sector has experienced fundamental changes in structure and function over the last few years as a result of digital developments and these are expected to increase. It is transforming not only the means of delivery of financial services but also the organization of economic relations by moving from traditional banking services to digital payment systems, financial technologies and central bank digital currencies. Digitalisation is thus playing a strategic role in the European Union, for example to enhance financial integration, modernise payment systems and boost economic competitiveness. Thus, it is timely and relevant to investigate the economic effects of digital finance both in academic literature and policy making.

Payment systems, credit mechanisms, investment services, data-driven financial applications, digital currency projects are just a few examples of the various aspects of financial digital transformation. The use of digital technologies in the financial industry contributes to faster, more cost-effective and more accessible transactions, but also poses new challenges, including regarding data security, cyber risks, the lack of regulatory framework, and financial stability. This means that digital finance must be studied as a process of economic and institutional change and evolution, along with technological innovation. The primary goal of this thesis is to analyze the growth of digital financial transformation in Europe and to analyse its economic effects. The study focuses, in particular, on the development of digital financial technologies, the EU digital financial policies, the project on the digital euro and its impact on the financial system. Moreover, it strives to shed light on how digitalisation affects financial intermediation activities, financial policy applications, international trade, and financial inclusion. To this end the study aims to answer the following research questions:

- What is meant by the term “digital financial transformation” and what are the components of it?
- What implications has the evolution of financial technologies had on the European financial system?
- What are the reasons for the emergence of the digital euro project and its key characteristics?
- What are the opportunities and limitations of the EU's regulatory approach on ‘digital finance’?
- What are the economic implications of digital financial applications for financial intermediation, monetary policy, international trade and financial inclusion?

- What role does digital transformation play in terms of the competitiveness and financial integration of the European economy?

The purpose of this research is to help advance the academic and political discussions on digital finance and digital currency. Digitalization is more than just technological development; it is a challenge for economic governance and financial stability, as illustrated by assessments, including the one made on the EU's example. This study shows the significance of the current shift in digital finance from an economic perspective and explains the possible consequences of this shift in the future. The thesis comprises of 4 main chapters. The first chapter deals with the conceptual aspects of financial digital transformation: the definition of financial digitalization, the development of financial technologies, the concept of digital currency, central banks and financial regulation. The second chapter examines the evolution of digital finance in the European Union; the digital finance strategies, the regulatory framework, the project of the digital euro, and the technical aspects of this project are analysed. The third chapter is about the economic implications of digital finance, covering the implications for financial intermediation, monetary policy, international trade and financial inclusion. The fourth and final chapter looks at digital finance indicators in Europe, assesses the results and explores the advantages and disadvantages of the European Union's digital finance strategy.

CHAPTER 1

CONCEPTUAL FOUNDATIONS OF FINANCIAL DIGITAL TRANSFORMATION

1.1 Definition and scope of financial digitalization

In its broadest definition, financial digitalization denotes the shift to a situation when digital technologies dominate in the production, delivery, access, and use of financial services; it is not only the movement of existing transactions to an electronic space, but a more fundamental rearrangement that changes the framework of financial intermediation, payment relations, data usage, and market organization (OECD, 2025). Hence, the definition of financial digitalization cannot be confined to the visible instruments like internet banking, mobile apps, or card payments as the multi-layered area of transformation spans the design of financial products to risk management, customer relations, and market infrastructure (Wang et al., 2024). In conceptual terms, the term digitalization refers to the process according to which technology is no longer a supporting aspect, but a constituent element of financial transactions, in other words, technology is no longer its peripheral aspect, but its internal component (Breuer et al., 2023). The peculiar feature of this change is that it speeds up the financial process, data-driven decision-making, and restructures the service delivery around platform logic (OECD, 2025). Financial digitalization thus is not a technical innovation, but a structural change that redefines the institutional architecture, the competitive framework and access points of finance (BIS, 2025). The initial aspect that needs to be taken into account when determining the scope of the concept is that the financial digitalization is a process that is happening at both a service and a system level: at the service level, the payment, credit, savings, and investment instruments utilized by individuals and firms are changing, whereas at the system level, the financial market infrastructures, data flows, and monetary relations are being redefined (ECB, 2021).

Digitalization, in this regard, does not just involve delivering financial services via digital technologies, but also implementing production processes via digital inputs and adjusting organizational structures of financial institutions along technology lines (OECD, 2024). That is, the user interface is not the only aspect of financial digitalization as Software architectures that operate in the background, cloud computing, data processing capacity, algorithmic decision support systems, and interoperable payment infrastructures are also key elements of this transformation (IMF, 2025a).

Thus, the notion fills the gap between digital financial services and digital transformation of the financial sector; the former is used to refer to services directly provided to the user, whereas the latter is used to refer to organizational and technical basis on which these services are created (World Bank, 2020). The second significant aspect of the definition of financial digitalization is that this process encompasses both innovations in the private sector and public monetary and payment regulations; in other words, the problem cannot be attributed only to fintech initiatives, central banks and regulatory authorities are also significant participants in the change (European Commission, 2023).

In fact, over the last few years, the discussion of digital finance has grown on the topics of electronic payment systems and mobile banking to incorporate more comprehensive aspects of open finance, crypto-assets, tokenization, central bank digital currencies, and data access regimes (European Commission, 2020). This growth demonstrates that financial digitalization cannot be defined by a specific technology; the notion implies the usual transformation various technologies cause on financial operations and, therefore, has a multi-component form (BIS, 2025).

To better differentiate the extent of financial digitalization, the process can be viewed along at least four primary axes: digitalization of service channels, transformation of payment and settlement infrastructures, the reinforcement of data-driven forms of financial intermediation, and transferring the concept of money to the digital space (BIS, 2025). The first axis is the digitalization of service channels, which means the shift towards a model based on branches of banks to a model based on mobile, remote, and constant access to finance; the transformation spans a broad spectrum of activities, including customer acquisition and identity verification, to transaction instructions and portfolio management (OECD, 2025). The second axis is the digitalization of payment systems and settlement mechanisms; this is not just the electronicization of payments, but also the acceleration, increased interoperability, and reduced cost of payment networks (IMF, 2025). The third axis is enhancing the centrality of the data in the financial system; as the financial system is becoming digitalized, the data of transactions, behavior and platform data are becoming more important in fields like credit rating, pricing, fraud detection and personalized product development (OECD, 2024).

The fourth axis is the salience of digital representations of money and the role of the state in this field; this indicates that financial digitalization is not only about the renewal of the individual financial service anymore, but also about the adjustment of the monetary system to the digital environment (European Commission, 2023). Putting these four axes together, the area of financial digitalization becomes a whole bigger than the accumulation of payment and banking apps; since the transformation targets financial organizations, customers, and monetary authorities at the same time (ECB, 2021).

Even though digital finance and fintech terms are synonymous in the literature, the two terms do not precisely mean each other; fintech is a more specific term that covers the use of technological innovation in financial services, whereas financial digitalization is a wider phenomenon that includes the overall impact of technological innovation on financial institutions, marketplaces, and regulatory frameworks (FSB, 2024). This difference is significant as the financial digitalization is not only the appearance of new ventures but also alteration of the business model of conventional banks, the platformization of financial intermediation, and the redesign of the regulatory framework (European Commission, 2023).

The same reason implies that a keen differentiation should be drawn between digitalization and digital financial inclusion; financial digitalization is a greater structural process, and digital financial inclusion is the result of this process in the society in terms of access and use (IMF, 2021). Inclusion is intensely influenced by the proliferation of digital financial services because it can raise the number of accounts owned, payments made, and access to basic financial services; nevertheless, this influence is not the sole aspect of financial digitalization and does not describe the entire phenomenon (World Bank, 2022). Here the process of financial digitalization is an infrastructure and institutional transformation, which opens access to more people, and inclusion is the outcomes of this change to people and businesses (Basnayake et al., 2024). The next important aspect of the scope is that financial digitalization is not just a consumer finance sphere; Corporate finance, capital markets, insurance, asset management, surveillance technologies, and regulatory technologies belong to this area (European Commission, 2020).

Thus, it is not possible to exhaustively understand the concept through the digitalization of retail banking only, but the financial digitalization influences the wholesale financial sphere as well, by changing the information flow, the manner of its execution, and the ability to monitor risks among the market participants (Breuer et al., 2023). Specifically, with the intensification of data-intensive and platform-based models, the financial service provision has shifted its focus on a bank-centric and closed framework to a multi-actor, modular and interconnected framework; open banking and open finance discourses have taken center stage in the financial digitalisation process (European Commission, 2023).

Data in this new structure is no longer a byproduct of transactions, but a strategic resource that has an economic value and determines financial decisions; thus, the question of data governance is a mandatory part of financial digitalization (OECD, 2024). The same can be said of the creation of digital payment networks, which is among the core aspects of financial digitalization, but has not only

revealed the speed and convenience aspects of this process, but the interoperability, accessibility, and competitiveness aspects as well (IMF, 2025). To be able to create economic value, a digital financial infrastructure must not just be digital, but it must be scalable, reliable, accessible, and compatible with other systems, which need to consider the technical and institutional aspects of the concept (OECD, 2025).

Here the extent to which the financial system becomes digitalized depends not just on the appearance of the innovation, but also on the way the innovation is integrated into the financial system; in other words, to be described as being part of financial digitalization, technology must infiltrate the systemic functioning (BIS, 2025). In fact, over the last years, the creation of digital platform banks, crypto-asset linked structures, and novel types of leverage has demonstrated that the digital finance frontier has continued to be widened and has a direct impact on the discourse surrounding financial stability (BIS, 2025). Therefore, financial digitalization must be regarded as a process that not only produces efficiency and access, but also as a change that leads to new types of vulnerability (OECD, 2025).

Another factor, in the context of the concept scope, is the European context, which is concerned with both competitiveness and innovation, but also consumer protection, cyber resilience and financial stability; it demonstrates that the initial dimension of financial digitalization is the one of a public policy (European Commission, 2020). This method enables one to consider financial digitalization not as the self-initiated market development, but as the process of transformation directed and guided; that is, regulative decisions as much as technological changes predetermine the scope of digitalization (European Commission, 2024). EU efforts regarding cyber resilience, crypto-asset regulation, and access to financial data show that financial digitalization is no longer viewed as a one-sector innovation, but an integrated project of a financial architecture (European Commission, 2024).

At this juncture, the role of the public authority also needs to be included in the definition of financial digitalization since the state and central banks have now become key actors in payment systems, digital identity, access to data, and central bank money (European Commission, 2023). In this way, it is no longer a market process, driven by the innovation of the private sector alone, but a hybrid sphere of transformation in which the monetary order of the state and the financial innovation of the private sector meet (BIS, 2025).

In the process of determining conceptual limits, one should also not confuse financial digitalization with the notion of cashing things out, the proliferation of digital payments is a significant indicator, but the practice is more comprehensive and covers such functions as credit, savings, investment,

insurance, and circulation of financial information (World Bank, 2022). Likewise, the process of financial digitalization cannot be narrowed down to mobile money applications that enhance inclusion in developing economies, in high-income economies, the process is intensified by data sharing, platforming, open finance, and central bank digital currency projects (IMF, 2021).

This distinction shows that financial digitalization is not a linear process, but may evolve in various directions based on the institutional framework, infrastructure, financial maturity, and regulatory capacity of nations (OECD, 2024). However, the overarching idea of all this heterogeneity is that financial services are getting constructed around digital data, network effects, and software-based infrastructures; it is specifically this structural change that is the essence of the concept (Breuer et al., 2023). The user behavior is another factor that determines the extent of financial digitalization as the spread of digital tools is altering financial preferences, payment habits, and institutional expectations and, therefore, defines the direction of the transformation on the demand side (IMF, 2025).

According to the findings of the Financial Access Survey conducted by the IMF, digital access points, as well as the usage of digital financial services, emerged as a more visible phenomenon in the 2020s, indicating that the digitization is not a confined phenomenon of innovation but a quantifiable systemic trend (IMF, 2025). As digital finance expands, trust, authentication, cybersecurity, and continuity of operations have become the immediate contents of the concept, rather than the surrounding of it; since a technical failure or data breach in a digital financial system impacts the fundamental services delivery (OECD, 2025).

Thus, the digitalization of finance does not imply simply more technological finance, it implies rather the reconstruction of the trust architecture in the new digital environment, and in this regard, it is not similar to the conventional financial modernization stories (European Commission, 2024). Although the benefits of digital finance as low cost, speed and accessibility are often outlined in the academic literature, the real importance of the concept is that it can transform financial relationships, which are increasingly fragmented, data-intensive, and network based; they can also modify the balance of power in the market (Wang et al., 2024). Likewise, research on the effect of digital finance technologies on the stability of the banking system demonstrates that digitalization not only provides a convenient way to conduct business but also entails implications of competition, risk transfer, and market conduct (Antwi et al., 2023).

1.2 Evolution of financial technologies

Technological change of financial technologies is not only a process of new tool introduction but also represents a process of the reorganization of financial service production, distribution and market organization over time with the help of technology (Kou et al., 2024). This evolutionary path has led to a multi-layered transformation, starting with the traditional automation phase of banking, progressing to platform-based finance, services based on data, decision systems based on artificial intelligence (AI), open banking architectures, blockchain-based structures, and debates around central bank digital currency (CBDC) (Barroso & Laborda, 2022). Therefore, the history of financial technologies cannot be understood in a list of technologies, but in highlighting what role was played by finance technology in a particular period (Palmié et al., 2020). More succinctly, the development of financial technologies; The evolution has been characterized by the interconnected phases of the process that include the speeding up of the transaction process, a higher level of information processing, customer relations digitization, institutionalization of data access, and the appearance of digital money (Aldasoro et al., 2025).

The key element in this is that the financial sector has shifted from being one that is dependent on technology to being one where technology is a part of the sector (Campanella et al., 2023). The initial stage of financial technologies is usually attributed to the pre-digital banking automation period, but the actual shift in the modern literature is linked to the fact that financial services have become online, portable, and accessible at any time (Kou et al., 2024). This pivot is reflected in the substitution of the physical branch-based service model by a multi-channel, user-centered and low-friction transaction architecture (Barroso & Laborda, 2022).

Although technology was mainly a beneficial resource that supports the back-office activities during the former era, in the latter stage, it became one of the main elements that directly influence the customer journey and form a competitive edge (Campanella et al., 2023). The payment, savings, credit, and investment services have become the areas where this change has become the most noticeable, as a large part of the financial operations started to take place via digital interfaces and software-based structures (Kou & Lu, 2025). The second significant phase of the development of financial technologies is the appearance of the fintech ecosystem as its own innovation space (Palmié et al., 2020).

The question at this point is not merely how banks use technology, but technology firms, payment intermediaries, data feeds, software developers, platform operators, and venture capital networks have started to collaborate in changing financial services (Palmié et al., 2020). In that way, financial

innovation is no longer an internal modernization of an individual institution but has taken a form which grows in a multi-actor ecosystem and is shared by a variety of actors (Palmié et al., 2020). The same logic concerning ecosystem explains why the innovation in the financial sector is becoming more and more rapidly spread; the technological development is not only on the level of products but also on the level of collaboration networks and data sharing and standards (Barroso & Laborda, 2022). Thus, the history of financial technologies development is not a one-centered innovation narrative, but a reorganization process influenced by the interplay of banks and non-bank participants (Kou et al., 2024). Payments have been one of the most noticeable areas of this evolution, as payment systems are not only one of the most technology-open areas but also the financial service that displays the change in user behavior most rapidly (Panetta et al., 2023).

The emergence of digital payment technologies has resulted in the creation of a shift away to a cash and card-oriented system towards mobile payments, contactless payments, instant payment systems, and embedded payment solutions (Panetta et al., 2023). This has not only resulted in the electronicization of payment transactions, but also in the integration of the payment experience with e-commerce, platform economy and use of mobile devices (Panetta et al., 2023). The development of payment technologies thus has been a trailblazer in the digitalization of finance, which later provided a technical and behavioral basis to changes observed in fields like credit, investment, and insurance (World Bank, 2022).

Alongside the shift in the payment industry, the process of credit and financing has undergone a major change, with online platforms shifting the credit access process out of the traditional bank-customer dynamic (Kou et al., 2024). Online lending, alternative credit scoring, platform-based financing, and digital application processes have demonstrated that financial technologies have transformed not only the channels of distribution, but also the approaches to risk assessment (Kou et al., 2024).

At this point, the development of financial technologies has gone beyond automating transactions to decision-making, that is, technology is no longer just a tool that delivers the service but also an element of a mechanism that conducts financial analysis (Bahoo et al., 2024). In particular, in the context of the large-scale use of data-intensive models, customer profiling, credit scoring, fraud detection, and portfolio management are expected to be more dependent on complex algorithmic structures (Pattnaik et al., 2024). The most interesting fact in this context is that the development of financial technologies is not limited to the further creation of faster transactions but also a larger amount of information and conclusions based on it (Aldasoro et al., 2025). Thus, in order to grasp

how financial technologies are developed at the contemporary level, one has to pay attention to the correlation between the power of the data processing and financial operations (Aldasoro et al., 2025).

Machine learning, predictive analytics, natural language processing, and generative AI are starting to be applied in various fields like risk assessment, customer service, fraud prevention, and portfolio optimization, as well as compliance processes (Pattnaik et al., 2024). It is the beginning of a new stage of development of financial technologies because the question is no longer only how to create digital interfaces but to restructure the process of decisions with the help of software (Aldasoro et al., 2025). However, AI-driven evolution also brings with it new problems such as oversight, explainability, bias, model risk, and systemic impact, as well as efficiency (Bahoo et al., 2024). Thus, financial technologies are not developed in a linear manner, but as an expansion process, with each new technological advancement creating new regulatory and trust challenges (Aldasoro et al., 2025). The possibility to share the data on an enterprise level with open banking and application programming interfaces is another crucial phase in the development of financial technologies (Babina et al., 2025). Open banking has redirected the focus of financial innovation towards related service structures, where the customer transaction data may be shared with third-party service providers subject to a set of regulations (Babina et al., 2025).

This innovation is very significant in the history of financial technologies; in this case, innovation is not developing a new financial product, but a new set of combinations of services based on access to data (Akyildirim et al., 2025). Due to open banking, the financial service is more modular and functions like credit, payment, budget management, investment advisory, and identity verification can be bundled by various providers under a consistent user experience (Babina et al., 2025).

This field is significant not only because it is developing new forms of programmable digital assets, but also because it suggests a new technical logic of how transactions of consensus, registration, ownership, and transfer can be performed (Kou and Lu, 2025). The constraints of classical financial infrastructures have become apparent through blockchain-based financial applications, especially when it comes to cross-border transfers, smart contracts, tokenization, and decentralized financial structures (Rjoub et al., 2023). Nevertheless, this evolutionary path is not the final one and has not yet reached a stable result; on the contrary, it is a rather disputable field of development since it is highly volatile and is fraught with issues related to governance, security concerns, and regulatory ambiguities (Kou & Lu, 2025). However, the blockchain and tokenization discussions show that the development of financial technologies is ceasing to focus on the delivery of services, but on the very structure of the financial market infrastructure (IMF, 2024). The development of robo-advisor apps in the area of

investment services is also a significant connection in the progression since it has caused the cost of managing wealth to be cheaper and more standardized as well as accessible to a broader range of users (Cardillo & Chiappini, 2024).

Robo-advisory shows the transition of the investment advice relationship-driven model to an algorithm-based, scalable, and seamlessly functioning model (Faiz-ul-faham & Shekhar, 2024). This innovation is one of the examples of the evolution of financial technologies that both brings about a reduction in cost and increases in accessibility (Cardillo & Chiappini, 2024). Meanwhile, it speeds up convergence between artificial intelligence and investment services with the themes of the personalization of investment decisions, the use of behavioral data, and portfolio recommendations automation (Faiz-ul-faham and Shekhar, 2024).

Thus, the development of financial technologies has developed a larger change not only in payment and banking, but also in investment services, the access to which was previously high (Cardillo & Chiappini, 2024). All these changes are the reasons why financial technologies have over time become more inclusive and at the same time, more complex (Dao et al., 2025). Initially rationalized by efficiency and cost-cutting, technological innovations have since been inseparable with larger scopes of problem, like financial inclusion, competition, data sovereignty, user rights, and regulatory coordination (Ferilli et al., 2024).

Thus, the development of financial technologies must not be interpreted as only an increase in the complexity of technologies, but also a reconstitution of the social and institutional aspects of the financial system (Dao et al., 2025). In the European context, especially, the correlation between fintech development and digital financial literacy and the digital financial divide demonstrates that the effects of technological innovation on the society are not uniformly distributed (Ferilli et al., 2024). This scenario shows that technical advancement is not enough in the development of financial technologies; the ability to access and operate such systems safely is at least equal to the infrastructure (Ferilli et al., 2024).

