

**Christos V. Gortsos /
Rolf Sethe (eds.)**

**Central Bank
Digital Currencies**
*Proceedings of a
Colloquium*

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Rolf Sethe (eds.)

Central Bank Digital Currencies

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Colloquium*

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Preface by Sebastian Bonhoeffer and Mario Wimmer

As the joint institute for advanced studies of ETH Zurich, the University of Zurich, and the Zurich University of the Arts, Collegium Helveticum unites scholars and artists with different backgrounds to provide an inspirational and productive working atmosphere. Witnessing the contentment, engagement, and dedication of the fellows of Collegium Helveticum, the new international fellowship program established in 2021 seems to have struck a nerve.

The Collegium is designed to inspire dialogue across diverse fields and thus create a space to gain experience in successfully communicating both across disciplines and with a broader public. For this to become possible, we provide for a conducive space for colleagues from around the globe to rethink their work and find new lines of inquiry. Located in the historic observatory of ETH Zurich, Collegium Helveticum offers a platform for exchange between different cultures, disciplines, and generations, nurturing that most important resource: diversity. The Collegium in some sense serves as a fallow field within the academic ecosystem, an interstitial space between ploughed fields which contributes to the health of the surrounding crops and ensures the conditions for the ecosystem to flourish in general. As do many other institutes of advanced studies, Collegium Helveticum contributes to fostering the required diversity of perspectives which so often spurs creativity and productivity in academia. My experience as director suggests that institutes for advanced studies like the Collegium constitute indispensable residual spaces in the academic ecosystem of the 21st century.

What Collegium Helveticum can offer is a necessary addition to the busy work in the labs, seminars, studios, and classrooms, i.e., a limited period of protected time, and a space that invites exchange across disciplines and fields of research. In return, the Collegium asks its fellows to contribute to the cultural and intellectual life of Zurich by convening workshops, symposia, conferences, or exhibitions. As a senior fellow at the Collegium Helveticum Professor *Christos Gortsos* and his local academic partner Professor *Rolf Sethe* have made the best use of the resources the Collegium can provide by engaging in open-ended and cross-disciplinary conversations. They organized an exciting workshop on “Central Bank Digital Currencies”, a highly interdisciplinary topic with far ranging implications. Following the discussions as much as I could as someone outside the field, I was impressed by the excellent presentations and the engaging discussions between high-profile experts, and I began to better understand what huge impact the introduction of a digital currency by the

central banks might have. It is these insights that I take away from each of the exchanges taking place at the Collegium Helveticum that make it such a rewarding task to serve as its director.

During their time at the Collegium, fellows are interlocutors for each other and the local academic and artistic community. Once, having returned to their home institutions, they become not only friends of the house but also ambassadors within a growing international network. At the end of each fellow year, it is with some sadness that I see all fellows moving on. However, experiencing how a workshop that took place at Collegium Helveticum just a couple of months back, turns into a book like the one you are holding in your hands, feels like an unexpected gift. Therefore, I do not want to close without my deep expression of gratitude to our former senior fellow Professor *Christos Gortsos* and my team who supports numerous fellows each year to guide the events they host at the Collegium to success.

Zurich 17 August 2023

Sebastian Bonhoeffer
(*Director of the Collegium Helveticum and Professor at the ETH*)

Dr Mario Wimmer
(*Deputy Director of the Collegium Helveticum*)

Foreword of the editors

The last decade has seen a variety of developments in the financial sector caused by the emergence of the distributed ledger technology (DLT). It led to innovations such as smart contracts, Bitcoin, and other crypto assets, as well as decentralized finance at large. However, DLT did not only affect the private sector but is also challenging the public sector. In several jurisdiction we are witnessing an intense discussion on the introduction of Central Bank Digital Currencies (CBDCs), which would be the digital form of state-issued legal tender.

The Collegium Helveticum and the University of Zurich's Priority Research Program on Financial Market Regulation (URPP FinReg) jointly hosted a colloquium on CBDCs on May 9th, 2023. It was based on the initiative of the first co-editor of this book, *Christos Gortsos*, Professor at the Law School of the National and Kapodistrian University of Athens and, in the academic year 2022/2023, senior fellow at the Collegium Helveticum and visiting researcher at the Faculty of Law of the University of Zurich, in close cooperation with the second co-editor, Professor *Rolf Sethe*, who made possible and organised the publication of the presentations in this book.