Thus, the evolution of financial technologies implies not only the creation of more advanced tools, but also their social adoptability and institutional manageability (World Bank, 2022). In recent years, this evolutionary process has engaged the authorities of the population in a more active way since the introduction of digital payment systems and the development of private digital currencies has compelled central banks and other state regulators to take new stances (Prodan et al., 2024). Discussions of central bank digital currency are a new step in the development of financial

technologies in this regard, since it is the first time when digitalization is not only a question of individual financial innovations but a direct connection of the future of the public money (IMF, 2024). This step separates the evolution of financial technologies in comparison to the fintech waves in the past; Since the problem is no longer confined to the innovation of market-based services, but rather related to the question of how the monetary system is going to be structured in the digital era (Prodan et al., 2024). The projects of central bank digital currency are regarded as the system that can co-exist with, and not compete with, the rapid payment systems and electronic money solutions, and on the other hand, make the discussion of the public trust and monetary sovereignty back in the spotlight (IMF, 2024). Therefore, financial technology development is shifting away from the narrative of innovation that is largely a private affair to a more intricate monetary and financial infrastructure co-created by the state and market (FSB, 2024). The present development of financial technologies can be best characterized by the fact that various layers of technology are not isolated anymore, but they are becoming more and more integrated (Kou & Lu, 2025). The systems of payment, sharing data, artificial intelligence applications, machine-based investments, blockchain-based solutions, and the discussion of digital currencies have become mutually supporting in the same transformative sphere (Aldasoro et al., 2025). This integration implies considering the development of financial technologies not as a sequence of innovations, but rather as an intertwined outcome of many linked technological trends (Kou et al., 2024). As a result, the history of fintech development is a wide-ranging historical shift, including the automation of banks and the emergence of digital platforms, the development of payment tools and the emergence of open banking, algorithmic decision-making systems and the advent of blockchain and digital currencies (Barroso & Laborda, 2022). Although with this evolution finance has become faster and more accessible, it has also introduced more complicated problems, including data density, new types of competition, the necessity to regulate, and reorganize the institutions to the forefront of the financial system (Campanella et al., 2023).

1.3 Digital currency as a new stage of financial transformation

Digital money is another step in the digitalization of finance that surpasses the previous levels, which merely changed service channels and instruments of transactions, by explicitly questioning the nature of money, its logic of action, and institutional premises (Hull and Sattath, 2024). Thus the phenomenon of digital currency indicates a more profound change than the issues of internet banking, mobile payments, or fintech innovation; as it is not only the delivery of financial services that will be different here, but also the technical and institutional frameworks in which the form of money in which

economic relations will be conducted will be realized (Bindseil & Senner, 2025). Money has not been radically different in earlier waves of digitalization, only its access and usage patterns have been digitalized; but with the advent of digital currency, the question of redesigning money to reflect its digital character is raised (Fantacci et al., 2025). In this sense, the digital currency is not only a byproduct of financial transformation, but it has become an integral part that is redefining the path of the transformation (Quaglia & Fantacci, 2025). The basic capabilities that money has traditionally performed, as a medium of exchange, a store of value, a unit of account, have not been eliminated in the digital era; but the question of what technical infrastructures and trust relations will be employed to perform them has fundamentally changed (Hull and Sattath, 2024).

These three structures are similar in the sense that they are digital, although the base of trust, stability mechanism, nature of law, and their place in the monetary system is very different (Hull and Sattath, 2024). Crypto assets became a framework without a central issuing body, emphasizing the concept of digital scarcity and network-based trust, but have failed to become a stable medium of money to be used widely due to their high price volatility (Dionysopoulos et al., 2024).

Intended to eliminate this issue by providing a more predictable structure of values, stablecoins have placed other concerns in the limelight, including the quality of reserves, the security of repayment, market confidence, and abrupt outflow risks (Oefele et al., 2024). As opposed to other forms of digital currencies created by the private sector, central bank digital currencies are frameworks created within the monetary assurance of the state population, therefore rendering the societal aspect of the digital currency discussion apparent (Soana, 2024). This is precisely the reason why digital currency ceases to be a breakthrough financial service, but an institutionalized area of decision making in terms of the future of the monetary system (Quaglia & Fantacci, 2025). The latter is the second reason why digital currency is regarded as a new phase of financial transformation because the role of government money must be reconsidered in the context of the active diffusion of private forms of the digital payment money (Fantacci et al., 2025). The increasing digital platform economy and the expansion of cross-border payment networks alongside the arrival of giant technology firms in the payments industry have made it evident that money cannot be defined by the banking industry alone in the future (Quaglia & Fantacci, 2025). Considering these trends, the inactivity of central banks may imply that payment infrastructure and money circulation are becoming more reliant on private networks, and digital currency is a new front on which the population can intervene (Chu, 2025).

Therefore, digital money is now a technologic, political, and institutional feature of the financial revolution (De Conti, 2025). The earlier stages of digitalizing the financial system were mostly

advanced by means of bank accounts and card networks and electronic money solutions; in the current stage, the discussion is expanded to whether the central bank money will become available to the general population in a digital version (Baeriswyl et al., 2024).

This is an essential question since, though central bank money has mostly manifested itself as cash in the hands of the general population, the functional load of money is also becoming comparatively smaller in the digital economy (Brühl, 2025). Here, the shape of the public money in the digital world turns into a central concern of monetary sovereignty and payment systems in regards to the public good (EUR-Lex, 2023). This is the main problem of the digital money discussion that proves that financial change can no longer be just the aggregate of the innovations produced within the market, but it needs a direct redefinition of the architecture of public money (ECB, 2024). Digital currency also moves the logic of financial transformation no longer operated by a physical carrier, but by a software infrastructure; since the design of a digital currency incorporates many technical decisions, such as the structure of wallets and validation schemes as well as the ability to use offline and the capacity to process data (Brühl, 2025). These technical decisions are not neutral; they all have an impact on how money is consumed, user privacy, how it interacts with financial intermediaries, and how the system will behave during a crisis (Soana, 2024). Thus, digital currency is not to be viewed as a digital replica of the current types of money, but rather as an institutional structure that can be programmed and tailored to a particular economic objective (Bindseil & Senner, 2025). This is a factor that separates digital currency and the earlier stages of financial transformation; in the earlier instruments the design would be more associated with the delivery of the service, whereas in this case it is directly associated with the monetary order itself. The third cause of considering digital currency a new stage is the possibility of fragmentation of the monetary system that the privatization of digital currency forms may cause (De Conti, 2025).

Crypto assets and stablecoins have created a payment and a store of value in particular user circles and market segments, thereby forming alternative networks that are disruptive of the centralized form of the monetary order (Dionysopoulos et al., 2024). On the one hand, it has facilitated the ability to be innovative and on the other hand, it has caused the emergence of various forms of digital money in the same economic space with various degrees of credibility as well as various degrees of legal protection (Oefele et al., 2024). This expansion of the monetary space results in new vulnerabilities, specifically in regard to stability and convertibility, since a digital asset being money-like does not imply that it will actually act like money during crisis (Chen et al., 2025).

Therefore, the fundamental issue in the digital money age is not just the existence of innovation, but how to maintain the hierarchy and convertibility relationship between different forms of money (Hull & Sattath, 2024). This is exactly where the advent of central bank digital currencies comes into play; since these systems purport to provide a more comprehensive monetary system in the face of the possibility of fragmentation through the integration of digital innovation with social guarantees (Chu, 2025).

In this regard, digital money is not merely a rational continuation of personal financial technologies, but also a collective answer to the questions of the system that they pose (Quaglia & Fantacci, 2025). The financial stability dimension also plays a role in declaring the digital money as a new stage; Since the modification of the money form can influence the deposit system, the basis of banks funding, and the flight to safe assets in case of the crisis (Ponce et al., 2025). The migration of individuals taking out money at the central bank through commercial bank deposits to the central bank money might have implications on how the intermediation chain is operating, especially with the wide adoption of retail central bank digital money (Heitmann et al., 2025).

Thus, digital money must not be considered according to its convenience in making payments or the technological advancement, but also based on its effect on the balance sheet of the financial system (Chen et al., 2025). The point here is not that digital money exists, but its design; since decisions like the access model, the interest rate regime, holding, and distribution system would change the path of the influence on the financial stability (Ponce et al., 2025). This demonstrates that digital money is not a passive product of financial change, but a novel institutional space that has been actively designed (Bindseil & Senner, 2025). The fourth explanation as to why digital currency is a new step is that the connection between money and data is as close as it has never been before (Soana, 2024).

Although cash payments provide a high level of anonymity, the form of digital currency cannot but produce data, which is essential to the effectiveness of the payment system, as well as its surveillance capabilities (Ahnert et al., 2025). Thus, the balance between privacy, security, anti-money laundering, and transparency in the design of digital currency will need to be reestablished (Soana, 2024). It is exactly based on this fact that the problem of digital money should not be discussed as a technical branch of financial technology, but as a debate about the order of money with legal and political implications (Belikoff, 2025). The digitalization of money leads to data ceasing to be merely a secondary element supporting transactions and becoming a primary element determining the terms of money use (Ahnert et al., 2025). This is one of the core distinctions that made the digital currency and the former types of electronic payment different (Bruehl, 2025). The fifth factor indicating that digital

currency is a new stage in financial transformation is the re-establishment of the connection between money and inclusion (Tan, 2024). Although the traditional financial system account-based access may marginalize certain segments of the society because of particular costs and institutional barriers, properly designed digital currency networks have the potential to expand access to payments (Tan, 2024).

The crucial fact here is that digital money will not necessarily lead to an inclusive effect, but in the event that the architectural decisions are correct, it will unite financial access and popular money on a new platform (Singh et al., 2025). Specifically, the two-tiered distribution models provide the opportunity to balance the aspects of inclusivity and stability of the system by providing the assurance that the connection with current financial intermediaries will not be fully disrupted and central bank money will be given to the user (Tan, 2024). It demonstrates that the digital currency cannot be a privilege of high-tech users, but it is important to take into consideration the principle of universal accessibility and use (ECB, 2024).

The digital currency contributes to the geo-economic aspect of the financial change as well; Since digital payment networks and digital currency standards play a crucial role in not only the efficiency of the domestic market, but also in international financial competition and strategic autonomy (Quaglia & Fantacci, 2025). In the European context, in particular, the debate surrounding the digital euro is also associated with the aim of technological innovation, as well as the need to decrease the external reliance of the European payments region and preserve the presence of public money in the digital era (ECB, 2025).

Thus, digital currency, as another stage of the financial transformation, is associated with even more significant problems like sovereignty, infrastructure ownership and regionalization of the financial sector (EUR-Lex, 2023). The point of interest here is that digital money is not just a new payment method, but also an infrastructure project, which can be used to establish a strategic niche in the financial sector (Chu, 2025). The other factor that has made digital currency take a premium position in financial transformation is that the line between personal and governmental digital money is becoming more evident (Fantacci et al., 2025). Crypto assets and stablecoins are being formed as market-based experiments whereas central banks digital currencies are being defined by the values of public trust, legal certainty, and systemic integrity (Soana, 2024). This distinction demonstrates that the debate over digital currency cannot be distilled down to merely the question of the technology to use, but rather must incorporate the question of which type of money will play which functions in the public (Hull & Sattath, 2024).

The historical importance of money as a not only an economic but also an institutional relationship does not lose its significance in the digital era; thus, technical efficiency and social approval need to be addressed simultaneously in the realm of digital currency (De Conti, 2025). The digital euro case is instructive in this regard; since the objective here is not just to develop a new digital tool, but to translate the principle of public money in the euro zone into the digital economy (Brühl, 2025).

This practice is also reflected in the legal framework proposed by the European Union of the digital euro; the text indicates that the digital euro is envisioned as a type of the public money that can be treated as the legal tender in euros (EUR-Lex, 2023). To this extent, digital currency is a structure that transcends individual innovation in the next stage of financial revolution and reinstates the social aspect of the monetary order (ECB, 2025).

1.4 The role of central banks in digital finance

Digital finance has not diminished the status of central banks in the financial system, but instead, it has increased their visibility and directness (Hemingway, 2025). Although central banks were viewed as more of a back office, providing monetary authorities and payment systems in the early years of digitalization, they are currently one of the biggest players in developing institutions in digital currency, instant payments, data governance, financial integrity and market infrastructure (BIS, 2025). This shift indicates that the financial innovation can no longer be attributed to the ability of the private sector to develop a product; the government decisions that have to be taken in regard to the whole system of money have also become focal in the change (Bank of England, 2025). Thus, central banks in digital finance cannot be seen as an issue of technical adjustment, but rather as a constitutive task that defines the shape of the monetary order in the digital era (Hemingway, 2025). The basic central bank intervention in digital finance is to keep money in the hands of the people (Keister and Sanches, 2023). Regardless of the level of digitalization of the financial system, central bank money enjoys a special status as the final payment instrument and monetary anchor that is trusted by economic participants (Fernández-Villaverde et al., 2021). Thus, central banks have not been displaced in the role of issuing money, but instead have been required to play this role differently due to the emergence of digital finance (Andolfatto, 2021). With the advent of the digital age, the question is no longer about how to manage cash and reserves, but how to retain the institutional structure that will make sure that the money of the people will be available, reliable, and functional even in the digital world (Keister and Sanches, 2023).

Here, central banks are simultaneously the financial regulator as well as the institutional holder of social confidence in the context of digital finance (Fernández-Villaverde et al., 2021). The increase in the use of digital financial instruments, the growth of money-like instruments in the private sector, and platform-based methods of payment needs closer attention to the delimiting of the boundaries between the public and the private money (Keister and Sanches, 2023). The role of the central bank becomes obvious in this situation; since the issue of what digital asset will be the heart of the system and what assets will be functionality of this heart will eventually fall within the jurisdiction of the monetary authority (Andolfatto, 2021). Thus, the emergence of digital finance does not push the central bank to the fringes of the scene, but puts it even more squarely on the axis of the legitimacy and stability of the system (Fernández-Villaverde et al., 2021).

The second core role of central banks is to create a safe and effective payment infrastructure (Ragazzo & Caminha, 2025). Although this role has historically been performed at a more wholesale payments and reserve accounts level, with the development of digital finance, central banks have become considerably interested in the retail payment sphere (Ragazzo & Caminha, 2025). The reason is that the efficiency of payments in the digital economy is not only associated with the user experience of individual users but also has systemic effects, like competition, costs, interoperability, and financial inclusion (Alfonso et al., 2025). At this stage, central banks are not only supervisory bodies but, in certain scenarios, also as a coordinator of the populace that creates, runs, and dictates standards of payment infrastructure (Ragazzo & Caminha, 2025).

This change is especially evidenced by the spread of instant payment systems (Ragazzo & Caminha, 2025). Collective action problems, network effects, and interoperability issues that payment service providers have found challenging to address on their own have rendered the central bank expanding its regulatory capacity with its operational capacity more significant (Ragazzo & Caminha, 2025). Under these circumstances, the central bank does not become a competitor to the market, but an impartial regulator-operator that creates infrastructures that help in making the market work efficiently (Ragazzo and Caminha, 2025). This position in digital finance reflects the shift in the traditional role of the central bank as an institution of the classic after-intervention role to the role of an institution-established and institution-directing architect (Ragazzo and Caminha, 2025).

The inclusion of factors like interest rate, access, holding limit, and distribution model in the design of central bank digital currency is thus not a coincidence (Davoodalhosseini, 2022). All these factors influence how much deposits will be removed off commercial banks and into central bank wallets, and how this will impact supply of credit (Fegatelli, 2022). Thus, central banks approach digital

finance with the purpose of not only creating ease of payment but also with creating a balance that will not harm the lending potential of the banking system (Adalid et al., 2025). This, in fact, is where the significance of digital finance to central banks is situated; the policy of technology policy and the policy of monetary policy overlap in the same decision space (Davoodalhosseini, 2022).

The central banks become even more significant at this stage as an institution of stabilization that restricts the impact of digital finance on the banking system (Tercero-Lucas, 2023). When digital currency instruments are not properly designed, they can erode bank deposits, increase banks' funding costs, and lead to undesirable contractions in the credit channel (Nyffenegger, 2024). On the other hand, a complementary relationship can be developed between the banking system and digital currency in well-designed models (Luu et al., 2023). The task of the central bank, then, is not to issue a new instrument, but to make sure this instrument is incorporated into the system without disrupting financial intermediation (Tercero-Lucas, 2023).

The stabilization role of the central bank in digital finance does not restrict itself to deposits outflows (Schilling et al., 2024). With the increased presence of central banks in the digital financial arena, new strains arise between price stability and financial stability, as well as an efficient intermediary (Schilling et al., 2024). This conflict shows that the central bank might not be capable of fulfilling all its objectives at once and on the highest level in the digital era and that the design decisions need preferences to be made (Schilling et al., 2024). Thus, central banks should not act as an unbiased technology implementer in digital finance, but as a policy-maker striking a balance between various goals of the population (Nyffenegger, 2024).

Another function undertaken by central banks in digital finance is institutional design (Duncan & Mainente, 2025). Digital money and digital payment infrastructure are not simply issued or launched tools, but they entail a broad variety of design decisions, such as revenue model, consensus mechanism, intermediation structure, authentication scheme, and access architecture (Duncan & Mainente, 2025). Such decisions define the way banks will be connected with the system, the role that the private payment institutions are going to play, and the channel which users are going to use to access the money of central banks (Bank of England, 2025). The central bank is thus not an ultimate determiner in digital finance, but a pioneer player who sets the rules of the system upfront (Duncan & Mainente, 2025).

The design aspect also reveals the fact that digital finance cannot be acted unilaterally by central banks (Li, 2023). The needs in digital currency may fluctuate greatly based on the privacy expectations of users, ease of use, their current payment patterns, and the reaction of the banks (Li, 2023). Thus,

the central banks are more than merely to create a technical solution but to run a public design process that considers the terms of social adoption (Choi et al., 2025). The extensive consultation, experimental lab work, and stages of preparation that are typical of the central bank projects nowadays have thus become part of the digital finance governance (Bank of England, 2025). Another crucial function undertaken by central banks in digital finance is to strike a balance between privacy and financial integrity (Wang, 2023). The somewhat high level of anonymity inherent in cash payments is bound to decline in the digital payments landscape, posing fresh challenges to user liberties and governmental controls (Choi et al., 2025). On the one hand, central banks need to achieve two competing objectives: on the one hand, digital currency should provide a decent degree of privacy, and on the other hand, a system of monitoring and compliance should be developed to combat threats such as money laundering and financing of terrorists (IMF, 2025). This balance has become one of the key customer functions of the central bank since it not only defines the technical security but also the social validity of digital finance (Wang, 2023).

The same dynamics of privacy and integrity is why central banks cannot afford to be indifferent about digital finance (IMF, 2025). When the digital payment realm is wholly predetermined by the data collection patterns of private actors or, in its turn, excessive surveillance-focused patterns of the general designs, trust in money can be harmed (Choi et al., 2025). The role of the central bank in this case is to defend the line between economic efficiency and legal legitimacy (Wang, 2023). Cybersecurity is only one of the direct factors influencing the public stability of digital finance because of the principles that regulate the usage of data (IMF, 2025).

This aspect of institutional coordination demonstrates that central banks are, too, redefining competition in digital finance (Ragazzo & Caminha, 2025). Competition is not only between various payment products any more, but it is also based on how the infrastructure will become a shared platform and which norms will be deemed decisive to enter the market (Alfonso et al., 2025). In this case, the central bank creates a system whereby the private actors are given an equal platform to compete with in regard to quality of services and user experiences by ensuring that the infrastructure is open to everyone (Ragazzo & Caminha, 2025). Thus, the involvement of the central bank in digital finance must be interpreted as an attempt to create a pragmatic synthesis between a free market and state infrastructure (Alfonso et al., 2025).

The rise of central banks in digital finance also has a national and regional strategic aspect (BIS, 2025). Efforts in digital currency in other nations are associated with not only payment efficiency but also the development of the national payment zone resiliency, the cost of the international transactions,

and minimizing reliance on external infrastructure (Alfonso et al., 2025). The case shows that central banks are seeking domestic stability, but also expanded objectives of monetary sovereignty and institutional independence in the sphere of digital finance (Hemingway, 2025). By the level of development of digital finance, the central bank is no longer an institution that monetary policy is made, but a strategic administrative unit that stands between the payment space and the data space and the digital currency space (BIS, 2025).

In turn, the presence of central banks in digital finance cannot be regarded as a close analog of classical central banking moved to the digital environment (Adalid et al., 2025). Nowadays, central banks are the guardians of the digital manifestation of social money, institutional architects creating and maintaining payment systems, risk managers ensuring financial stability, public designers who balance privacy and financial integrity, and regulatory coordinators who steer private innovation within shared standards (Ragazzo & Caminha, 2025). This versatile position shows that digital finance has not relegated central banks to the periphery, but instead has reinstated them at the heart of financial change (Bank of England, 2025).

1.5 Regulation and governance in digital finance

Digital finance is not just a phenomenon that can be discussed as a new technology in the financial services, but the field that has to be highly regulated: activities are considered legitimate, risks taken, and actors have duties (Laguna de Paz, 2023). In sum, the regulatory approach to digital finance is not to hinder innovation, but rather it is part of the constitutive order – the order of the market in its very first instance (Ren et al., 2024). The concept of governance is further elaborated on by the rules set by the legislator or regulatory authority: not only is it the rules that are the subject of the question here, but how the rules are coordinated between the supervisory authorities, financial institutions, technology providers, data owner, and infrastructure operator (Bagherifam et al., 2025). The traditional perspective on financial regulation (Eichengreen, 2023) is not as simple as one might assume because the barriers have come down with the advent of digital finance, and the governance issues are more complex than those traditionally thought of as part of financial regulation. While in the digital finance context, the gap between the economic activity and the legal nature is increasing, the characteristics of the institutions, licenses and the nature of the products are the traditional features of financial regulation (Laguna de Paz, 2023). These are probably the result of platformization and data-driven intermediation, the two most prominent characteristics of the business model of various functions of banks, tech firms, payment institutions and data processors. The institutional form is not

a sufficient lens to examine the regulatory issues, as questions such as the purpose of the economic activity, controlled information, and the creation of network effects and market power are part of the regulatory logic (Eichengreen, 2023). That is why the regulation of digital finance is moving towards an institution-oriented approach to an activity-oriented and infrastructure-responsive approach (Laguna de Paz, 2023). In this case, the main aim of regulation is not merely to restrict the entry to the market; The central purpose is to transparently determine how various actors will engage in the same digital ecosystem, which principles they are going to follow, and under what circumstances they are allowed to utilize which data (Ren et al., 2024). In this regard, Data Governance is one of the most centre of gravity regulatory aspects of digital finance as the majority of the digital financial services are not money-oriented, but data-oriented (Casolaro et al., 2025).

Open banking and open finance have proven that regulation can be applied not only due to product security and licensing requirements but also through access to data, data portability and participation by third parties (Colangelo, 2024). The shift has shifted the focus of financial governance from closed corporate organization to controlled data sharing regimes and the role of the regulator from the one of a designer of the flow of data to the one of the flow of information (Colangelo, 2024).

Responding to questions of who will have access to what data and on which principles, how it will be processed and on which standards, and how it will be used in automated decision making processes is fundamental, too, but data sharing is not sufficient (Pfluecke, 2025). Data governance in the context of digital finance therefore not only serves to increase competition but is also a regulatory area that, together with privacy, lawful accountability and transparency of decisions, is also working on transparency of data and its use for the benefit of the economy. Data governance in digital finance is therefore not only a means of increasing competition, but also a regulatory area with particular regard to transparency of data and its use for the benefit of the economy, together with privacy and regulation of the accountabilities for this.

The increased use of automated decision-making applications in the credit, investment and customer review processes has led to the need to have a significantly closer relationship between financial law and data protection law (Pfluecke, 2025). It is not just a traditional regulation of market conduct, but the regulation of digital finance should also include the scope of operation of algorithmic decision-making and the auditing requirements that they will have to face (Pfluecke, 2025). But consumer protection problem with digital finance is not only a textual contract issue now it is also an interface design problem, data collection problem, and instructions problem to the consumers (Van Dinh et al., 2023).

Consumer protection should not be interpreted as an area of law that addresses consumer grievances after the provision of the service, but rather as a regulatory approach which is to be taken when designing the service (Van Dinh et al., 2023). This field has now become a marker of institutional quality that has a close association with trust, comparability, risk control, and market controllability, as recent research that has tried to measure digital financial consumer protection demonstrates (Van Dinh et al., 2023).

In particular, the European-level principles on the application of AI in the context of investment services do not exclude the duty to act in the best interests of the customer when applying the digital tools (ESMA, 2024). Such a strategy is significant as the question of governance in digital finance is frequently not about how much technology can be allowed but a question of what the people are entitled to with such technology (ESMA, 2024). Likewise, even when automated systems are employed in suspicious transaction monitoring processes, although they might be fast and scalable, these systems do not automatically remove issues like accountability, false positive, ability to explain decision reasoning, and legal auditability (Turksen et al., 2024). Therefore, the use of AI-powered surveillance tools can contribute to financial integrity not only thanks to their ability to process more data but also because of the legal defensibility and auditability of their processing (Turksen et al., 2024).

The use of the word RegTech and SupTech in this context not only applies to technical innovation, but also to organizational instruments which are changing the way in which regulation and supervision are implemented (Bagherifam et al., 2025). RegTech solutions, which are deployed to automate the compliance processes of regulated institutions, and SupTech solutions deployed to augment the capabilities of oversight authorities are changing the nature of financial institutions' digital governance from a data-centric, continuous-focused approach (Bagherifam et al., 2025). But this change does not imply that regulation is being turned over to software; instead, it renders the necessity of technology to be deployed in a manner that aligns with legal principles and corporate responsibility more apparent (McCarthy, 2023).

Indeed, the literature on RegTech and SupTech also recognises their efficiencies, but also shows that in the absence of flexibility and principle-consistency in the regulation, they may not be as effective in delivering long and consistent outcomes (McCarthy, 2023). The capacity problem in the regulation of digital finance is that the regulatory body is still an information-processing institution, which is slower compared to market participants, and that may lead to the delay of regulation or the generalization of regulation (Ren et al., 2024). This implies that both the rules that are to be set and

how the regulator can implement them in a dynamic digital market condition are part of the existing regulation debates (Bagherifam et al., 2025). Another area where regulatory and governance issues become salient in the world of digital finance is operational resilience. With a high dependency on complex software, outsourced IT infrastructure, and clouds (Kun, 2024), operational resilience is a key consideration. This dependency has brought about a new understanding of operational risk and highlighted the problems of infrastructure systems that can lead to operational issues, not just within the organisation, but with systemic consequences that can impact a large number of organisations (Kun, 2024). Third-party technology providers (TPPs) are becoming ever more reliant on licensed financial institutions (LFIs) to operate their services, raising the prospect of financial institution regulation being expanded to the third-party technology space (Kun, 2024). It is a gradual expansion that is not random, such as digital finance, where the separation between who acts as an institution and what is the infrastructure that enables this is increasingly becoming indistinct (Buttigieg and Brunelli Zimmermann, 2024). In Europe, this new knowledge is integrated into the DORA framework, together with corporate compliance, regulation also includes the regulation of the critical information & communication technology (ICT) providers within the realm of financial stability (EBA, 2025). But despite these achievements, coordination of supervision, fragmentation and varied supervisory approaches at national level remain important issues for DORA assessment (Buttigieg and Brunelli Zimmermann, 2024). So, operational resilience in the digital finance is not just reinforcement of the cybersecurity measures – it also involves the interdependencies and construction of a multi-level architecture of supervision (Kun, 2024).

There are areas that defy the intermediated financial intermediary model such as crypto assets, tokenized models and decentralized finance apps where they operate across borders and create alternate lines of responsibility to the traditional financial intermediary model (Benson et al., 2024). So the regulatory challenge in the crypto markets is not simply one of encouraging innovation, it is as well one of preventing illegal transactions, safeguarding investors, and ensuring uniformity in the regulations' compliance with the laws of various jurisdictions (Benson et al., 2024).

Cross-border use, collateralization and secondary market liquidity issues are significant due to the uncertainty about the enforceability of legal nature of an asset and lack of market confidence (Lavayssière 2025). This case illustrates how the digital finance governance is not only dependent on technology neutrality but that some of the more specific legal categories, depending on the nature of technical innovation, are necessary (Lavayssiere, 2025).

Regulatory experimentation is another instrument which has become prominent in recent years in the regulation of digital finance; Since it is not always possible to anticipate all risks and develop comprehensive regulations at the very beginning facing the fast-changing technological innovations (Cornelli et al., 2024). In this context, regulatory sandbox applications create some kind of hybrid institution that allows to test innovation within the regulatory framework, thereby eliminating the dichotomy between liberalisation and total prohibition (Cornelli et al., 2024).

Experiments conducted on the UK show that the advantages of these experimental spaces are twofold: that they give rise to learning and adaptation benefits, as well as that they influence the state of financing by establishing a message of trust among investors and market participants (Cornelli et al., 2024). The sandbox model, however, is not enough of a governance model as the outcomes of the various experiments and temporary spaces need to be transferred later on to standards that are generally known and legally binding (McCarthy, 2023). Thus, good governance in digital finance neither can be an informal approach to pushing innovation beyond regulation nor can be an institutional approach that stifles all variations with the same rules; instead, a tiered institutional structure that is neither based on empirical learning nor normative certainty is what is required (Ren et al., 2024). In this respect, financial transformation is not just a component of regulation and governance, but it is a key part of it: the direction of the financial transformation is determined and governed by financial transformation. For any digital finance regime, the logic of governance must be one that fosters competition and decreases data centralization, allows space for innovation and safeguards the consumer, establishes accountability and leverages automation and market fragmentation, and is resilient (Laguna de Paz, 2023; Eichengreen, 2023). Consequently, regulation and governance in digital finance will not be seen as just a list of technical compliance standards, but as a complex framework that establishes the legal, institutional equilibrium and social legitimacy of the digital financial market (Bagherifam et al., 2025).

CHAPTER 2

DIGITAL FINANCE AND DIGITAL CURRENCY IN THE EUROPEAN UNION

2.1 Development of digital finance in EU countries

Digital finance in the European Union is a wide-ranging transformation process, which cannot be equated with the spreading of one single technology. The development of internet services, the normalisation of online banking, the increasing use of card and mobile payments in everyday life, the rise of open banking infrastructures, the rising significance of data in the financial sector and the partial integration of the European payments market have all influenced its development. In this respect, the evolution of digital finance in EU countries should be interpreted as a consequence of a shift in the relationship between consumer behaviour, the banking sector, payment infrastructures, public policies and competitiveness. The digitalisation of financial services in Europe has thus not only transformed the way financial services are provided but also the ways in which financial services are accessed, paid for and used by both financial institutions and their users (European Commission, 2020).

The first key driver to the EU's digital finance growth will be digital access for the household and individual market. Digital financial services rely on the availability of the internet and on digital device ownership as well as key digital skills. In Europe, the second half of the 2010s has seen the rise of a social infrastructure for the dissemination of digital financial services, with the internet increasingly playing a role. Digital finance is not restricted to a particular user segment as 93% of EU residents aged 16-74 said they used the internet in the past three months in 2024 (Eurostat, 2024a).

This has marked a significant milestone for digitisation of financial services. With so much going electronic in this modern day, the significance of a physical bank branch has diminished, as have the other ways of transacting business which were paper based. The branch is replaced by mobile apps, Internet ID verification, electronic contracts and virtual customer acquisition. The European banking sector is the first sector to offer its services on the Internet, and in this process has re-organised its relationship with its customers. From this point of view, the developments of digital finance in EU countries can be characterised as a reorganisation of the financial services production with respect to time, space and data, as described by Gomber et al. (2018).

Table 2.1. EU digital adoption indicators related to digital finance, 2014–2024

Year	Individuals using internet banking in the EU, % of individuals	Internet users buying or ordering goods or services online in the EU, % of internet users
2014	47	59
2015	48	61
2016	49	63
2017	51	66
2018	54	69
2019	58	71
2020	57	72
2021	58	74
2022	60	75
2023	61	75
2024	67	77

Source: Eurostat, ICT usage in households and by individuals; Council of the European Union, E-commerce in the EU.

As illustrated in Table 2.1, there are two parallel, but closely connected, trends of the evolution of digital finance. More and more financial transactions are going straight to the Internet and the rise of e-commerce has shown that society at large is demanding more electronic payments. Internet shopping has grown in the EU from 59 % in 2014 to 77 % of consumers today, which shows that digital payment modes are an innovation of the financial sector and form part of consumers' normal shopping habits (Council of the European Union, 2024).

The EU average of internet banking users is 67%, indicating a maturing phase of digital finance's banking component. This mean is not however representative of EU differences. Online banking has been well established in many countries of Northern and Western Europe, but is less advanced in some countries of Southern and Eastern Europe. Other countries such as Denmark, the Netherlands and Finland boast a high proportion of internet banking users, while in other countries such as Bulgaria and Romania, fewer users have internet banking. The gap suggests that digital finance is not only a technological improvement, but also depends on income, level of education, digital competency, and attitudes towards and trust in financial institutions (European Investment Bank, 2023).

Table 2.2. Internet banking use in selected EU countries, 2014 and 2024

Country	2014, % of individuals	2024, % of individuals	Change, percentage points
Denmark	86	98	+12
Netherlands	83	96	+13
Finland	84	95	+11
Sweden	82	83	+1
Belgium	59	83	+24
Spain	39	75	+36

Germany	51	67	+16
Poland	33	57	+24
Italy	26	51	+25
Bulgaria	5	31	+26

Source: Eurostat, ICT usage in households and by individuals.

As can be seen in Table 2.2, digital finance is not progressing at the same rate in EU countries. In countries with a high usage base, such as Denmark, the Netherlands and Finland, growth in usage up to 2024 is likely to be modest. By contrast, Spain, Poland, Italy and Bulgaria had a lower initial level of use and consequently higher growth. This means that digital finance has a converging impact in the EU, but not all differences between countries are removed by this convergence. The rate of financial digitalisation depends on the national banking system, the age structure of the population, the digital skills level and the attitude of public authorities of payment systems (OECD, 2020).

Online banking is a pivotal element in the evolution of digital finance in the EU, but the digitalisation of banks is not the only aspect of the digitalisation of finance. Digital finance can be felt by users in the payment services, where it is most tangible. Card payments, contactless payments, mobile wallets and instant payments have transformed consumer habits in Europe. Across the pandemic, contactless payment options became more prevalent and cashless payment habits have grown more firmly. This has not only increased the convenience of digital payment instruments, but has also been a key factor in maintaining trade flow and access to essential services during this period (European Central Bank, 2020).

The development of digital finance at the societal level is clearly reflected in payment behavior in the Euro area. In 2016, the share of cash in point-of-sale payments in terms of transaction volume was 79 percent, while this figure dropped to 52 percent in 2024. Also during that same period, the payment via card and mobile applications grew, as was the use of digital payment means (European Central Bank, 2024). This doesn't indicate that cash has been eliminated, rather it reveals that Europeans are increasingly using a hybrid approach with payment. Access to cash remains significant for consumers but their everyday use of cash is being replaced by the use of card and mobile payment tools (European Central Bank, 2024).

E-commerce has not only revolutionized the retail industry but has also driven the demand for payment infrastructure. With an increasing number of consumers buying goods and services online, it is more crucial than ever that they are protected from payment fraud, have a fast return option and can deal with cross-border transactions securely. According to the Council of the European Union

(Council, 2024), 345 million people made online purchases in the EU in 2024, making digital payments a part of the European internal market.

In addition, the rise of e-commerce has added another dimension of competition for financial institutions. The banks, payment institutions, e-money institutions and technology companies have started to engage in the same chain of transactions. From the customer's point of view, the payment process is just a click or a confirmation on the user's mobile phone. However, there is a whole lot going on in the background: identity verification, fraud prevention, card schemes, payment service providers, bank accounts, data processing systems and more. This building blocks the fact that digital finance in the EU is not only about the banking sector. Financial services has in recent years become more modular, platform based and multi-actor (Haddad & Hornuf, 2019). Open banking is a big step in the EU's digital finance journey. With the second version of the Payment Services Directive (PSD2), third-party service providers are now able to develop financial services through secure and regulated access to bank account data. This structure has given banks a role other than just being an account holder, by becoming part of a whole digital finance system. A range of products have emerged from this framework, such as account information services, payment initiation services, personal finance management applications and digital credit assessment solutions (European Banking Authority, 2019).

The impact of open banking is linked to the idea of consumers having greater control over their financial data. In the model, a bank account is no longer a closed, internal data space, but a data source from which various financial services can be built, if the user desires. For the EU it is not just about boosting competition and fostering innovative services. Moreover, open banking has been fulfilling the goal of establishing a more integrated European financial space by enabling data portability, secure authentication, conditions for market entry in financial services (European Commission, 2020).

The growth of fintech startups has also contributed to the diffusion of digital finance in the EU countries. Payment, Credit, Regulatory Technology, Insurance Technology, Asset management and Crypto Asset Services are some key focus areas in the fintech ecosystem that has sprung up in Europe. Following London's exit from the EU, centers such as Paris, Berlin, Amsterdam, Dublin, Stockholm, Vilnius, and Madrid have increased their weight in the fintech field, and the European fintech geography has moved towards a more centralized structure. This distribution demonstrates that digital finance is not dependent of a specific financial center and that various fields of specialization have emerged in the EU (European Investment Bank, 2023).

It is noteworthy that the Baltic and Scandinavian countries are pioneers in the field of digital finance. Estonia has developed an institutional pattern supporting easy access to financial services

using digital identity and digitalization of public services and e-government services. Lithuania has made itself noticed in the European market of financial technologies by implementing a licensing model for electronic money and payment institutions. High levels of digital skills, robust internet infrastructure, and high bank account uptake have helped to boost the uptake of digital finance in countries like Sweden, Denmark and Finland (OECD, 2020).

Digital finance in the Southern countries and the Eastern European countries has developed less rapidly and on a less even footing. The process is slower in these countries, due to banking practices, the cultural importance of cash transactions, an older population, less robust digital infrastructure in rural areas and digital skill gaps. However, in the past decade, Internet banking and digital payments has grown much in these countries. Mobile banking, especially, has been a driver of the increasing adoption of digital finance as it provides a more convenient banking platform than conventional online banking (World Bank, 2022).

The topic of financial inclusion in the development of digital finance is bi-directional in the EU. Digital channels can offer more convenient and less expensive financial services to those who have fewer opportunities to access branch banking services. It can also, however, lead to new forms of exclusion of people with low levels of education, of people with disabilities, of low-income groups, of users with limited digital skills and of the elderly. Thus, it is not possible to quantify the development of digital finance in EU countries just based on the growth in usage rates. Equally crucial are digital services' security, understandability, and accessibility and inclusivity (OECD, 2022).

In this context, digital financial literacy is becoming a growing concern for EU countries. Using digital financial services does not simply mean being able to open an application. The user needs to be able to distinguish phishing attempts, have secure encryption habits, understand transaction fees, see the consequences of data sharing and be cautious against the risks of digital fraud. Consumer protection has also moved beyond the traditional contract texts (OECD 2018) in the era of the digitalisation of financial services.

Also, the development of digital finance in the EU has influenced the business model of the banking sector. Banks have re-evaluated their branch networks, invested in mobile applications, started to analyze customer data more intensively and worked more closely with third-party technology providers. This has transformed the costing of banks. Digitalization has also improved the efficiency aspect, but additional costs have emerged, including in the field of cybersecurity, software infrastructure, cloud services, data management and regulatory compliance (European Banking Authority, 2021).

EU countries have also been at the epicentre of the debate regarding strategic dependency in the payment market since digital finance has been growing in the region. Many of the payment transactions made with cards and online in Europe are made using infrastructures that are connected with the global payment card schemes and big technology companies. This has led to the question of Europe's strategic autonomy in payment services being brought to the fore. Digital finance is therefore regarded as both a private sector innovation and from an economic sovereignty of the European internal market and security of financial infrastructure perspective (European Central Bank, 2020).

Digital finance in the EU has undergone a fast pace of change during the pandemic. The transition to digital financial services was accelerated by the lockdowns, work from home and e-commerce. At this time, users with lesser engagement in digital channels also started to engage in mobile banking, online payment and e-commerce applications more often. Following the pandemic, many of these habits have become ingrained in our daily lives and digital finance is no longer a short-term need but a standard part of our economic experience (European Central Bank, 2022).

The transition towards digital finance among EU countries however, has not been linear and smooth. The increasing prevalence of digital payment and banking services highlighted the dangers of cyberattacks, online fraud, identity theft, and disruptive operations. Financial services digitalization has helped speed up transactions, but the rise of errors and attacks has also been seen. As such, as well as technical ability, building trust in the finance architecture is also essential for the development of digital finance (European Banking Authority, 2021). The distinguishing aspect of development in the EU is the co-shaping of digital finance between market-driven growth and public regulation. Digital finance in Europe has evolved different tracks than it has in the United States, where it's driven by big technology firms, or China, where it's driven by core platform payment solutions. The EU solution has aimed to find a balance between data protection and consumer rights, on one hand, and competition and financial stability and operational resilience on the other. The search for balance has resulted in a more regulated, although sometimes slower, institutional development of digital finance in Europe (European Commission, 2020).

Small businesses and European capital markets are also playing a key role in the development of digital finance. Advances in digital payment systems, online sales channels and alternative financing products are providing new opportunities for SMEs. For businesses, bank funding is frequently elusive and other options such as invoice financing, crowd funding and platform loans have given them additional resources. Although the size of this space is still below that of the banking sector, it's a start towards making financial services more diverse and data-driven (European Commission, 2022). To

sum up, digital finance in EU countries has seen a significant progress over the past decade with internet banking, e-commerce, digital payments, open banking and fintech ecosystems. This is in line with the trend of the EU, but there are substantial variations in the level of adoption, as well as in digital skills, payment habits, and institutional capacity between countries. In recent years, in Southern and Eastern Europe countries, the level of digitalization is even higher, although in Northern and Western Europe, it is also high. While the digital finance landscape in Europe has matured and gained a high level of stability, it has not yet been adequately structured, except if it answers the questions of inclusion, security and competition as well as strategic independence (European Commission, 2024).

2.2 EU regulatory framework for digital finance

The EU regulatory framework for digital finance is designed to strike a balance between unlocking financial innovation and ensuring that risks associated with the innovation remain within the institutional perimeter. It is not just a legal technical area aimed at regulating individual financial products, but a whole framework, which aims at the integration of the integrity of the European internal market, confidence of the consumers, financial stability, data protection, cyber resilience and monetary sovereignty in the same legal mechanism. The European approach to digital finance is rather institutional with an objective of innovation to develop within the rules, instead of leaving the market to self-development (European Commission, 2020).