This one-day event, which was opened with a welcome address from Professor *Sebastian Bonhoeffer* (Director of the Collegium Helveticum) and Professor *Rolf Sethe* (Head of the URPP FinReg), aimed at providing an in-depth analysis of various aspects of CBDCs. The colloquium was divided into three panels.

- The first one focused on selected legal aspects of CBDCs. Professor *Marco Dell'Erba* (University of Zurich) delivered a speech on the "Relationship between CBDCs and Stablecoins", followed by Professor *Rolf H. Weber* (University of Zurich) who developed on the "Global Financial Architecture and Decentralised CBDC Regimes".
- The second panel highlighted the views of Central Banks on CBDCs. Dr. *Thomas Moser* (Swiss National Bank) delivered a speech on "The Perspective of the Swiss National Bank (SNB)" followed by Professor *Chiara Zilioli* (European Central Bank) who spoke about "The Perspective of the European Central Bank (ECB): Towards a Digital Euro".
- The third panel turned to institutional aspects relating to the introduction of CBDCs. Professor *Seraina N. Grünewald* (Radboud University) gave a presentation on "CBDCs and Central Bank Independence/Accountability"; Professor *Christian Hofmann* (National University of Singapore) developed on "The Shift from Private Money into 'Unlimited' CBDCs: An Unviable De-

velopment or a Chance for Reform and New Opportunities?"; and Professor *Dirk Niepelt* (University of Bern) showed the "Macroeconomic Perspective on Retail CBDCs and the Digital Euro".

Professor *Christos Gortsos* moderated the whole colloquium and concluded the same by a summary.

The editors of this book are extremely grateful to the speakers for their insightful presentations and manifold contributions to the discussion. They also wish to warmly thank Professor *Sebastian Bonhoeffer* and Dr. *Mario Wimmer* (Deputy Director of the Collegium Helveticum), for their valuable support. Special thanks are finally extended to *Mick Lehmann*, *Andrea Truttmann*, *Jessica Mani* and *Lily-Marie Beyeler* and Dr. *Inke Nyborg* for the excellent organization of the event.

The present book contains, in writing, most of the presentations in the colloquium. It is structured in five Chapters under two Parts, which develop on the above-mentioned aspects presented by their authors. Its publication would not have been possible without their great commitment and effort. We warmly thank them.

Even though developments relating to the introduction of CBDCs are constant, we trust that this book will be of value to all those interested in that emerging field, considering the high-level expertise of the contributing authors.

We are very grateful to Dr. *Tobias Baumgartner* and *Sophie Tschalèr* from EIZ-Publishing for their support in publishing this book and to *Petja Ivanova* for her prudent review of the galley proofs.

Zurich, 17 August 2023

Christos V. Gortsos and Rolf Sethe

Part I:
Legal and Macroeconomic
Perspectives

Global Financial Architecture and Decentralized CBDC Regimes

Rolf H. Weber

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I. CBDC as New Element of the Global Financial Architecture

1. Principles of the Global Financial Architecture

After each financial crisis, regulators express their opinion that international rules should be better coordinated and/or harmonized to avoid spillover or contagion effects. Due to their nature, both data and financial assets flow around the globe and have a cross-border nature. Therefore, the voices ad-

vocating for a global financial architecture (GFA)¹ became stronger during the last decades and many harmonized regulations have been implemented in the course of this time.

According to the prevailing academic research, a new GFA should encompass the following substantive topics:²

- *Viable legal infrastructure*: Clear and defined rights and adequate regulations, i.e., a stable normative framework, lead to an appropriate governance structure.
- *Coherence*: Uncoordinated piecemeal regulations will not establish a coherent institutional and legal framework;
- *Sequencing*: The adaptation of a national system to international standards must be done in several steps allowing the market participants to get accustomed to new rules over time;
- *Evaluation*: There is a need for appropriate and ongoing monitoring of a changing regulatory framework;
- *Interconnection*: Legal reforms in different segments of the financial markets should be executed in an interrelated way;
- *Standards*: The consistency of the accounting and other relevant standards is an important pre-condition for a sound legal framework;
- *Transparency*: Better informed markets are likely to make better decisions;
- *Avoidance of corruption, money laundering and other criminal activities*: Undesired behavior undermines public confidence.

Cryptocurrencies in general and Central Bank Digital Currencies (CBDC) in particular which have been developed during the last ten years cause new challenges for the abovementioned substantive topics of a new GFA; the following article attempts to shed light on the specific problems imposed by the decentralized infrastructure of digital currencies on the centralized global architecture in financial markets from an information technology³ and model-theoretical perspective.⁴

¹ For a good early discussion on the GFA, see Norton, 891 et seq.