Before comprehending the EU's rules on digital finance, it is important to grasp the need for digital finance regulations. The financial services industry is moving to digital, and transactions are increasingly speeded up, cross-border service delivery is made possible, data is used more intensively by users, and financial institutions rely more heavily on providers of technology services. This change breaks the traditional financial law framework based on the institution. New players such as banks, payment institutions, e-money institutions, crypto asset service providers, cloud technology companies and data intermediaries are now also integrated into the financial value chain. As a result, the EU regulatory approach to digital finance does not just focus on banking regulations but also covers payment services, crypto assets, operational resilience, access to financial data, anti-money laundering, and artificial intelligence (European Banking Authority, 2021).

With the 2018 FinTech Action Plan, the EU's regulatory approach towards digital finance became more specific. The purpose of this plan was to facilitate technological innovation in the financial sector, expand the European financial technology market, lower regulatory constraints and adjust supervisory capacity to new technologies. The significance of the plan lies in the fact that it does not

consider fintech just a passing fad but rather an area that impacts the future competitiveness of the European financial system directly. In this phase, the EU started to consider digital finance beyond the innovations it's presenting to consumers, but also regarding the capital markets, payment systems, cybersecurity, and the delivery of cross-border services (European Commission, 2018). In 2020, the Digital Finance Strategy was adopted, making this approach more comprehensive to become a regulatory program. The strategy was designed to facilitate the digital transformation of the European financial sector, minimize fragmentation of the internal market, secure consumers' access to innovative financial services, and ensure financial stability. This document took digital finance from a side track in various pieces of legislation to a policy track. The main guideline of the strategy is based on the development of common rules to allow the scalability of digital financial services across the EU, and to ensure that these rules are designed to keep up with the technological advances (European Commission, 2020).

Payments is one of the most established and successful areas of this regulation. Given that this is the domain in which digital finance comes closest to the user, the EU's measure was quite decisive. PSD2 has broken the monopoly power of banks in the payment system, allowing third-party service providers to provide services for payment initiation and account information. Strong customer authentication has proven to be the security base of open banking and is meant to build people's confidence in digital payments (European Banking Authority, 2019).

The relevance of PSD2 in the context of European digital finance regulation is that payment services are no longer simply a technical domain but the access to data and competition area. Access to bank account data with the user's consent has paved the way for the emergence of new business models in financial services. In this model, the payment account has gone beyond being a closed bank product and transformed into a digital infrastructure where different actors can provide services. As a result, open banking is one of the most tangible examples of the interplay between data portability, security and competition in the legal framework of digital finance in the EU (European Commission, 2023a).

As time has passed, the payment service industry has developed to present new challenges to PSD2. In reality, differences in technical standards and supervisory practices across member states have tempered the anticipated seamless unfolding of open banking. New regulations have been proposed due to fraud, the strong customer authentication and user experience implications, access quality by third-party service providers, and conflicting interests between banks and fintech companies. The proposals on PSD3 and Payment Services Regulation are thus designed to increase security in the

payment market, but to also clarify and increase harmonisation for the use of open banking (European Commission, 2023).

Crypto assets have a special status in the regulatory framework governing digital finance in the EU. In early years of crypto assets, this aspect in Europe has been primarily dealt with by national laws, anti-money laundering rules and principles of general financial law. But as the cryptocurrency asset space continues to expand and the world continues to debate the merits of stablecoin projects and the rising number of investors losing money, the need for more direct and applicable regulation at the EU level has been strengthened. The Markets in Crypto-Assets Regulation (MiCA) is the most comprehensive institutional answer to this need (European Parliament and Council, 2023).

The main objective of MiCA is to connect the crypto asset market under a single legal framework in the EU. The regulation requires crypto asset issuers, asset backed tokens, e money tokens, and crypto asset service providers to comply with obligations in regard to authorisation, disclosure, governance, market integrity and consumer protection. This works to avoid the emergence of crypto assets as a totally free and unregulated market and ensures legal clarity and the possibility for legitimate market participants to operate in the EU market. One particular feature of MiCA is its focus on crypto assets as payment systems, financial stability and monetary sovereignty, in addition to investor risk (European Parliament and Council, 2023).

The regulation of stablecoins has a special relevance in the MiCA. New risks may arise for the traditional monetary and payment system as tokens become widely used for transactions where the value of the token is dependent on a specific asset or currency. Reserve assets, its redemption rights, liquidity management, governance of the issuer, and the protection of the user are thus brought to the heart of the legal framework. It is not just about closing the door on the development of instruments such as digital currencies, but about introducing them under clear obligations and setting conditions for the structures that have the potential to be systemic (Zetzsche et al., 2020).

Financial services have come to rely more and more heavily on software systems, cloud infrastructures, data centres and external technology providers, and the traditional definition of operational risk is proving to be insufficient. The Digital Operational Resilience Act (DORA) is a horizontal regulation that aims to directly address this new dependency structure. The legal obligations of DORA are detailed on information and communication technology risk management, reporting of incidents, resilience testing, supervision of third-party technology providers and information sharing (European Parliament and Council, 2022).

The importance of DORA is that it is not just a technical challenge of information technology, but a problem of cybersecurity. Digital disruption can have an impact on payment process, market infrastructures, customer data and financial market trust. This has led to the inclusion of operational resilience in the EU regulatory agenda for financial stability. Finally, Financial Institutions now fall under the regulatory scope of the contracts they enter into with external service providers, the risk management processes and their crisis continuity plan through DORA (ESMA, 2024). With the evolution of digital finance, there are new requirements for regulation on data access and data governance. Open banking is an evolution and change in the data in payment accounts, whereas open finance is a data sharing system. The Financial Data Access Framework (FDAF) idea aims to provide customers with safe, controlled access to data from different financial services such as saving, investing, insurance, pensions and loans. A key component of competition and innovation is financial data, and the consent of users and security of the data are at the centre of regulation (European Commission, 2023).

Open finance regulation raises questions about the ownership of the data and conditions for sharing the economic value of the data. Financial institutions have always operated on customer data in their closed systems, for product design, risk analysis and customer management. The open finance approach is meant to crack it and provide customers with a better right to their finances. The data-sharing side of the business, though, can present problems such as consent procedures, discriminatory pricing, misuse of the data, and threats from cyberattacks. This is why the EU model aims to create an access regime which is not free market but subject to standards and supervision (European Commission, 2023a).

Artificial Intelligence's influence also has been rising in digital finance. AI systems are being used by banks and investment institutions for purposes like credit approval systems, fraud prevention, categorizing customers, advising investments, compliance procedures, and enhancing processes. These technologies will help to speed up decision-making, but present challenges of explainability, discrimination, model risk and responsibility sharing. The indirect links between the AI Act and automated finance decisions relate to transparency, human oversight, data quality and risk management of high-risk AI systems (European Parliament and Council, 2024).

The use of artificial intelligence in financial services is not only regulated by the AI Act. Current financial market conditions also ensure that companies have a duty to safeguard customer interests, to carry out financial market compliance tests and to undertake governance duties. But, procuring third-party AI systems does not relieve financial institutions of their duties. This is in line with the

EU's general approach to digital finance, which is that the application of the technology does not remove existing legal obligations, but rather that existing legal obligations must be re-applied in new technical contexts (European Securities and Markets Authority, 2024).

A key tenet that often comes up in EU digital finance laws is consumer protection. Digital channels are user friendly, but can be confusing when it comes to financial products. Low friction transaction design, automated approval processes, mobile interfaces and customised advertising can all steer consumers toward a decision, without an appropriate risk assessment. As such, disclosure requirements, transparency and complaints procedures are a shield of protection in the EU regulatory framework for digital financial services. This is evident in different aspects, including in crypto asset white papers (European Parliament and Council, 2023), in relation to secure identity verification in payment transactions and in relation to the regulatory principles in investment services.

With digital finance, the supervisory structure of the EU regulatory system is undergoing a transformation as well. The EBA, the ESM Authority and the EIOA are the key authorities in the field of digital finance in terms of connecting to the regulatory framework, developing technical standards, guidelines, opinions and jointly reporting. This creates a multi-layer governance structure of the financial regulation in the EU. There are EU provisions that are directly applicable and national authorities have their normal supervisory duties. Digital finance is cross-border and so is the alignment between these two levels of importance (European Supervisory Authorities, 2022).

Another key aspect of the regulation regime is that technology has become a more significant topic for the financial supervisory regime. The financial institution is now dependent on external sources for cloud services, data analytics, authentication and cyber security, and even on customers and risk has not been confined to the licensed financial institution. Therefore, DORA has included critical 3rd party ICT providers in the regulatory regime. It is an example of EU digital finance law which has gone beyond institutional licensing to infrastructure dependencies (European Parliament and Council, 2022).

The EU digital finance regulation has a strong internal market focus. Variations in the rules that each member state applies can pose a challenge to scale up digital financial services and result in regulatory arbitrage. These regulations (as well as MiCA and DORA) are therefore not directions, but rather common rules which are directly applicable. The decision points to the goal of establishing a regulatory framework throughout the EU, rather than national and sector-specific frameworks in digital finance. Common rules help financial service providers to function in similar conditions in different countries and provide consumer protection. (European Commission, 2020).

However it is noted that there are tensions between the EU regulations. Too strict a regulation will also come at a cost for small fintech start-ups. A high degree of regulation can increase the cost for smaller fintech startups to keep up with it. The compliance burden for small businesses becomes quite complex when combined with MiCA, DORA, the payment services regulations, obligations under open finance, anti-money laundering regulations, and the artificial intelligence requirements. As such, the success of the EU digital finance law depends on the extent to which the rules are proportionate and implemented effectively and enforced (European Banking Authority, 2021).

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2.3 The digital euro project

The digital euro initiative is among the most crucial initiatives for digital financial transformation in the European Union. This project is not just a search for a new payment instrument, it is also a contribution to the goal of maintaining a role for public money in the euro area digital economy, to heightening the resilience of the European payment systems, to minimize reliance on private payment systems in the digital economy and to adjust monetary sovereignty to digital conditions. The digital euro project is inherently linked to the core of the monetary system as central bank money in digital form (European Central Bank, 2020).

This concept of a digital euro is now a policy concern as cash has become less common in the euro area, electronic payments have become more prevalent and private payment solutions are more influential on everyday economic activity. In Europe, people are still accustomed to using cash, and they consider it a legitimate form of public money, but many payments are made with cards, mobile apps and online payment systems. This adjustment leaves the nature of central bank money subject to the discretion of the central bank, which could restrict the flow of such money to citizens and businesses. Rather than replacing cash when it comes to this risk, the digital euro would be designed to supplement the public money function of cash in the digital space (European Central Bank, 2022).

The key concept of the project is to safeguard the direct access to public funds in a digital economy. Bank accounts and payments made by card in everyday transactions are frequently thought of as electronic money, but they are based on commercial bank money or private payment systems. But the euro area's ultimate bond of trust is central bank money. The digital euro, then, cannot be considered a regular financial product, but rather a new link between the characteristics of money in the hands of the user and the trust architecture of the monetary system. The digital euro is indeed more than just a product with the potential of introducing competition into the digital finance market, it is an institutional project to make the publicness of the euro system tangible in the digital environment (Bindseil, 2020).

Private digital currency projects have also been influential in driving the digital euro initiative to the forefront due to the pressure they have placed on the matter. Central banks have been forced to reconsider the functions of money and payment systems as a result of crypto assets, stable coin projects and growth of major tech firms in the payments space. The core challenge for the Euro area is the loss of the public money as the benchmark of the power of money in the daily payments cycle, as economic transactions increasingly take place in private networks. The digital euro should thus be understood as a move to maintain and strengthen the public nature of money in the face of a heightened private digital infrastructure (Brunnermeier & Landau, 2022).

The European Central Bank finally released its first detailed report on the digital euro in 2020, examining the circumstances that could make it a project needed. The digital euro was mentioned in the report as central bank money to be used by citizens and businesses for retail payments. In this sense, the primary aim of the digital euro is to provide a secure, convenient and cross-border payment solution. This was seen as a shift from the digital euro as a fintech product in the narrow sense, to becoming a public policy instrument associated with the main functions of the Eurosystem (European Central Bank, 2020).

The project entered the research phase in 2021, where the technical, economic and institutional design options for the digital euro were assessed. The research process involved looking at topics like access model, privacy, offline use, distribution channels, payment scenarios, impacts on financial stability, and user experience. The research undertaken at this stage revealed that the digital euro would not be a simple account-based approach that the central bank offers directly to consumers, but rather a two-tiered model in collaboration with financial intermediaries was more suitable. The project thus took a step towards a new model, one that would be based on the credibility of central bank

money and the capacity of the private sector to deliver user-friendly services (European Central Bank, 2023).

Two-tiered distribution system is a key aspect in the digital euro project. In this scenario, the European Central Bank and the national central banks are responsible for issuing and setting up basic digital euro infrastructure, and banks or other payment service providers will communicate with the user. This is because the central bank would not be able to have a direct service with millions of individual customers. Meanwhile, it aspires to not fully replace the current banking system. This is a crucial decision to make for a digital euro to function without being in competition with the financial intermediation system (BIS, 2021).

One of the most debated issues in the design of the digital euro is privacy. Cash payments offer a high level of anonymity, whereas digital payments create transaction information. Hence, the digital euro project needs to weigh carefully the convenience of digital payments with user privacy. Offline digital euro payments will try to achieve a similar level of privacy as cash, but online payments will have ongoing anti-money laundering and anti-terrorist-financing requirements, according to ECB documents. This separation demonstrates that a digital euro's controversial design space is in terms of payment security and fundamental rights (European Central Bank, 2024).

It is not deemed enough to be restricted to online payments when designing the digital euro. For the project offline use is considered as a vital part. The offline payment feature is essential to prevent payment failures when there is no internet access or technical glitches happen. This will be crucial to the digital euro's ability to exhibit cash-like resilience. Ultimately, the continuity of payment systems is not only about speed – the continued availability of public funds in the event of a crisis, disaster, cyberattack or connectivity failure is an essential component of financial security (Kiff et al., 2020).

Table 2.3. Main phases and design priorities of the digital euro project

Period	Project stage	Main institutional focus	Key design priorities
2020	Initial analytical phase	Publication of the ECB report on a digital euro	Definition of digital euro, possible issuance scenarios, role of central bank money
2021–2023	Investigation phase	Examination of design and distribution models	Privacy, access, offline use, two-tier distribution, financial stability safeguards
2023	Stocktake and transition decision	Completion of the investigation phase	Assessment of user needs, intermediary role, legal and technical foundations
2023–2024	Preparation phase	Development of rulebook and technical preparation	Scheme rules, provider selection, holding limits, user experience, legislative input

2024	First progress stage	Refinement of design choices	High privacy standards, offline functionality, calibration of holding limits, technical testing
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Source: European Central Bank, 2024.

Table 2.3 shows that the process of the digital euro project is not a one-step process. In the research phase of the project, the initial conceptual and political arguments were made and then, in the technical and institutional design phase, various design options were considered. Moving to preparatory phase following 2023 does not necessarily imply the launch of the digital euro. This phase is meant to be used prior to a possible issuance decision to establish the legal, technical and operational framework. The decision on issuance will not be available until after the European Union (EU) legislative process which will include the project's CI dimension, and which is yet to be completed, beyond the central bank decision (European Central Bank, 2024).

The European Commission's regulatory proposal from 2023 has shed light on the legal aspect of the digital euro project. The plan will feature the digital euro on par with cash euros as a euro central bank currency, under specific conditions, and as a legally tender currency under those conditions. As this framework makes clear, the digital euro cannot be a typical payment application and is not designed to be put into circulation, but a new form of public money. The legal tender of the digital euro will serve to guarantee its technical suitability and economic and legal validity (European Commission, 2023).

For the project to be successful, design is crucial, and the connection between the digital euro and cash – social acceptance – plays a vital part. Europe is on a fast lane towards digitalisation and cash is still important in the domain of trust, inclusion and privacy in Europe. The digital euro's representation as a form of cashless payment could impact the trust in the currency. This is why EU institutions stress that the digital euro will be in addition to cash. This attention is not only on communicating, but also it's a must from the financial inclusion point of view. The social dimension to designing a digital euro will require careful consideration of how the payment system will be designed to be accessible to those with fewer bank accounts, or less familiarity with digital technologies than cash, including the most vulnerable and the elderly (European Parliament, 2023).

Within the digital euro project, the holding limits are mentioned as one of the most crucial instruments for financial stability. The use of retail CBDC without limits may spur a fast transition from commercial bank deposits to central bank money in times of crisis. This situation may have a negative effect on the banks' funding base and their loan capacity. The one difference between the digital euro case and other proposals is that there is a clear requirement for specific holding limits or

balancing features to be developed. The aim is to avoid the digital euro being a mass savings vehicle, but rather a means of day-to-day transactions. The aim is for the digital euro to be not a mass-savings means but rather for everyday use (Adalid et al., 2022).

The interest will also be an essential feature of the digital euro design. An interest-bearing digital euro could provide a powerful instrument that may impact the transmission of monetary policy, but also might have more impact on the banking system. The ECB's mindset seems to be one in which the digital euro is seen as a common payment method, not as a vehicle for investment or as a store of value, based on the prioritizing strategy it adopted when designing the digital euro. This preference is representative of the concerns around financial stability. A digital euro that proves to be too lucrative as a deposit option may be an added strain on the banking system (Bindseil & Panetta, 2020).

Another important aspect of a digital euro is strategic independence of the European payment market. The presence of big non-European payment networks and tech firms in the Euro area card and online payments is high. In the current situation, therefore, EU institutions are more reluctant to intervene in terms of regulation of payment data and payment structures, competition and infrastructures security. The European endeavour to identify a shared and trusted payment instrument in Europe includes the digital euro. The project's goal is to link directly to the internal market's payment system and foster monetary sovereignty (Panetta, 2022).

The implementation of the digital euro project is not just about technology but also about user experience, as it is crucial to its success. Consumers don't want to pay with a more complicated and slower method of payment than they're accustomed to. This means that the digital euro needs to be easily accessible for everyday payments, accepted by many and operational across various payment systems. The digital euro could serve a range of functions such as payments at physical stores, online payments, payments between people and payments for the public. This shows that the project can't be the sole effort of central bank money but it should be something that is actually usable, which is ease of use (European Central Bank, 2023). There is also a new area for compliance for banks and PSPs in the digital euro project. The two-tier approach is to rely on private financial institutions to manage the distribution and customer relationship with the digital euro, which will necessitate integration and technical and operational implementation with the digital euro infrastructure. This can open avenues for banks to consider the services to be provided, but does have the potential to cause a shift in costs, competition and customer availability. Among the sectors in which the issue of standards compliance, technology investments and (income) models are particularly relevant, smaller banks and payment institutions stand out as a sector of interest for discussion (Auer et al., 2022).

The project ties also are noteworthy with crypto assets and stablecoins. The digital euro is designed to be a secure payment tool as well as the volatility of crypto assets or the reserve risks of private stablecoins. However, a half solution would be to simply consider the digital euro as a response to crypto assets. The project aims to bring back the role of central bank money in the digital finance market. The digital euro, therefore, is an opposite to the multitude of private digital currencies and a step towards strengthening the European payment system (Bank for International Settlements, 2023). Critics of a digital euro argue that the economic and social benefits and advantages are not guaranteed. But other payments like card payments, bank transfers or mobile payments are widely used in Europe and the digital euro will provide something different to the user, say critics. It is important to note that these are criticisms which remind us that this is not a project technically possible by itself. To be well accepted by society, the digital euro will need to provide something new in terms of trust, privacy, low cost and acceptance, and crisis resistance (European Parliament, 2023).

Democratic element of a digital euro project is also important. Central bank digital money has the potential to affect the payment habits and data trails, as well as the financial institution relationships, of millions of individuals. Hence, the project cannot be carried out just based on technical skills. To make the project politically legitimate, the legal framework, the European Parliament and Council process, public consultations/consideration of users expectations have to be engaged. The digital euro is linked to one of the core functions of the monetary system, and can only be technically successful if it is accepted by society (European Commission, 2023). The new digital euro is only valuable because it links the current payment system with the new monetary order. In contrast to most digital payments, which are related to commercial bank money and private infrastructure, the digital euro will introduce central bank money directly into digital payments. This can serve a basis for developing a common reference point for payment systems throughout Europe and provide users with secure access to public funds in everyday transactions. To ensure the success of the project, the technical system must be reliable, the legal system need to be clear, and a balance needs to be achieved with the banking sector and the project must meet the users' actual needs (European Central Bank, 2024).

To understand the project of a digital euro it is important to understand its political and monetary arguments but also its technical features. That's because the digital euro is not designed as a vision of central bank money, but as a real payment system that can be utilized daily in payments. The project's success is not only a matter of the decision of the European Central Bank to launch the digital euro, but also a much wider issue. The key technical aspects of the digital euro project are how users will access it, how payments will be made, how transactions will be processed in both online and offline

environments, how personal data will be safeguarded, and the role of commercial banks and payment service providers in the system (European Central Bank, 2024).

The first major component of the technical design of the digital euro is the two-layer distribution system. This is the model in which the Eurosystem will be the issuer of the digital euro and responsible for providing basic monetary security, while banks and authorized payment service providers are directly engaged with the users. This means that the digital euro will be available primarily through banking or payment service providers. This decision means the central bank will not have direct access to all the individual customers, and will allow existing financial institutions to play a role in the digital euro ecosystem. In theory, this is not a separate and isolated system, but a type of public money that will complement the existing payment system in Europe (Bank for International Settlements, 2021).

The availability of the digital euro will be through digital wallets for users. They might be provided by banks or payment service providers and will enable users to maintain, create, and receive balances of digital euros. The digital wallet structure is essential for the real use of the digital euro: the payment method will be known to the citizen via the wallet interface and not the technical infrastructure itself. Thus, wallets must be secure, clear, inexpensive and suitable for various groups of people. The public character of the digital euro (European Central Bank, 2023) is directly related to simplicity of the design of its accessibility, particularly for elderly users, people with limited digital skills, and users with disabilities.

One of the striking technical aspects of the digital euro project is its offline payment feature. Offline use will allow the digital euro to be used for payments without an internet connection or when there is a temporary failure of the payment system. As the feature enables the digital euro to be as resilient as cash, it is crucial. In everyday economic life, payment systems are expected to be merely efficient, but they are also supposed to continue to fulfill their core function as a payment system in times of crisis, disaster, cyber attacks, or connection failure, etc. The offline payment option could make the digital euro a more robust component of the system that maintains the continuity of public money, beyond being an online payment instrument of the modern era (Kiff et al., 2020).

Offline use also has a special meaning in terms of privacy. In cash payments no data record is created other than that of the parties involved in the transaction, but in digital payments, transaction data is part of the system. This raises the question of privacy with the digital euro project not as a technical aspect but as a crucial social aspect of digital currency. The fact that the ECB's preparatory work envisages a higher level of privacy for offline digital euro payments is important in terms of the digital euro being able to maintain some characteristics close to cash. The obligations to prevent

money laundering and terrorist financing for online transactions, on the other hand, are expected to persist (European Central Bank, 2024).

The technical design of the digital euro also includes measures for security and authentication. A digital euro wallet will need to be capable of user access, confirmation of transactions, security of the device and protection from fraud. The robust customer authentication experience included in European payment services regulations is an important point of reference for the digital euro. But a digital euro's security design must not only focus on combating fraud; it must also have a quick, reliable authentication system that isn't unnecessarily complicated for users. Increased complexity of security might make users stick with the familiar payment solutions (European Banking Authority, 2019).

A second technical issue that was addressed in the case of the digital euro concerns limits. As a central bank money, it could be seen as more secure by its users than commercial bank deposits. This may lead to the danger of a quick transformation from deposits to digital euros, particularly in the event of a crisis. Therefore, setting certain limits on digital euro balances is being considered to mitigate the project's impact on financial stability. The limits should, technically speaking, be applied at the wallet level, ensuring that the limits are not set with the intention of making the digital euro a large scale savings instrument (Adalid et al., 2022).

It is also important for the digital euro to be compatible with current payment systems for the project to be technically successful. In Europe, a wide variety of payment methods are already being used, such as card payments, bank transfers, instant payments, online payment and mobile payments. As a new entity, the digital euro could only be utilised in a niche market. Hence, a digital euro must be developed to be able to be used in various fields, including store payments, e-commerce, P2P payments and public payments. Such a structure proves the digital euro's adoption is not only due to being a secure central bank-issued currency but also its ease of use in everyday life (European Central Bank, 2023).

The connection between technical design and the future of cash also needs to be secured in the digital euro project. What the digital euro isn't designed to do is to supersede cash, but rather to augment it. It matters because cash remains an effective means of public money in terms of privacy, inclusion and ease of use during crisis situations. The digital euro will seek to preserve some of these attributes in the digital form. Offline, privacy, free basic services, and easily usable wallet design are thus not simply technical features. The features make sure that the digital euro is not just a

transformation instrument, but a complementary instrument that can make public money fit in the digital economy (European Commission, 2023).

These technical aspects will shape the role of digital euro in the European payment system. If a project is going to be based on central bank money in digital only format, the project might not be able to build up an adequate user base. It is important for the digital euro to be reliable, usable, privacy friendly, accepted and aligned with current payment patterns from a user perspective. So far, the technical aspects of the digital euro project can not be detached from talks about monetary sovereignty and public money. The economic and social effect of the digital euro will be significantly influenced by design decisions regarding wallet structure, offline payment, two-tier distribution, wallet limits, data protection, and interoperability (Auer et al., 2022).

2.4 Technical design choices of the digital euro project

The digital euro is a retail payment instrument designed to allow citizens and businesses in the euro area to access central bank money in digital form. Therefore, the issue is not simply about the European Central Bank developing a new payment instrument; the basis of the project lies in which wallet users will access the digital euro, which infrastructure will be used for transactions, how offline payments will be made, the level of protection of personal data, and how commercial banks will be positioned in this system (European Central Bank, 2023).

Table 2.4. Main technical design choices of the digital euro project

Technical design element	Expected structure in the digital euro project	Purpose of the design choice
Two-tier distribution model	The Eurosystem would issue the digital euro, while banks and authorised payment service providers would distribute it to users.	To preserve the role of financial intermediaries and avoid direct retail banking by the central bank.
Digital wallet	Users would access and use digital euro through wallets provided by banks or payment service providers.	To make the digital euro usable in everyday payments through familiar digital interfaces.
Offline payments	Payments could be made without an internet connection in specific conditions.	To increase resilience and provide a cash-like payment function during outages or limited connectivity.
Privacy safeguards	Higher privacy is expected for offline and low-value payments, while legal compliance would remain for online transactions.	To balance user privacy with anti-money laundering and financial integrity requirements.
Holding limits	Users would be allowed to hold digital euro only up to a certain amount.	To prevent large-scale shifts from bank deposits to central bank money.

Non-investment design	The digital euro is expected to function mainly as a payment instrument rather than a savings product.	To support daily payments without disrupting bank intermediation.
Interoperability	The system should work with existing payment infrastructures, merchants, e-commerce platforms and public payment channels.	To support broad acceptance and practical usability across the euro area.
Coexistence with cash	The digital euro would complement cash rather than replace it.	To maintain public access to both physical and digital forms of central bank money.

The most crucial technical decision of the digital euro will be the dual distribution system. Under this approach, the digital euro will be issued by the Eurosystem and will be a reliable central bank money, while banks and authorized payment service providers will deal directly with the users. Citizens will therefore be able to access the digital euro via their current banks or payment service providers, rather than directly with the central bank. The option allows the central bank to avoid becoming a retail customer service provider, and at the same time to try to maintain the position of banks and payment institutions as it is now (Bank for International Settlements, 2021).

The technical aspect of this model is that the digital euro is not intended to be a closed and totally independent central bank payment system, but rather a type of public money that will coexist with the existing payment system in Europe. The digital euro will be accessible to users via a digital wallet and will be used for holding, making and receiving digital payments. It is expected that the wallets will be made available by the banks or payment service providers. The wallet structure is important for the project to be adopted in everyday life, for the user, the digital euro will have a meaning through the simplicity, security and accessibility of a wallet, and not on the technical infrastructure (European Central Bank, 2024).

The digital euro wallet should not be considered solely as a smartphone application. During its preparation process, the European Central Bank stresses the need to design the digital euro for a range of user groups. It's essential for older users, less tech-savvy users, people with disabilities, and those who live in places with weak internet connections. For a payment instrument that constitutes public money, it is not enough for it to be functional only for tech-savvy users. Accessibility, ease of access and the affordability or even availability of basic payment services are therefore important technical considerations for the digital euro (European Commission, 2023).

One of the most impressive technical aspects of the digital euro project is the offline payment option. When there is no internet connection or temporary technical disruption, the payment will take place offline, with the digital euro. This capability may allow the digital euro to have some of the

same characteristics as cash. It is a payment method that can be made without Internet, electricity or cash. An offline functionality is relevant to the public money's payment function as it becomes effective in the event of crisis, natural disaster, cyberattacks, infrastructure failures, and connectivity issues (Kiff et al., 2020).

Technical robustness isn't the only reason why it's important for the offline payment feature, as it's also about privacy. Transaction data is usually traceable and storable in digital payment systems. In contrast, with cash payments, no detailed record of the data is created other than the transaction parties. The design of the digital euro is therefore a key aspect of its social acceptance, as it will enable higher level of privacy when paying offline. However, the credibility of the project can be undermined if users fear that the digital euro will turn into a tool to monitor all payment transactions (European Central Bank, 2024).

The privacy aspect of the digital euro is not a zero-sum game. European regulatory system continues to have obligations for combating money laundering and terrorist financing. So, it takes varying degrees of privacy into account when designing the digital euro for online vs offline use. Small-amount offline payments are expected to enjoy a higher degree of privacy than online payments, and the legal oversight responsibilities will remain in place for online payments. The project aims to strike the right balance between the privacy of its users and financial integrity (European Commission, 2023).

Another technical preference for the digital euro is the holding limit, i.e., limiting the amount of digital euros users can hold. This preference is directly related to financial stability. As digital euro is central bank money, it could be seen as more secure by the users than commercial bank deposits. Citizens can quickly withdraw their money from banks and place it in digital euros, potentially undermining the financial model of banks, particularly in times of crisis. Given this, it is crucial to include holding limits in the technical design to keep the digital euro a convenient day-to-day payment solution and avoid creating a significant savings option (Adalid et al., 2022). The operation of the project will also depend on how these limits are to be implemented. The suggestions being considered are to have a fixed cap on how much digital euro can be held by a user in their digital wallet, move the remainder into a commercial bank account, or integrate the bank account and digital euro wallet when making a payment. These are designed to make payment easier for the user and to minimise the risk of deposits falling out of the banking system. The technical design here is not only one of ease of payment, but also plays a part in ensuring the balance between commercial bank money and central bank money (Bindseil, 2020).

It is also crucial whether the digital euro will be able to offer interest or not. The current direction of the project is to create a digital euro as a payment tool and not an investment tool. An interest bearing digital euro would make it easier for customers to switch from commercial bank deposits to the new coin, and be more effective in the transmission of monetary policy. Thus, it is more sensible to design the digital euro without interest or with a limited structure that lends itself to everyday transactions in terms of financial stability (Bindseil & Panetta, 2020).

Another key technical decision for the digital euro project is interoperability. Card payments, bank transfer, mobile payment applications, instant payment systems and online payment solutions are already used in Europe. The digital euro, if it will be structured as an entity outside these systems, could impose new costs on consumers and could be adopted by consumer groups in a limited manner. Thus, the digital euro must be developed to be utilised in various payment sectors, including store payments, e-commerce, peer-to-peer payments, and public payments (European Central Bank, 2023).

2.5 Central banks, CBDCs, and European monetary integration public money in digital form

The integration of European monetary is not a linear process, but rather will be realised through a series of stages, each one of which involves more than just the introduction of a common currency. The use of a single currency can be connected with how the citizens and businesses of the member states can access the euro, though a common currency in terms of currency units has become common practice for all member states. It's been the European Union that has been most obvious in the money sphere in introducing cash Euros. The introduction of the same banknotes into different countries has helped the monetary realm to transcend the law to everyday economic activity. On the payment front, however, things have been changing and today we can see a mismatch between the electronic dimension of economic life and the physical dimension of public payments (European Central Bank, 2020). This gap is in direct connection to the rethinking of central bank money in digital form. People use commercial bank money and/or electronic money mechanisms from private payment institutions as the basis of most of the money in use today. These types of money are used on a day-to-day basis in euros, but are not the same as central bank money, due to legal and balance sheet differences. Central bank money is a social debt, meaning that it is not credit risk bearing and is the last resort in terms of confidence in the financial system. Hence, CBDC is not a payment innovation per se, but an institutional solution to the problem of accessibility of public funds in the digital economy (Bank for International Settlements, 2023).

Central bank's role in the digitalised financial system is the main topic of discussion regarding a CBDC in Europe. Traditionally, central banks have offered public money on two separate levels: banknote issuance and banks' access to central bank reserves. Direct access to public money in a household or business is primarily in the form of cash. The proportion of transactions in cash is decreased, which means that there is a lesser amount of public funds visible in day-to-day transactions. In this scenario, users are more and more coming to rely on the digitized obligations of private intermediaries in the monetary system. Central banks' visions of the digital euro and other initiatives aim to preserve the central bank's role in this regard (Bindseil, 2020).

CBDC in this sense is a development that redefines, not restricts, central bank's mandate. Due to the growing presence of digital payments, central banks have been taking on more active roles in other functions besides ensuring price stability, such as overseeing the security of payment systems, the financial intermediation structure, data governance, cyber resilience and access to public funds. In this institutional context, the work of the European Central Bank on the digital euro should also be taken into account. The project does not aim at the central bank becoming a commercial player in the retail payment system, but on the creation of an architecture that will help safeguard the public nature of the monetary system in the digital payment system, irrespective of the competition with private market players (Panetta, 2022).

The digital public money is related to the idea of "unity of money" from the Euro area's point of view on monetary integration. The value of money is uniform throughout all the countries, banks and payment systems in the euro area. This is the basis for the trust in the monetary union. The digitalization can enable the more rapid deployment of multiple payment systems, but can also contribute to the erosion of money's role in various private payment networks. The payment infrastructure for payments in euro can increasingly rely on non-European or private digital currency projects, as the involvement of large technology companies, international card networks and private digital currency projects increases in the payment sector. The digital euro aims at giving a common denominator to this potential for fragmentation (Brunnermeier & Landau, 2022).

The digital implementation of public finance also reflects that monetary integration goes beyond payment infrastructures. While all banks, payment institutions and financial technology firms operate within different countries of the Euro area, users' experiences will be shaped by national practices, national payment solutions and market structure. In some countries, the payment via card is predominant while in other countries, bank transfer or local mobile payment applications are a stronger alternative. Designing a shared payment experience in the euro area is possible with a digital

euro, when properly designed. This experience may make monetary union more 'real' for citizens (European Central Bank, 2023).

Whether the contribution of the CBDC to monetary integration can only be based on ease of payment remains a question. The dilemma that Europe is faced with is that of the role of private cryptocurrencies and public money in the system. Commercial bank money is safe because it is usually one-to-one and exchangeable with the central bank money. Other digital currencies may begin to acquire varying degrees of trust and even that trust in this convertibility link could diminish, triggering a divergence in the monetary order. CBDC is at the top of this hierarchy and can serve to maintain the same trust relationship in the digital world (Bank for International Settlements, 2021).

The impetus towards the two-tiered model for the digital euro is a continuation of the European monetary integration connection to the banking system. In this case, an intermediary bank or payment service provider will be in direct contact with the user, and the central bank will issue digital currency and be the focal point of trust for users. So, money issued by the central bank is digital, but the financial intermediation system is not completely eliminated. The examples show that the design of a CBDC involves more than just technology efficiency; it also involves the banking system, the credit channel and financial stability (Auer et al., 2022).

One challenge to financial stability is the fact that cash will be less used once a CBDC is implemented. Financial stability is an area where CBDC could play a role in European monetary integration, but also needs to be carefully designed, as the use of cash will be reduced once a CBDC is implemented. Perceived as a very secure asset, retail digital central bank money might lead to a fast adoption of the digital euro, especially in a crisis situation. This would make it more difficult for banks to be liquid and to obtain funds, particularly during a panic. As a result, holding limits, no interest applied and tiered pricing are mentioned when talking about the digital euro. The goal is to enhance the everyday payment use of the electronic cash and not to create an alternative to large-scale deposits (Adalid et al., 2022).

These restrictions in the CBDC design suggest that the features and architecture of digital money is a significant determinant of its economic consequences. Technologies can be grouped under the same name but represented by models that give rise to very different outcomes. This effect on the banking system will not be identical if it is an interest-bearing CBDC versus an interest-free and limited holding capacity CBDC. In Europe, the way forward is more towards a "public and secure" digital euro rather than a radical monetary policy experiment. The premise of this orientation is that

decentralization of money should be implemented in its digital form without disturbing the monetary order (Bindseil & Panetta, 2020).

The other aspect of CBDC related to the European monetary integration is the cross-border usability of the CBDC. The Euro area has a common currency, but the use of the currency in retail payments has not always been as easy as using a local currency. High fragmentation of acceptance infrastructures, fee differences, and payment habits remain. The digital euro, a public payment instrument that would be used in the same way in the Euro area, can help lessen this fragmentation. Such an instrument can help to (European Commission, 2023) bring a higher level of consistency to the economic space of the monetary union at the level of everyday transactions.

In Europe, there is also a debate on strategic autonomy, and the digital version of public funds is also part of this. Payment systems are now a component of economic sovereignty and data control more than ever before. This has led to a discussion on monetary sovereignty in the digital age, as a large part of retail payments is conducted with non-European card networks or large technology platforms. In this regard, the digital euro is Europe's attempt to create a public, trustworthy and shared digital payment system in its own monetary zone. This quest does not mean closing off to the outside world; It aims to reduce unilateral dependencies in payment infrastructure (European Central Bank, 2024).

Monetary identity is also a crucial aspect of the significance of CBDC's integration. The physical dimension of the common currency, banknotes, has established a common monetary space, a new place, for European citizens. Today, in a world of digitalization, it is hard to sustain the same symbolic function with the bank note, just the physical piece. The public euro can become visible in everyday transactions again, when the digital euro will be introduced, thus making the idea of a common currency in the digital age more relevant. Thus, digital public money can be seen as more than merely a narrow efficiency measure for cutting down on payment costs, but also as a component of social and political legitimacy of monetary union (European Parliament, 2023).

The question of privacy comes into direct focus at this juncture of legitimacy of monetary integration. While cash offers the user a high level of privacy, digital payments generate transaction data. The issue of society adopting a central bank's digital currency demands the solution to the fact that all its transactions will be tracked by the public authority. The more important aspect of higher privacy for offline payments is therefore relevant in the design of a digital euro in Europe. Digitalization of public money could be used as a means to reduce the principle of privacy, which would result in monetary trust being cast aside (Kiff et al., 2020).

In the context of European integration, the inclusion aspect of digital public funds is also remarkable. While digital financial services are often perceived as fast, cheap and convenient, they are not necessarily equally accessible for those who are not, or are not yet, "digital" in their skills and for certain groups who have less access to financial services. The digital euro should be a public good, and it should not be limited to tech-savvy customers. The social dimension of monetary integration (European Central Bank, 2023b) thus refers to the offline usage, to the simplicity of the interface, to the free access to the basic services and to the channels targeted to specific groups of users.

CBDCs also have implications for European monetary integration through their effect on central bank balance sheets and the central bank's transmission process. Financial structures and financial practices can differ across countries, whereas the Euro area has a centralised monetary policy. Widespread use of a digital euro could affect individual countries' household savings preferences and banks' deposit base. Thus, the design must take the whole euro area into account. To launch a common digital currency in a monetary union requires considering not only average user behaviour, but the impact of such a move in countries with less developed banking systems or where cash is used more. (Adalid et al., 2022)

Wholesale payment infrastructures can also be interpreted as a link between CBDC and European monetary integration. Strong integration has been offered by the Eurosystem for years in interbank payments via T2 and TARGET services. However, integration has been more limited and more market actor dependent in the case of retail payments. Central bank money may help narrow the gap between these two levels with the advent of the digital euro. This implies that public money will no longer be just a technical interbank asset or cash and will also be used in the digital retail payment space (European Central Bank, 2024a).

The emergence of stablecoins from the private sector has turned the discussion on the CBDC in Europe more pressing. Stablecoins offer value stability pegged to a particular asset, but the concept has its own set of challenges, including the quality of the reserves, redemption rights, market liquidity, and governance. If such a private digital currency is widely adopted, particularly for non-euro currencies, then it could indirectly dollarize or become private currency dependent in the European monetary area. The digital euro has the potential to offer a digital alternative based on public money to counter these risks. Taken together with other regulations like MiCA, this potential indicates that Europe attempts to regulate the private digital currency space while at the same time ensuring that it is balanced with a public option (Zetzsche et al., 2020).

But the enhancement of monetary integration with the use of the CBDC is not automatic. The digital euro could become a tool with limited use in the event of design flaws, low engagement by users, complexity of access or lack of coordination with banks. In order to be adopted, a digital version of public money must be needed for daily economic operations, and have clear value added over the current payment system. This value; Trust, cost, privacy, extensive adoption, offline use, and Europe-wide integration will serve as the foundation for this (Goodell et al., 2024).

The scope of central banks' CBDC activities will also affect who will be the actors involved in the monetary system in the future. The European model aims to create a system of trust for public funds and service delivery in the private sector, not one that requires all payment relationships to be dealt with by the central bank. This is in line with the overall nature of monetary integration in Europe. A large share of financial services is provided by regulated private institutions with public guarantee of the common currency. The digital euro also aims to bring this balance to the digital payment environment (Bank for International Settlements, 2023).

To sum up, the link between central banks, CBDCs and European monetary integration is the most institutional aspect of the digital finance debate. The digital delivery of public money does not entail the obsolescence of cash, rather, central bank money will continue to be available, reliable and usable in the digital economy. In Europe, this is more than just a question of efficiency in the payment system. The digital euro seeks to retain the integrity of the currency, reduce the fragmentation that the private digital currency networks have caused, ensure financial stability, reinforce strategic autonomy and embody the concept of a common currency in the digital era. This means that CBDC is not only an extension of the already completed process of European monetary integration, but a step to strengthen the institutional basis of a common currency in a digital economy (European Central Bank, 2024).

2.6 Risks and challenges

Europe is rapidly transitioning to a digital age, with payments, access to financial services, and the monetary infrastructure all undergoing significant changes, as a result of the European Union's digital developments in finance and digital currency. But this change is fraught with danger. Digital finance's biggest characteristic is that it has brought financial transactions to be faster, more connected and more data-heavy. These features are efficient but can also put people at risk. One institution's disruptions can rapidly impact user actions, market faith and financial stability. The risks of digital finance, however, are not only technical but should be looked at within the EU (European Banking Authority) as a broad problem area, with institutional and economic implications.

One of the biggest challenges of digital finance is operational resilience. The number of software systems, cloud infrastructures, data centres, authentication systems, and external technology providers are increasing in the financial services industry. This dependency is beneficial to the flexibility and scalability of the services, but presents a greater dependency of the basic operation of the financial system on the technical infrastructure. Traditional banking considers operational risk to be caused by the internal processes, failures to act as intended by employees or physical facilities, whereas in the digital finance world, it can be far more pervasive throughout the network. The failure of one external service provider can affect several financial services providers at once (European Parliament and Council, 2022).

This is particularly true in regards to the use of cloud. While large cloud providers provide financial institutions with speed, cost and transaction capacity, they also cause the concentration risk that could lead to failure. However, if many banks, payment institutions or investment service providers are using technology suppliers, a failure of the technology or a cyber attack on this supplier is not only a problem for the individual institution, it could be a problem for a large part of the financial sector. The EU legislation DORA has not only shown an interest in the internal systems of the financial institutions, but has also shown an interest in critical third-party technology providers, who are also part of the system subject to DORA supervision (European Parliament and Council, 2022). While the most apparent threat in digital finance is cybercrime, data theft or service disruption are not the only issues to consider. The trust that underlies the financial system can be directly impacted by a cyberattack, as can the consumer's behaviour, corporate reputation and the stability of markets. When these attacks are introduced into the digital banking applications, payment systems or crypto asset service providers, they can decrease users' trust in digital financial services. Cybersecurity, therefore, is no longer a problem that can be addressed by the technical security groups. Prevention of cyber incidents is only part of the picture, however, as is the ability to respond swiftly and maintain the continuity of services in the stable evolution of the digital finance sector in Europe (European Union Agency for Cybersecurity, 2023).

Data usage is the other significant risk in digital finance. The financial services digitization makes it easier to monitor financial habits of users, their spending habits, income flows, and credit history, among other things. This data density can allow for more personalised services and risk assessments. But this information about finances comes with privacy and power imbalance concerns. Limited awareness among users of the data that is being processed, for what, with what third parties it is shared

and how it can be used in the future. Hence, digital finance should be connected and aligned with data protection and financial consumer rights (European Data Protection Board, 2020).

Another challenge that has arisen in the financial sector is discriminatory or exclusionary decision making processes resulting from the use of data. Discriminatory or exclusionary decision making processes are another challenge in the data-driven financial services. Algorithms from credit scoring, insurance pricing, investment advice and fraud detection, among others, can be used to recreate inequalities in historical data. Not only do users receive incorrect decisions, but often times they do not know how the decision was made, or they do not know how to ask a question about the decision. In the new era of automation in financial services, who's responsible gets more complex. Consumer protection may be undermined if there is not a clear regulation of the relationship between the bank that uses the model and the financial intermediary that implements the decision, and the technology company that develops the model (European Securities and Markets Authority, 2024).

These risks are enhanced by the use of AI applications. In customer service, compliance regulations, credit assessment, investment analysis, and market monitoring, financial institutions are implementing AI. The decision making process may not be transparent with these systems, but they are capable of processing large amounts of data in a short amount of time. An absence of accountability poses a big regulatory hurdle for finance. For instance, if an application for a loan is rejected, it should be easy to understand why, if an investment product is recommended to a particular user, or if a transaction is classified as suspicious. As AI becomes increasingly involved in financial decision-making, the focus of and on oversight is evolving from outcomes to the models which produce them (European Parliament and Council, 2024).

There is one big thing with digital finance— people are more susceptible to being manipulated in the digital space. The transactions carried out via mobile apps can seem swift and simple, but sometimes the convenience of mobile makes the individual's thinking and judgment of the risks compromised. In this regard, it is worth mentioning the trading of cryptocurrencies, the taking of loans using digital applications, the use of levers in transactions and the rapidness of investment decisions. Financial services are more available due to low transaction costs and constant accessibility, but also have the potential to make people more prone to excessive transactions, panic buying, and not understanding the product. Digital financial consumer protection is therefore more than merely the provision of informational texts, but also the design of the interface, the provision of risk warnings and product suitability (OECD, 2022). One of the most dynamic and complex risk zones of digital finance in the EU is cryptocurrency markets. These markets come with characteristics like price

volatility, manipulation, cyberattacks, lack of regulation and information for investors. For some, cryptocurrencies represent an opportunity to invest and transfer but for a large number of users, cryptocurrencies are a risk of losing money. Stability of value may provide a sense of security, but it may also add a significant level of risk if the value of the reserves, redemption rights and liquidity management are not properly structured. Implementation capacity, coordinating supervisory powers and adjusting to the evolving pace and nature of the market are key factors for the success of the EU MiCa regulation, which seeks to harmonize the area under common rules (European Parliament and Council, 2023).

Additionally, the threat to crypto assets with respect to money laundering and terrorist financing is significant. Complexity of some transactions, intermediaries in other countries and international borders are a possible source of problems for the financial integrity. The EU has, therefore, raised the standards regarding the disclosure of information on the sender and recipient in the transfers of crypto assets. This approach shows how digital finance cannot be limited to a market innovation, but also explored through its ability to address financial crime. The lack of regulation may impede trusted actors from getting into the market, and may also open the door for malicious actors (European Parliament and Council, 2023).

There are also certain dangers linked with digital euros, and designs of CBDC in general. The public digital currency can be an attractive option for users as an alternative to cash, which could have adverse effects on the banking sector. The more people save in the central bank, the more they will be stressed out in times of financial crisis, especially commercial banks. Therefore, it is imperative to find the right balance between the digital euro being a means of everyday payments and a replacement for deposits. The consequences of such concern are limits, no interest applied or other tools that aim to stabilize the situation (Adalid et al., 2022).

One of the challenges in the implementation of CBDC is privacy vs financial integrity. Of course, unlike cash payments, digital currency leaves behind transaction data, and cash payments offer users privacy. For any digital currency released by a central bank to be accepted by society, it's essential to stop it from being perceived that every payment conduct of users will be tracked by the state. On the other hand, public authorities have to not overlook risks like money laundering, financing of terrorism and tax evasion. A key issue in the design of the digital euro is the degree of privacy that will be provided and when controls will be put in place (European Central Bank, 2024).

In this context, digital exclusion is important. As financial services go increasingly digital, some consumers may be able to access services quicker and at lower cost, or they may be excluded from

the financial system. In this regard, older people, low-income groups, persons with disabilities, people residing in rural areas and users with less digital skills are more vulnerable. Decisions that cut down on branches or decrease the quality of cash services can have a negative impact on access to financial services for these groups. Digitalization, if not designed inclusively, can lead to new inequalities, not to financial inclusion (World Bank, 2022).

Open banking and open finance is not without risk, either. Allowing users to share their financial data with other service providers (with their consent) can help to promote competition and innovation. This means that there are complex consent, sharing, and security issues with data. If it is granted by the user to access data from more than one service provider, then it might not be known who is responsible in case of a data breach. Moreover, it is often impractical for users to be able to read, understand and agree to lengthy and complex consent statements. But Open Finance is not just about being able to access the data, it's also important that this happens in a manner that is easy to understand and audit, the European Commission states (European Commission, 2023).

Other important factors for the EU are differences between countries in relation to supervision and enforcement. Supervisory capacity is still essentially based on the supervisory powers of the national authorities and digital financial services are readily available in the single market. The interpretation of the same EU regulation in various member states may be different and cause uncertainty for companies and inequalities in the protection of users. This is especially noticeable in the case of crypto asset service providers, payment institutions and fintech platforms. Information sharing and harmonisation of implementation between national supervisory authorities is crucial for EU-level common rules to be effective (European Supervisory Authorities, 2022).

A discussion about the environmental impacts of digital finance is also gaining traction. There has been awareness since the beginning of the crypto-assets for their energy use, and data centres and strong computing power have brought the digital economy to the forefront of the environmental discussion. This is where the European sustainable finance and digital finance programmes meet. Though digitalisation of the financial system can help to cut the amount of paper consumed and physical transactional costs, it will not be totally “environmentally friendly” without taking into account the energy consumption of data processing, blockchain infrastructures and technology hardware. The sustainability of digital finance relies on the infrastructure and energy model that is used by the technology (European Securities and Markets Authority, 2022).

In conclusion, the dangers of the digital finance or digital currency space in the EU cannot be considered as technical issues one by one. These are all elements of the same transition toward

operational resilience, cyber security, data privacy, AI, consumer protection, crypto assets, design of the CBDC, market concentration, digital exclusion and aligning with regulation. The EU is good at defining these risks in the context of a regulatory framework and finding institutional solutions. However, the mere existence of regulation is not sufficient, but its quality of implementation, the users' trust, technological resilience and coherence between the member states will be key. Digital finance offers Europeans a huge economic opportunity but the sustainability and reliability of the revolution hinges on the right management of the vulnerabilities associated with this transformation (European Commission (2020)).

CHAPTER 3

ECONOMIC IMPLICATIONS OF DIGITAL FINANCE IN EUROPE

3.1 Effects of digital finance on financial intermediation

The economic impact of digital finance in Europe will need to be understood first by studying how financial intermediation has evolved. The concept of financial intermediation has historically been defined as the relationship that's created between the households and firms in need of funds and the savers through the action of banks and capital markets and other financial institutions. This link has long been defined around the banking system in Europe, and in continental European economies, banks have a pivotal role in firms' financing. Digital finance hasn't abolished this structure, but it has certainly changed the way intermediation is carried out, the costing structure, the nature of the competition, and the way data is used (Basel Committee on Banking Supervision, 2024).

The first 'digitalization shock' in financial intermediation has been the change in the bank-customer relationship from a face-to-face to a digital interaction. In addition to the traditional branch network, paper documents, and face-to-face interactions, mobile banking, online applications, distance acquisition of customers and automated transaction authorizations have established a more solid position. The shift has impacted the cost dynamics of banks. The cost of software, cybersecurity, cloud, data management, and digital compliance have risen, while physical branch costs have fallen. Thus, digital finance is more than just a cost-saving operation for banks – it is a transformation of the nature of cost and institutional capacity that becomes increasingly technology-intensive. (European Banking Authority, 2021).

With digitalisation, data has gained significantly in the financial intermediation field. In the traditional credit space, documents of income, collateral, credit history, and bank relationships are key factors in evaluating credit; in the digital finance space, payment habits, number of transactions, platform details, e-commerce data, and alternative data sources are important. This can enable for a more thorough credit risk measurement. For small businesses and newly established firms, evaluating based on more up-to-date transaction data instead of limited credit records based on the past can facilitate access to finance. The shift has also led to increasing reliance on algorithm-based decision-making in the financial sector (OECD, 2024).

Digital intermediation in Europe has become more powerful and blurred the distinction between banks and non-bank financial players. Payment institutions, e-money institutions, fintech startups, open banking service providers and large technology platforms have started to intervene in various

segments of the financial value chain. The actors typically don't do the traditional banking activities like taking deposits or issuing loans, but do share traditional banking activities like providing payment initiation, collecting account information, providing the customer interface, analyzing data, or evaluating credit. Thus, financial intermediation is moving away from a single-centered bank relationship towards a more modular structure (European Commission, 2023).

This modular design can be expected to enhance competition. Open banking and open finance models can also reduce the information edge of traditional banks by enabling various service providers to gain access to users' financial information when they grant permission. By opening up an account history to another service provider, a consumer or business may be able to obtain better payment, credit or financial management services. This has forced banks to create a more streamlined and efficient digital experience, and better pricing. The EU's financial data access framework should continue to apply this logic to wider financial sectors (European Commission, 2023).

But there is not an equal competition advantage to digital intermediation. Concentration in financial services can take new shapes in the digital age due to data, scale and network effects. Big tech companies have significant advantages to offer in financial services, due to their size, data processing power and platform ecosystems. Payment, credit, or insurance services are services that start to be adopted more quickly than banks and are already available in users' daily lives on a platform. While this may enhance user experience in the short term, in the long term, the concentration of data on some large platforms and reliance on these platforms by financial services could lead to market power issues (Bank for International Settlements, 2023).

For banks, the other impact of digital finance will be on non-interest income. A range of digital payment services, subscription financial management solutions, data-led consulting, tailored products, and platform partnerships provide banks new revenue opportunities. Competition in payment services, on the other hand, can also lead to lower transaction fees and lower traditional revenues. Especially when competing with low cost fintechs, banks have to find ways to reduce their profit margins and increase the quality of their services. The pressure can make some institutions more risky or drive them to pursue mergers and alliances for achieving economies of scale (Basel Committee on Banking Supervision, 2024).

The speed of credit intermediation has also been transformed by digital finance. Online applications and automated document checks, combined with digital identity verification, can help to speed up credit assessment processes. This is important for SMEs, because they may require working capital in short periods of time. Digital financial tools offer SMEs new opportunities for financing in Europe,

and have resulted in more data-driven and rational financial decisions. This gives an edge to companies that have a strong data history, but can also present a new risk of exclusion for companies with poor digital footprints (OECD, 2024).

Digital finance will also affect intermediation for banks in the way of risk management. In fact, machine learning and big data analytics can help in generating a signal quicker in the credit risk, fraud monitoring, market risk and operational risk processes. But models are dependent on data quality, history and software assumptions, introducing new types of risk. Traditional banks' risk management frameworks are being called into question by model errors, unexplainable risk decision-making processes and dependence on external technology providers. The shift of AI and digital operational resilience regulations towards the financial sector in Europe is therefore not coincidental (European Parliament and Council, 2024).

Spatial dimension of financial intermediation is also changing through digitalization. The decline in branches, and the proliferation of digital services can be economically explained, but could also result in low physical access to financial services in certain areas. Banks, and their branches, are still a source of trust and access for older populations, rural populations, and users who have low digital skills. Thus, digital intermediation brings about efficiency and has transformed the way financial services are accessed by society. Access to digital finance is thus part of the impact of digital finance in Europe, and not only in terms of bank profitability or transaction costs (World Bank, 2022).

The complete disappearance of banks is not expected in the future of financial intermediation. A more realistic shift is to make banks less the single central players in the financial system, and to become players beside various digital actors. Banks continue to enjoy a robust position in the areas of deposit collection, creation of loans, capital adequacy, trust and regulatory oversight. But the customer interface, data analytics, payment initiation and personalized service areas are now more competitive. In Europe, the main impact of digital finance on intermediation is not so much debanking the financial system as redistributing intermediation (Bank for International Settlements, 2023).

The change has two consequences for the European economy. Data-driven and faster intermediation can help make capital more efficient. A larger number of services is available to SMEs, consumers and investors. On the other hand, there are new threats in the financial system due to data concentration, reliance on technology, algorithmic exclusion and cybervulnerability. Thus, the economic role of digital finance in intermediation must be broken down into a regulatory and supervisory capacity dimension. Europe's power is not only in its ambition to tackle digital finance,

but also in its approach to addressing financial stability, data protection and consumer confidence (European Commission, 2024).

3.2 Digital finance, digital currency, and monetary policy

The advent of digital finance goes beyond the mere technical update of payment systems. Monetary policy works through the financial markets, banks, credit conditions, household spending, and the investment decision. Some of these channels can be speeded up by digital finance while others can be undermined by digital finance or complicated. This is especially significant in Europe, where although the monetary policy is centrally issued in the Euro area, the financial behaviors, banks and level of digitalization in the economy is different across countries. Such disparities can lead to monetary policy being transmitted in a more fragmented manner in the digital finance era (European Central Bank, 2024).

Digital banking can influence the time it takes for deposit and loan interest rates to reach the customers. Developers are creating mobile banking features and online platforms that help consumers better research and contrast loan rates and terms from a variety of banks, and compare deposit interest rates. This facility for comparing rates can drive competition between banks, resulting in quicker adjustment of deposit and loan rates to policy interest changes. But this is not the same in every country. The relationship between banks and customers is likely to be stronger in countries with low digital financial habits than in high digital financial habit countries, where customers are more mobile (OECD, 2024).

Digitalization can be viewed from two different angles, in the context of monetary policy and the banking channel. Digital tools offer banks lower transaction costs, quicker risk measurement, and enhanced reach of customers, on the one hand. This can help to facilitate credit supply. Conversely, banks' deposit base and profits could suffer as a result of fintech competition. If banks' profit margins are shrinking, their ability to save and hold capital reserves could be reduced as can their desire to lend. This likely means that the central bank's interest rate policy decision is not as directly and evenly transmitted to the economy as it would be in the traditional banking system (Basel Committee on Banking Supervision, 2024).

Digital payment also have an impact on the shape of money demand when viewed from a monetary policy lens. The decrease in cash usage changes households' behavior of holding money for transaction purposes. With the growing use of card, mobile payment and instant transfer in everyday payments, actors in the economy can transfer liquidity between various payment instruments more quickly. This

rapid pace also can make the financial system more flexible, but may also generate new vulnerabilities, such as the rapidness of moving deposits during a crisis. In a digital environment liquidity can flow freely between institutions within seconds without any physical flow, making the management of liquidity an area that should be monitored with greater care from a monetary policy perspective (Bank for International Settlements, 2023).

The issue of digital money, and in particular central bank digital money, has more direct implications for monetary policy. A retail CBDC, like the digital euro, has the potential to enable citizens to have access to central bank money in a digital format. This would help to strengthen the payment system and to maintain the function of public funds in the digital economy. Yet, design of the CBDC has a significant bearing on the transmission of monetary policy. If a CBDC were of interest, could be held in large quantities, and very attractive, it would be in competition with commercial bank deposits. The aim of the design of the euro in the digital form is therefore to place it as a daily payment instrument and not as an investment instrument (European Central Bank, 2024).

The credit channel of monetary policy is associated with the impact of CBDC on the banking system. Deposits are a major source of credit to commercial banks. Large inflows of deposits from households and firms to digital central bank money could lead to weaker bank funding. This may impact banks' ability to make loans and interest rates. This concern is addressed in the design, including limits on holding, no interest earning, and a two-tiered distribution structure. The primary aim of this is to secure digital access to public funds and not to unduly impact the middleman role of the banking industry (Adalid et al., 2022).

Another problem from a digital monetary policy point of view is the transparency of central bank money. If citizens' direct access to public money weakens because daily payments are carried out completely via private digital payment instruments, that has consequences. The consequences of this are that citizens' direct access to public money may become less effective if daily payments are done through entirely private digital payment instruments. This may not appear to be a technical issue in the near term since commercial bank money can be readily exchanged on demand for central bank money. In the long term, however, the materiality of central bank money in society is of importance for the trust architecture of the monetary system. A digital euro could contribute to the institutional framework of monetary policy, as public money in the euro area will be fit for the digital age (European Commission, 2023).

One of the challenges for monetary policy is stablecoins and crypto assets. The use of private digital currency instruments in the euro area, denominated either in euro or in assets or foreign currencies,

might reinforce the risk of currency substitution. Whilst the widespread adoption of stablecoins may help to alter payment habits away from central bank networks, it could also impact on the effectiveness of monetary policy. The importance of MiCA is not just investor protection but also in terms of monetary sovereignty and financial stability. The European digital euro approach and crypto asset regulation all tackle the general trust problem of money (European Parliament and Council, 2023).

Digital finance also impacts central banks' use of data. Digital payments and financial platforms may provide more robust and detailed information about economic activity in a quicker time. Such data can serve as a precursor to consumption patterns, liquidity and a financial stress indicator. This can enhance the ability of central banks in monetary policy analysis. The fact, however, that data sources are concentrated primarily on private platforms and the access to data is dependent on commercial structures also leads to new questions about the ability of public authorities to assess the economic outlook on their own (International Monetary Fund, 2024).

The impact of digitalisation on monetary policy is one of the ways that the monetary policy is faster reacting. Digital channels allow for faster reaction times to interest rate changes for investors, banks and consumers. This speed helps to make the policy more effective but will also cause volatility in markets. Specifically, internet investment platforms, automatic portfolio management and computer-chosen trading systems are capable of reacting very swiftly to shifts in interest rates expectations. In this context, the communication of monetary policy becomes more delicate, as an unclear message rapidly turns into a broad range of price changes in the digital markets (European Securities and Markets Authority, 2024).

A second major concern of the Euro area is whether the digitalisation process will lower the differences in monetary policy transmission across the Euro area. Digital banking and common payment infrastructures theoretically can minimize transmission differences by enhancing financial integration. But, due to the varying extent of digital finance adoption across countries, there may also be new differences emerging. Deposit competition and customer mobility are higher in countries with a more advanced digital banking experience, and customer mobility could be lower in countries that are more traditional. This may continue to leave a gap between the euro area average impact and euro area national impacts of monetary policy (European Commission, 2024).

To summarise, digital finance, digital money and monetary policy have a complex relationship for Europe. Digital banking can help speed up the transmission of interest, digital finance can help more competition, digital payments can help alter liquidity behavior, and CBDCs can help keep public money in a digital form. The same process also impacts the funding structure of banks, deposit

stability, responses of the financial markets, and monetary sovereignty. Hence, the effect of digital finance on the monetary policy in Europe remains ambiguous. The impact can go in either direction, depending on the design of digital tools, the regulatory environment, the architecture of the banking system and user behaviour (Bank for International Settlements, 2023).

3.3 Digital finance and international trade

The one of the large effects of digital finance on the European economy comes in international trade. Trade is not just the transportation of goods and services from one country to another, it encompasses many financial transactions including payment, financing, insurance, handling of trade documents, currency risk, customs procedures and supply chain security. Thus, digital finance can have a significant effect on European foreign trade capabilities on several fronts, such as payment speed, financing SMEs etc. The financial infrastructure to facilitate commercial transactions needs to be digitized as well (OECD, 2024) as firms gain access to global markets via increasing digital means.

The most obvious facet of digital finance and international trade is cross-border payments. When a European company pays a supplier in a different country or receives payments from a foreign customer, it may be necessary to use correspondent banking, currency conversion, compliance verification and various payment systems, which can result in time delays and added costs. These processes can be accelerated and streamlined by digital payment systems, track transactions more easily and facilitate small-value commercial transactions more economically. This is especially crucial for SMEs that have narrow margins. Small businesses can be hindered from engaging in cross-border trade due to high cost of cross-border payments (Financial Stability Board, 2024).

For the European Union, the impact of digital payments on trade is also related to the internal market. The free movement of goods and services within the EU is well established, but the different payment infrastructures can create difficulties for trade. It is key for the practical operation of the digital single market for a consumer or firm to be able to pay in the same easy fashion in each of the member states. In this regard, payment friction can be minimized by card payments, instant payments, online payment systems, and payment initiation services via open banking. The digital euro project is also connected to this discussion: It promises a common public payment method in the euro area (European Central Bank, 2024).

The impact of digital finance is more complex yet more economically impactful as is seen in the context of trade finance. Exporters and importers need to deal with the time lag between the date of export and the date of payment. Letters of credit, guarantees, factoring, insurance, and supply chain

finance (SCF) help fill this void. The handling, verification and transmission of documents in traditional trade finance are time-consuming. Delays in trade finance can be decreased by digital document handling, electronic invoicing, e-signatures, blockchain-based record management, and data-driven risk assessment. This enables companies to better control their cash flow (OECD, 2024).

One of the key points of importance for SMEs is digital trade finance. Large firms are more likely to have long-term relationships with banks, collateral capacity, and foreign trade experiences, while small firms are more likely to have credit history, collateral, and document inadequacy issues. The visibility of payment and sales data in digital finance can help SMEs to access finance. Credit assessment can be done using the history of the business's sales on an e-commerce platform, digital records of the invoice and payment history. It can be used in conjunction with the traditional assessment using the collaterals. However, the possibility relies on the quality of the data, platform access and regulatory assurance (World Bank, 2022). One of the more obvious connections that digital finance provides to foreign trade is ecommerce. Businesses in Europe have the ability to access cross-border customers via digital channels. Here, the trustworthiness of the payment network becomes a part of trade. Issues like consumer protection, secure identity verification, payment currency conversion, tax compliance and refund processes are brought into play once the customer makes a payment. The barrier to small businesses going overseas is lowered when digital finance works well in these domains. Otherwise, the ease of European Commission (2024) digital commerce is undermined by payment risk and compliance complexity.

There is also close connectivity between digital finance and SCM. European companies buy from many suppliers and logistics companies around the world, pay their bills through a range of different insurers and financial institutions, and operate links in global value chains. These relationships involve significant considerations regarding payment timings, delivery of goods, document verification and risk sharing. Financial flows in the supply chain can be made more traceable with digital systems. Factoring invoices early, digital discounting and monitoring invoices in real time can enhance the liquidity management of firms. The attributes are more useful during heightened uncertainty, including during times of energy prices, geopolitical tensions, and supply disruptions (Bank for International Settlements, 2023).

Digital finance is also on show for the contribution to trade in the field of currency and exchange rate risk management. When trading in non-euro markets, European exporting companies are affected by fluctuations in exchange rates. Digital financial platforms can facilitate currency conversion, hedging and cash management services more easily. There are now digital services for smaller

companies to access some financial risk management solutions that were more accessible to larger companies in the past. But many of these tools have a complicated nature that can pose a danger of misuse at the consumer or small business level. Hence, financial literacy and product transparency play a role in digital trade finance (OECD, 2022).

Blockchain and tokenization are among the technologies that are often mentioned in the context of international trade finance. These technologies can be used to offer efficiency in document verification, ownership registration, smart contracts, and payment delivery matching. A shipment document, insurance record and payment terms of a good can be matched on the same digital infrastructure, reducing transaction risks. But, one should never forget that trade finance is not a pure technical record matter. If these conditions are not met, economic trust (Bank for International Settlements, 2023) may be missing, even if digital records are valid. Digital records may be valid, but without legal validity, court recognition, liability of parties, data security, and cross-border regulatory compliance, they may not offer economic trust (Bank for International Settlements, 2023).

Strategic dependence is the other problem arising from the digital finance in international trade. The financial infrastructure of trade is dependent on other external providers if the majority of payment and platform trade in Europe takes place via non-European payment systems, technology platforms or cloud infrastructures. This is not only a matter of cost or competition; Data sovereignty is also important in terms of sanctions, geopolitical tensions, and infrastructure disruptions. Resilience and strategic autonomy of payment systems, therefore, in Europe's digital finance strategy is closely connected to financial infrastructure of international trade (European Commission, 2024).

Digital finance also has an impact on trade in services. The relevance of small cross-border payments is rising as digital services, software, consulting and creative industries are important sectors in the European economy and as platform-based business models are gaining in popularity. Fast and economical payments are essential for the sustainability of small digital service providers, freelancers and micro-businesses. For such small amounts of payment, traditional international payment methods can be costly or slow. European companies can be competitive in this area with the support of digital payment solutions (Financial Stability Board, 2024).

The effects of all these confirm that digital finance is indeed a supporting tool for international trade. The cost, speed and accessibility of trade changes when the financing, payment, risk management and data verification processes are digitized. Main challenges for Europe is to make sure this transformation takes place for not only large companies but also for SMEs and smaller exporters. Digital trade finance can have a more robust impact on further connecting the European internal

market with global markets, if designed properly. But, if data intensity, complexity of integration across borders, and infrastructure dependency are not controlled, digitalization can also lead to new trade barriers (OECD, 2024).

3.4 Financial inclusion and exclusion

A key social and economic implication of digital finance in Europe is financial inclusion. Using digital banking, mobile payments, online loan applications and digital ID verification can help make financial services more accessible. Fewer branch visits required, lower transaction costs, and services are available round the clock. This is a tremendous chance, particularly for individuals with restricted physical financial framework. But this inclusive impact of digital finance does not happen automatically. Without adequate digital competence, trust, access to devices, the internet and financial education, that same shift can lead to new forms of exclusion (World Bank, 2022).

The EU as a whole is an area of good financial access, but not everyone has the same access to digital financial services. While a high rate of bank account ownership may be widespread, digital banking at its best, safely and consciously is not. More older and low-income people, migrants, people with disabilities, people who live in the countryside and people who have limited digital skills might benefit less from the opportunities of digital finance. Financial inclusion cannot simply be measured by account ownership, but should also be considered by the ability to access digital services (European Commission, 2024).

One of the most prominent reasons for digital exclusion is differences in digital skills. A level of proficiency in using a bank application, the risk of fraud online, the process of strong authentication, knowledge of data sharing rights and secure conducting of digital payment transactions. Those who do not have this skill, do not use digital services or use them with risk. Digital skills are set as one of the main policy areas in Europe's Digital Decade goals, as the transition to the digital economy goes beyond infrastructure to require human capacity (European Commission, 2024).

Financial literacy and digital literacy are crucial at this juncture. The classic financial literacy is grounded in concepts of interest, debt, saving, risk and budget management. These are supplemented with knowledge of cybersecurity, data privacy, online identity, application permissions, digital fraud and algorithmic decision-making processes. If a user is unable to recognise the actual interest rate of an offer of a seemingly low interest digital loan, or the risk of crypto asset applications, then digital finance can lead to harm, not inclusion. Hence, in Europe digital financial inclusion should be tackled together with consumer protection (OECD 2022).

Another way to measure the inclusive impact of digital finance can be done using costs. It is possible to make small transactions at a lower cost with the help of mobile and online services. Access to money transfers, bill payments, small savings, micro-investments and low value loan applications can be enabled via digital channels. This can be beneficial for low-income users. Access to digital services does, however, depend on a smartphone, Internet package, and bank account and identity verification tools, which can pose difficulties for certain groups. While it is true that digital finance may appear to be less expensive than cash-based finance, the low-level access costs of digital finance must not be overlooked (World Bank, 2022).

There are a number of risks to consider when it comes to digital financial exclusion, especially in relation to branch closures. The growing prevalence of digital channels can lead to fewer and smaller physical branches being maintained. This is a logical move from an economic efficiency point of view but renders financial services more challenging for certain users. Branches are a place of trust for the elderly, persons with disabilities and those who prefer to receive services in person for more complex financial transactions. The development of digital finance in Europe does not mean that physical access channels are becoming completely irrelevant. An inclusive transformation should boost the digital services whilst maintaining other channels of access to essential financial services (European Banking Authority, 2021).

This is directly related to the financial inclusion debate, which is the digital euro project. A tool that is supposed to be a public money instrument must be open to all. What if only those who can use their smartphones and are familiar with digital banking, and can easily handle technical processes would benefit from the digital euro, leaving those who do not out the cold? What if the digital euro is only practical for those who use their smartphones and are accustomed to digital banking, and can easily handle technical processes? So offline use, simplicity of the wallet, free basic services and ease of use for different groups of people are crucial. The central bank should ensure that the features of the digital euro minimize digital exclusion if it will be used as a complement to cash (European Central Bank, 2024).

The digital form of financial exclusion is not limited to individuals. SMEs could also be losing ground in the digital finance transformation. Large businesses might have an easier time obtaining digital payment solutions, data analytics and financial management software, while micro-businesses might be behind the curve because of technical capabilities, costs and compliance. Digital invoicing, online accounting, payment integration and platform sales are huge opportunities for small businesses, but businesses without access to these become more invisible. The rise in digital data's significance in

accessing finance could create a disadvantage for small businesses that do not produce digital data for credit assessments (OECD, 2024).

The impact of digital finance on inclusion is also related to social trust. When paying with digital methods, consumers want to trust that their funds are secure, that their data is not being misused, and that if there is a mistake they have a means to go back to if they want to. This trust can be undermined by digital fraud, identity theft and misleading financial products. These risks have a greater impact on vulnerable user groups. To be inclusive, digital finance should not only be accessible, it should also be understandable, there should be an effective complaints mechanism, transparency of accountability and strong oversight (European Securities and Markets Authority, 2024).

Algorithmic decision making can provide a more "invisible" form of financial exclusion. If users cannot explain why someone was rejected for a loan, why they were not offered a more competitive insurance quote, or why they were not recommended to invest in a particular product, it can lead to confusion. If they are unable to explain why they were rejected for a loan, why they were not offered a more competitive insurance quote, or why they were not recommended to invest in a particular product, it can result in confusion. If income, region, age or consumption differences in historical data are seen by the model as a risk factor, some groups will be systematically referred to higher-cost services or be excluded from services entirely. This risk undermines the notion of the neutrality and objectivity of digital finance. This further emphasizes the importance of accountability and human oversight in financial services, in line with AI regulations in Europe (European Parliament and Council, 2024).

Digital finance is also relevant for migrants and cross-border people as an inclusion potential. In Europe, mobility is high, so daily life with digital payment and account services could become easier for people moving to and from other countries, working or sending money, or using financial services. These groups can be supported in accessing the financial system through low-cost cross-border transfers, digital identity verification and remote account-opening processes. However, digital access is restricted by identity documents, proof of address, language barriers and regulatory issues. These practical challenges must be considered in the design of inclusive digital finance (Financial Stability Board, 2024).

Access to cash is another angle on the financial inclusion issue in Europe. Digital payments continue to grow in use but for some users cash payments are still the preferred method. Cash helps budget control and privacy for less well-to-do, old people and people who do not trust digital services. Some users might be left out of the payment system if cash infrastructure is rapidly weakened by the

development of digital finance. Complementing cash is thus a key aspect in the digital euro discussion. The general objective of public policy in the field of digital payments should be to promote digital payment while safeguarding fundamental rights of the basic payment users (European Central Bank, 2022).

But financial inclusion in Europe can be boosted by digital finance, which will not happen on its own. Digital services should be affordable, accessible, secure and understandable. Digitalization can generate new space of inequalities if infrastructure, digital skills, financial literacy, consumer protection, and data justice are not taken into account together. A major challenge for Europe in this regard is to take digital finance beyond an innovation and competition agenda to a social access and economic inclusion agenda. The ability to create a fair balance between technological advancement and public accountability will make a lasting impact on the European economy if the digital finance system is inclusive (European Commission, 2024).

CHAPTER 4

ANALYSIS AND DISCUSSION

4.1 Trends in digital finance indicators in Europe

Digital finance indicators in Europe have shown steady but uneven development across countries and areas of use over the past decade. The aim of this section is to evaluate the digital finance transformation, discussed conceptually and institutionally in previous sections, through key indicators. Internet banking, online shopping, e-commerce activities of businesses, and digital workforce capacity are the most visible and measurable areas of this transformation. When these indicators are considered together, it becomes clear that digital finance in Europe is not limited to changes in banking channels, but is creating a broader transformation in consumption, trade, firm behavior, and the structure of the workforce (European Commission, 2024).

Table 4.1. Individuals using internet banking in the EU, 2014–2024

Year	Individuals using internet banking, % of individuals aged 16–74
2014	47.0
2015	48.0
2016	49.0
2017	51.0
2018	54.0
2019	54.6
2020	57.0
2021	58.0
2022	60.0
2023	61.0
2024	67.2

Source: Eurostat, Individuals using the internet for internet banking, online data code tin00099.

One of the most obvious signals of digital finance at the household level in Europe is shown in Table 4.1. The rate of Internet banking had risen from around 47 per cent in 2014 to 67.2 per cent in 2024. This growth indicates the digital channel in banking services has become more than just a supplementary channel, it is also a significant part of financial flows. The increase since 2019 indicates the change in financial services consumption in the pandemic has become a new norm. The region-level data from Eurostat also indicates that internet banking is gaining ground in the EU, with its adoption rising from 54.6 percent in 2019 to 67.2 percent in 2024 (Eurostat, 2024a).

Beyond the technical aspect of internet banking, the indicator also indicates that digital finance is more than just a technological solution. However, the level of digital banking adoption is very high in some Northern and Western European countries, compared to some Southern and Eastern European countries. This gap suggests that digitalization is linked to income level, education, digital skills, age structure and institutional trust. However, while the EU average is increasing significantly, the national models have varying rates of change within this increase. This means that the effects of digital finance are not the same throughout Europe (European Commission, 2024).

Table 4.2. Internet users buying or ordering goods and services online in the EU, 2014–2024

Year	Online buyers, % of internet users
2014	59
2015	62
2016	63
2017	66
2018	69
2019	71
2020	72
2021	74
2022	75
2023	75
2024	77

Source: Eurostat, E-commerce statistics for individuals.

The link between digital finance and payment and consumption behavior is provided in Table 4.2. The share of EU residents who buy goods and/or services online grew from 59 percent in 2014 to 77 percent in 2024. The demand for digital payment infrastructures is not just for banking but is also supported by the e-commerce explosion, as shown by this trend. With the growing number of online transactions, card and mobile payments, digital wallets, strong customer authentication and consumer protection have become even more central to the sector (Eurostat, 2024).

Economically, this indicator is that digital finance is directly connected with the consumer market. With the rise in e-commerce, the overall payment process is becoming fast, reliable, and cheap, which is becoming a part of the commercial transaction. The payment process in online shopping looks like a technical part for its users, but it is also a working collaboration of bank card infrastructures, payment service providers, fraud prevention systems, and data processing processes. In other words, e-commerce signals that digital finance is not just an internal affair of the financial sector but that it is directly related to retail trade and the service economy (European Banking Authority, 2024).

Table 4.3. Enterprise e-sales and turnover from e-sales in the EU, 2014–2024

Year	Enterprises with e-sales, % of enterprises	Turnover from e-sales, % of total turnover
2014	18.93	16.43
2015	19.30	16.80
2016	19.70	17.40
2017	20.40	17.70
2018	21.10	18.50
2019	22.20	19.83
2020	21.60	19.10
2021	22.80	19.40
2022	22.40	19.20
2023	22.90	19.60
2024	23.59	19.49

Source: Eurostat, E-commerce statistics, online data codes isoc_ec_esels and isoc_ec_evals.

Table 4.3 illustrates that there is a lower level of digitalization in enterprises, but a more structured one. Within the EU, e-commerce businesses went up from 18.93% in 2014 to 23.59% in 2024. During the same period, the share of turnover from e-commerce in total turnover increased from 16.43% to 19.49%. This rise is less pronounced than the values of the indicators of digital banking and online shopping for business at the household level, as the shift towards digital sales in businesses is influenced by a variety of factors beyond just user preference, including logistics, accounting, payment integration, inventory management, data security, and firm size (Eurostat, 2024c).

The impact of digital finance in Europe is firm-size dependent, as the progress of enterprise indicators is slower. Digital payment systems, e-commerce, electronic data interchange and integrated financial software can be more readily used in large businesses. The same transformation can be more expensive and tedious for small businesses. The gap illustrates that digital finance will be a driver of efficiency in Europe, but may also lead to a digital capacity gap between businesses. Thus, digital finance indicators should reflect both the average growth, but also who is leading the growth (OECD, 2024).

Table 4.4. ICT specialists in total employment in the EU, 2014–2024

Year	ICT specialists, % of total employment
2014	3.4
2015	3.5
2016	3.7
2017	3.8
2018	3.9
2019	4.0

2020	4.3
2021	4.5
2022	4.6
2023	4.8
2024	5.0

Source: Eurostat, ICT specialists in employment, online data code isoc_sks_itspt.

Table 4.4 shows the human capital capacity behind digital finance. Financial digitalization is not just about the increase of banking apps it's about the need to have a solid team of software developers, cybersecurity experts, data analytics professionals, cloud specialists, payment solution providers, and AI programmers. The increase in the share of ICT specialists in total employment in the EU from 3.4 percent in 2014 to 5.0 percent in 2024 shows that digital transformation has found a lasting impact on the labor market. This increase is an important indicator supporting the shift of financial services towards a more technology-intensive structure (Eurostat, 2024d).

The upswing in the number of ICT specialists boosts the economic capability dimension of digital finance, but also serves as a reminder of the human capital deficit in Europe. The goal of digital finance's healthy growth is the need for banks, payment institutions, fintech companies and regulators to have staff members with adequate technical expertise. The lack of talent (in cybersecurity, model risk, data governance, AI auditing, etc.) could hinder the development of digital finance. The ICT expertise indicator is thus not only a reflection of the size of the technology industry, but also of the institutional resilience capacity of the digital financial system (European Securities and Markets Authority, 2024).

When these four indicators are considered together, it is seen that digital finance is progressing at three different speeds in Europe. Internet banking and online shopping have proliferated on the personal level. E-commerce has experienced more stable yet robust growth at the business level. The human capital side has seen a gradual growth of experts in the field of ICT. As shown in this picture, digital finance is growing in Europe simultaneously on both the supply and demand sides, but there are also major disparities between firms, countries and user groups (European Commission, 2024).

This overall trend is matched by changes in payment behavior. Cash is still a major method of payment in the Euro area, whilst card and mobile payments are on the rise. The ECB's SPACE study shows that the share of cash in point-of-sale payments, in terms of transaction volume, decreased from 79 percent in 2016 to 52 percent in 2024. This shift suggests that digital finance indicators extend beyond online payments to the offline sphere as well (European Central Bank, 2024).

The indicators also shed light on how far the EU digital finance policy can go in its aim to promote innovation. Internet banking and online shopping is growing more important, so are cyber security,

fraud, data protection, and consumer rights. The reliability of payment infrastructures and cross-border transaction compliance are increasingly important as businesses' e-commerce activities expand. The skills gap in ICT rises with the growing demand for ICT skills, creating an economic constraint. Accordingly, it is important to consider digital finance indicators alongside the issues of regulation and institutional capacity (Financial Stability Board, 2024).

To summarise, the European digital finance indicators are showing a positive trend generally, but not evenly. The shift to digital services is lightning fast at the consumer end, more expensive and more complex on the business end, and the number of technologies is rising, but so is the number of technologies required. This finding is that digital finance is now a reality in the European economy. However, it is apparent that digitalisation does not necessarily deliver balanced outcomes. A key step towards making the economic value of digital finance sustainable is to ensure that it is backed by infrastructure investments, security, regulatory frameworks, digital skills and inclusion policies (Bank for International Settlements, 2024).

4.2 The changing relationship between digitalization, finance, and economic performance

Digitalization, finance and economic performance are increasingly interwoven in Europe. The digitalisation of the financial system is not just about faster banking transactions, lower payment costs. This process, in general, impacts on allocation of capital, access to finance by firms, consumer spending and saving patterns, risk assessment by financial institutions and the general economy's productivity potential. This does not mean, however, that the relationship between digital finance and economic performance is linear or unidirectional, but rather a multi-layered transformation space underpinned by infrastructure, data, competition, regulation and human capital (OECD, 2024).

Digitalization in Europe is mainly represented by transaction costs. Households and firms spend less time and incur lower transaction costs with digital payment systems, online banking, and automated financial services. When a payment order is completed without any branch or physical documents, it can help to achieve a faster completion of business transactions. These savings are especially critical for small companies, where transaction costs can have a direct effect on profitability in high-frequency, low-value transactions. In Europe, the proliferation of digital payment and e-commerce indicators have highlighted a growing tendency to integrate digital payment systems into economic activity (European Commission, 2024).

Digital finance does not only affect economic performance through cost cutting. However, the most significant channel is the shift in the availability of finance. Weaker traditional collateral lenders can

find new opportunities for assessment through digital loan applications, open banking data, electronic invoicing records, and payment history. Getting financing for SMEs has been a key challenge for growth and investment potential in Europe for a long time. Digital finance can help speed up credit assessment because it can provide firms with clearer data and facilitate more efficient financial resource allocation (OECD, 2024).

This connection is significant in productivity of the firm. Digital finance is not a technology that directly improves production technology, but rather one that helps to alleviate financial constraints, thereby contributing to productivity gains. Our findings indicate that firms that have greater access to finance are able to invest more easily in software, equipment, digital marketing, automation, and human resources. This is particularly crucial in fields involving intangible assets; where classic collateral structures can not always be used with software, data, brand, organizational skills and research activities. The advantages of the digitalisation of the finance industry on productivity can be seen when it opens up financing paths that are more able to utilise the economic potential of these companies (Bontadini et al., 2024).

A key issue in the European economy in recent years has been its lack of productivity. Digitalization is frequently mentioned as a solution to this problem; however, the contribution of digital technologies to the economy does not occur spontaneously. Digitalization at the firm level brings benefits in the form of better management quality, employee skills, better data utilization, better organizational flexibility and better access to finance. The productivity impact of digital finance thus relies on actual productive application of digital technologies in companies. In Europe, it has been observed that digitalisation can boost firm productivity; however, there are also different trends across countries and sectors in terms of the potential of digitalisation for firm productivity (Bunel et al., 2024).

Financial digitalization is tightly connected with competition, which is an important factor in this process. Open banking, payment services and fintech are pushing traditional banking institutions to enhance their offering and review their pricing. The more competitors, the more competitive payment services become, credit processes get faster, and there are new financial products. But, in digital markets, competition doesn't necessarily result in a decentralized structure. Power dynamics can arise from data, scale and platform effects, which can result in too much power being allocated to certain actors. To this end, the contribution of digital finance to economic performance is dependent on a competitive market structure and minimising data concentration (Bank for International Settlements, 2023).

The resilience of the banking sector is also associated with the impact of digital finance on economic performance. By digitalizing, banks can speed up their operations, improve their understanding of customer data and recognize risks sooner. But it is the same process that also makes banks more reliant on external technology vendors, cloud computing, and complicated software applications. Such reliance can also render the growth contribution of digital finance brittle when operational risks are raised. In Europe, for financial digitalization to create economic benefits, the banking system needs to have a secure, auditable, and resilient structure in its use of technology (Basel Committee on Banking Supervision, 2024).

Digitalization in monetary and payment infrastructures is also directly related to economic performance. Payments are crucial for the operation of trade and consumption, and speedy, reliable payments help these processes run. Instant payment systems, ecommerce payments and digital wallets allow economic transactions to be finished in a quicker time between households and businesses. This speed is very relevant in the field of cash flow. The faster that businesses are able to receive their receivables, the sooner their businesses can lower their working capital needs. But with the rise in digitization of payment systems, the economic impact of disruptions, cyber attacks, and frauds grows. However, when payment systems become unreliable, digitalisation may lead to loss of trust, rather than to efficiency gains (Financial Stability Board, 2024).

Economic performance is another aspect that should be taken into consideration when making decisions about digital currency. A public digital currency, including a digital euro, could serve as a common payment system infrastructure, allowing the internal market in the EU to function. A tool like that could ensure that central bank money is accessible digitally in our day-to-day payments and make it less reliant on private payment networks. But the economic effect of digital currency is related to the design of it. If the model is not viable for its customers, clearly taxing the financial system or compromising privacy, it will be hard to see how it can contribute economically. Thus, the digital euro is not a growth policy, but rather a policy of payment and monetary infrastructure (European Central Bank, 2024).

Also, capital markets and investment behavior are impacted by digitalization. These are online investment platforms, robo-advisory, automated investment portfolios and low-cost transaction options that can help the individual investors access financial markets. This access can contribute to savings being directed towards more diverse investment instruments. On the other hand, having quick deals could also encourage risky investing strategies when investors lack enough information. While

financial markets can benefit economic performance, this can only be achieved if investor protection and product transparency are in good shape (European Securities and Markets Authority, 2024).

The impact of digital finance on economic performance is also reshaping the employment and skills composition in Europe. As routine transactions in the finance sector become automated, some jobs are decreasing, and new expertise is needed in areas such as data analytics, software, cybersecurity, compliance technologies, and artificial intelligence auditing. This transformation can boost the productivity of the financial sector, but without skills transformation, labour mismatches can worsen. The economic impact of digital finance thus depends not only on the institutions investing in technology, but also on the employees who can learn new skills (European Commission, 2024).

The link between digital finance and economic outcomes needs to be examined in a more inclusive manner. Digital channels can play a role in expanding financial access by providing low-cost services. But people with low digital skills, older people, low-income groups and those in rural areas may be less able to enjoy these services equally. Likewise, small businesses that are not digitally oriented may not be well-positioned for algorithmic credit assessments. In this context, digital finance can help generate growth, but also exacerbate inequalities. Digitalisation is closely linked to the quality of economic performance and to those who are excluded from the system and not touched by digitalisation (World Bank, 2022).

The regulatory environment is a key driver of the direction of the digitalisation/economic performance relationship. The European Union (EU) digital finance approach takes a holistic view on financial stability, consumer protection, data security, operational resilience, and fosters innovation. While it may raise compliance costs in certain instances, in the long term, digital finance's economic value relies on trust. Loss of trust in financial services can quickly eliminate the benefit provided by low transaction costs. Hence, the European model aims to put speed and innovation as well as a stable market structure at the heart of economic performance (European Banking Authority, 2024).

4.3 Evaluation of the digital euro and EU policy framework strengths of the EU approach

The key of the EU approach becomes apparent when combined with the concept of digital euro and the EU's digital finance policy framework: the EU can combine regulation, public funds, market innovation and financial trust. Digital finance is not just seen as a field of technological progress in Europe, but also as one of payments security, consumer rights, data protection, financial stability, monetary sovereignty, and competition law. It's designed to maximise the economic value of digital finance while minimising the risks which transformation could pose. Unlike the EU, digital finance is

not just a fast market innovation on its own, but is a financial architecture that is subject to common rules (European Commission, 2024).

The most prominent public aspect of this framework is the digital euro. The project will make it possible for citizens and companies in the euro area to use the central bank's digital currency. This objective is tied to a fulfillment to shield the public-based monetary system in the era of waning cash transactions and the rise of private digital payment platforms. The digital euro will not replace cash; it will be a new type of public money to use in addition to cash. This is an expression of the European approach in which social acceptance and public trust are the focus. An important policy rationale is monetary sovereignty; users are not restricted to private sector payment methods that are only offered by private firms when they pay (European Commission, 2023a).

The EU's digital euro has one major advantage in its development, and that is the process of preparation is taking place in phases and not as a rush. Through the research and preparation process, technical design, legal framework, user needs and financial stability implications were all considered at once. The project is not just an ideology of monetary sovereignty, but one that is also supposed to be designed as a viable payment system, as demonstrated by technical options like the two-tiered distribution model, offline payment, privacy protection, transaction limits, and the interoperability with the existing payment infrastructures. In that regard, the digital euro embodies Europe's cautious attitude, in both its aims and design decisions (European Central Bank, 2024a).

The fact that the digital euro is based on a two-tiered model clearly demonstrates the EU's search for balance in its approach. The digital euro will be issued and secure monetarily by the Eurosystem, and then by the banks and authorized payment service providers who will interact directly with the user. Hence, the central bank guarantees the confidence of public money and existing financial institutions continue to serve the same functions. This model does not allow the central bank to have direct control over retail banking but does not rule out the role of an intermediary in the banking system. This decision is significant for Europe as the euro area is still characterized by a predominantly bank-based financial system (Bank for International Settlements, 2023).

Another key strength of the EU policy framework is that it deals with various risk issues of digital finance in different ways, each through its own regulation, but with a common rationale. MiCA provides legal clarity to the crypto asset market but DORA focuses on enhancing digital operational resilience of financial institutions. The instant payments regulation is designed to accelerate and expand payment infrastructures, and the financial data access proposal builds the foundations for secure data sharing in the open finance market. Thus, the EU has not only placed digital finance in

one legislative category, but has gathered together various technological and economic aspects in a single but interlinked package of regulation (European Parliament and Council, 2023a).

The importance of MiCA lies in its linking a rapidly growing and risky area like crypto assets to common rules across the EU. There are rules for crypto asset service providers, token issuers, asset-backed tokens and e-money tokens on authorization, disclosure, governance and market integrity. This regulation is a measure for investor protection and limitation of financial stability risk and gives legal certainty to the market. Europe has tried to regulate and supervise crypto assets for a place in the market, rather than a total ban (European Parliament and Council, 2023b).

Another key component of the EU digital finance framework is DORA. This regulation enables financial institutions to better manage their information and communication technology risks, as well as their reporting of cyber incidents, carrying out resilience tests and providing control of relationships with critical third party technology providers. With digital finance on the rise, the financial system is relying more and more on the balance sheet of banks as well as software, cloud services, data centres, and outside technology providers. DORA recognises this infrastructure dependency as part of financial stability (European Parliament and Council, 2022).

The EU approach also considers trust in the financial system as essential to the success of digital finance in the economy. Users can be faster and more convenient with digital payments, open banking, crypto asset services and AI-driven financial advice. But, when transparency, data protection, and accountability are lacking in these areas, user trust will soon be compromised. European Securities and Markets Authority (ESMA) (2024) does not exclusively define success in the market as a measure of social acceptance of financial innovation, but it also includes the safeguarding of user rights and privacy, information that is understandable to users and economic sustainability.

One such example is open finance policy. Sharing financial data with user consent can increase competition and enable the development of more personalized services. But there are significant consent, security and accountability issues with data sharing. EU's access to financial data is intended to apply standards, consent and regulation to data, not to make it a free market product. This aligns with a desire to shape digital finance development alongside data security and confidence (European Commission, 2023b).

The EU policy framework and the digital euro are evaluated based on the most significant advantage of Europe to strike a balance between public funds and innovation of the private sector. The digital euro will make public money tangible in the digital world, while private payment service providers and banks will remain involved in the distribution and in the service provision of the system.

While MiCA, DORA and open finance regulations are intended to put the private sector under a regulated framework, they do not close the gap on what can be done. The balance shows Europe's efforts to achieve trust, competition and stability in the digital finance market (European Central Bank, 2024b).

However, the advantages of the EU approach do not mean that there are not still some implementation difficulties. Fintech initiatives can generate higher compliance expenses due to comprehensive regulation. The disparities in supervisory capacity among member states can cause differences in the application of common rules, which can lead to inequalities. On the downside, the digital euro could fail to make much of a dent if it is not embraced by consumers or if it fails to provide substantial value over other payment methods. The effectiveness of the EU approach is thus not expected to rely primarily on implementing regulations, but rather on the impact that the regulations have on the market, on the confidence of the users and on the technological resilience (European Banking Authority, 2024).

4.4 Discussion of findings

The results in this thesis show that digital finance in Europe is not just a niche innovation on the fringes of the financial sector. Digitalization affects at the very same time payments habits, financial intermediation, monetary policy, international trade, financial inclusion and the future of public money. Thus, the impact of digital finance in Europe is not just about online payments by consumers or the development of digital applications by banks. It is changing the institutional framework of financial markets, behavior of users, and the role of public authorities (OECD, 2024).

The second section explores the EU digital finance framework, which demonstrates that Europe is taking a regulatory approach to this transformation. The EU is proposing to shape digital finance as a free-market innovation instead of letting it grow its own way, by using common rules, consumer protection, operational resilience and data governance. Different manifestations of this approach are MiCA, DORA, instant payments, open finance, and the digital euro projects. The most unique feature of the European approach is the promotion of innovation while simultaneously ensuring that innovation does not threaten the financial stability, privacy and market confidence (European Commission, 2024).

The economic impacts discussed in the third section have shown that the contribution of digital finance to the European economy is conditional. Digital finance can lower costs of transactions, ease access to credit, speed up payment systems and make trade finance more efficient. These contributions

are not automatic, however. In the absence of good data quality, inadequate digital skills, risks to cybersecurity, or limited market choice to a few large platforms, digital finance can generate new risks rather than contribute to economic activity. The economic value of digital finance, therefore, is less about digital finance technology and more about the quality of the institutional structure that carries it (Bank for International Settlements, 2023).

From a financial intermediation perspective, the results confirm that the banking sector has not been fully replaced, rather a new structure of financial intermediation has emerged, which is more fragmented and data-based. Banks still play a key role with regard to deposits, loans and trust, but will need to collaborate with new players regarding payment initiation, customer interface, data analysis, and personalized services. This poses opportunities and challenges for the European banking system. The opportunities for faster and lower cost services grow, but so do the investment cost of technology, competition, and operational risk, (Basel Committee on Banking Supervision, 2024).

Results from the monetary policy analysis and digital currency research indicate that the digitalisation process does not diminish the importance of central banks. On the contrary, as payment systems and access to public money shift to the digital environment, the responsibility of central banks becomes more visible. In this regard, the new digital euro will not only be a payment instrument, but also an institutional effort to ensure the role of central bank money in the digital economy. The design for the digital euro will prove to be important, though. Without clear retention policies and privacy controls, offline use, and the dual distribution model, the project could fail to achieve the desired level of financial stability or user trust (European Central Bank, 2024a).

Payment and trade finance processes are the most apparent uses of digital finance in international trade. European businesses, especially SMEs, can benefit from speedy cost-effective cross border payment solutions. Financial friction in trade can be minimized by the use of digital document management, electronic invoicing, instant payments and data-driven credit assessment. But strategic exposure can be heightened if the financial underpinning of trade is made too reliant on global tech giants or non-European payment systems. This discovery indicates that the digital finance influence on trade ought to be estimated not exclusively on the grounds of efficiency, but also on the premises of infrastructure sovereignty (Financial Stability Board, 2024).

The results of financial inclusion need to be taken with a pinch of salt. Digital finance can make finance more inclusive by providing low-cost and accessible services. Elderly, low-income groups, people without digital skills, people living in rural areas and small businesses, however, might be left behind in the digital transformation. Hence, financial inclusion can no longer be defined simply as

having a bank account in Europe. Safe, conscious and regular use of digital services has also become a part of inclusion. The finding shows that social and education policies are to be taken into account when formulating digital finance policies (World Bank, 2022).

The digital finance indicators analysed in the fourth chapter reflect the broad penetration of digital finance in Europe, although there is not an equal penetration. Internet banking and e-commerce and digital integration are growing quickly among individuals, but are growing at a slower pace among businesses. An increasing proportion of ICT specialists in the job market is indicative of the transformation of the work in the digital economy, but a lack of required skills is still a key constraint. As illustrated in this picture, digital finance is firmly planted in Europe, albeit at varying rates across countries, firms and user groups (Eurostat, 2024).

To sum up, the question for Europe is not whether to speed up the development of digital finance, but how to make sure it happens well. While digitalisation can achieve efficiency in the short term, it will not be sustainable unless it has a foundation of trust, inclusion and resilience. The EU's strong regulatory approach offers an advantage in this respect. In practice, however, a thorough regulation can be complicated and costly. Thus, the challenge for Europe is to strike a reasonable balance between regulatory clarity, and innovative flexibility (European Banking Authority, 2024).

The most symbolic illustration of the general discussion is the digital euro. The project is the embodiment of the strategic objectives of Europe in digital finance via the future of public money. The digital euro, if it is successful, could help ensure public money remains accessible digitally in the euro area, heighten a feeling of a European-wide collaboration in payment systems, and cut down on the reliance on private payment networks. Trust is key to success, and it is related to user trust as well. The significance of the project could not translate to real use if people do not see the digital euro as a secure, practical, privacy-respecting, and truly essential method of payment (European Central Bank, 2024b).

To conclude, the thesis reveals that there is a great opportunity for improving the economic performance of digital finance in Europe, but it must be managed carefully. Digitalisation speeds up financial services and opens up new financing channels. Likewise, data concentration, cyber risk, digital exclusion, market power and financial stability are all raised questions. These tensions are not forgotten in the EU's policy framework but are sought to be managed by means of regulation and public policy. As such, the European perspective on digital finance is much more than an economic growth tool – it is a structural change that needs to be managed in a trust-based, inclusive, and sovereign monetary system (International Monetary Fund, 2024).

CONCLUSION

The financial industry is one of the most remarkable examples of an economic and institutional transformation process in recent times, known as digital transformation. The penetration of financial services by digital technologies has not only altered securities and payments or banking activities, but it has also impacted how financial intermediation is done, the functioning of monetary policy, data management, and the nature of economic relations. The goal of this study is to explore the emerging pattern of financial digital transformation in the context of the European Union, as well as its opportunities and challenges. The first research question is what is financial digital transformation and what are the components of financial DT? The findings suggest that financial digitalisation is more than just placing the traditional services into the digital environment. Digital transformation is a process which is multidimensional, from payment system to credit methods, from data sharing to digital currency projects. In this, technology has not only been a part of the financial system, but it is now a key element of it. In the second question of the research we will focus on the impact of financial technologies on the European financial system. It reveals a greater level of competition in the sector due to the rise of fintech enterprises, open banking applications, financial services powered by AI, and digital payment systems. The developments have made financial services more convenient, widely available and cheap. But it has also been noted that new risks have arisen, including cyber security, algorithmic decision making processes and data security.

The digital euro project is one of the main projects within the European Union's digital finance strategy and was a major project investigated within this study. The study results indicate that the digital euro is more than just a new payment tool. The main goal of the project is to keep public funds available in the digital landscape, to make Europe less dependent on the external payment systems and to increase the financial sovereignty of Europe. From this point of view, the digital euro is more than just a technological innovation; it is seen as a component of Europe's long-term economic and strategic objectives.

This evaluation of the European Union's regulatory approach is one of the research questions. The results reveal that the European Union is working towards establishing one of the world's most comprehensive digital finance regulatory regimes. In particular, the policies developed in the areas of digital operational resilience, data sharing, regulation of crypto assets, and consumer protection aim to strike a balance between innovation and financial stability. But, with the pace of technological advancement, it is also clear that regulations should be constantly updated as well. The results on the economic effects of digital finance are also relevant. Digitalisation has changed financial

intermediation activities, which has enabled access to financial services. Competition and quality service has risen with the entry of new players as well as traditional institutions. Digital finance applications can have monetary policy implications, especially in regard to how central bank policies are passed on. One of the most important developments that might alter the use of monetary policy tools in the future is the central bank digital currency projects.

At an international trade level, digital payment infrastructures and cross-border transfer mechanisms can be beneficial for economic activity by lowering costs for transactions. As far as financial inclusion is concerned, digital technologies help many people and enterprises to have access to the financial system. These benefits are also recognised to be unevenly distributed, resulting from issues of digital skills, technological infrastructure gaps, digital divide and others. In general, the EU is working towards a fair balance between innovation and regulation in the digital finance space. The appeal of digital finance from greater efficiency to cost savings, economic integration benefits, and more is definitely considerable, but financial stability, data security, and the continued trust of users are essential for the success of the transformation. To sum up, the digital financial transformation has a multi-faceted effect on the European economy. Digital finance represents one of the key transformation fields, offering economic growth, improved access to finance and enhancing Europe's competitiveness internationally. Yet robust regulatory frameworks, robust digital infrastructure and inclusive policies are required to sustainably manage the process of transformation. The European Union will be a major determinant of the financial architecture for the future, with its work, especially on the digital euro. Hence financial digitalisation is more than a necessary option for the current, it is a crucial one for the future of the European economy.

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