² See Weber, 2001, 241, 265.

³ See below ch. [II](#).

⁴ See below ch. [III](#).

2. CBDC as Driver of New Regulatory Complexities

Private cryptocurrencies (e.g. Bitcoin, Ethereum, Stablecoins like DAI, Liquity)⁵ and the upcoming CBDC lead to greater currency competition, however, equally to increased regulatory complexities.⁶ Since cryptocurrencies are a part of the GFA and also require a global financial network infrastructure, interoperability becomes a major issue.⁷ Whereas private cryptocurrencies are designed for global use on decentralized infrastructures, CBDC, issued by a (national) Central Bank (or a regional Central Bank as in case of the European Central Bank), have a state-oriented character by definition.⁸

In addition, and apart from aspects of financial stability, CBDC represent a liability of a Central Bank.⁹ Furthermore, there are important legal issues that are not decisive for private cryptocurrencies, such as the qualification of legal tender, but are to be tackled in the context of CBDC.¹⁰ These issues will not be discussed hereinafter, rather, the question as to how CBDC can be integrated into and form a part of the GFA will be the main topic, both from a theoretical and a practical perspective.

CBDC can be designed in different technological ways; insofar, at least in principle, the existing GFA does not provide for any specific option or model. The following differentiations for the issuance of CBDC must be considered:

(i) *Technological basis of CBDC issuance*: Two principal designs are possible, namely

- An account-based CBDC, i.e., an account is established at the issuing bank for the public for (in principle) daily use; as follow-up question it must be decided whether the account is interest-bearing or not.¹¹

⁵ For a general overview, see Zellweger-Gutknecht/Weber, G 1, G 9/10 with further references.

⁶ Wang/Gao, 1 <<https://doi.org/10.1111/rego.12520>>.

⁷ See below ch. IV.3 and Auer, 1.

⁸ Zellweger-Gutknecht/Weber, G 5 et seq.

⁹ See Bossu, 7; see also Dionysopoulos et al., 20.

¹⁰ For cryptocurrencies in general, see Zellweger-Gutknecht/Weber, G 27/28; for a detailed analysis of the problem in case of a digital Euro coin, see Geva/Grünwald/Zellweger, 1127 et seq., and in case of crypto-based demand deposits of Central Banks, see Zellweger-Gutknecht, 228.

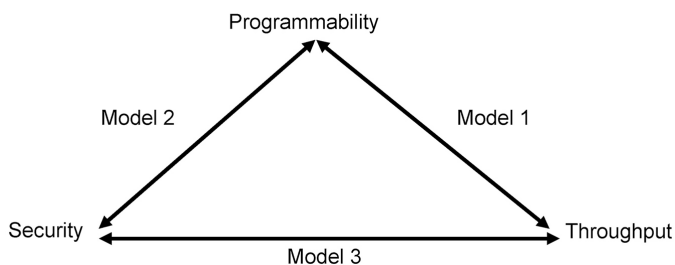
¹¹ Wang/Gao, 3 with further references.

- A token-based CBDC, i.e., “digital cash” is issued by the Central Bank, being the more “modern” option since a (contractual) relation to the account-provider is not necessary and, therefore, an improvement in payment systems becomes possible¹² and anonymity can be secured.¹³

(ii) *Addressees of CBDC*: The Central Bank has to decide whether “only” wholesale CBDC should be issued to participants such as clearing banks and public bodies (as presently foreseen in Switzerland)¹⁴ or whether retail accounts for day-to-day use are to be developed (causing constitutional challenges in Switzerland).¹⁵

(iii) *Existence of intermediaries*: Finally, the CBDC can be single-tiered, i.e., the Central Bank directly issues CBDC to the public and operates all aspects of the system, or two-tiered, i.e., the Central Bank relies on intermediaries (commercial banks) for the issuance of CBDC and for the interactions with the customers.¹⁶

A further complexity level concerns the programmability of payments and money which can be done with three possible approaches, namely (i) integrating the functionality into the fundamental ledger, (ii) providing the capability through an additional “module”, or (iii) “outsourcing” it to payment service providers. Thereby, the following trilemma occurs:¹⁷



¹² Dionysopoulos et al., 8/9.

¹³ Wang/Gao, 3 with further references; to the privacy issues in particular, see Dionysopoulos et al., 13/14.

¹⁴ See [Thomas Moser in this volume](#) (p. 93).

¹⁵ In academic literature it is debated whether Article 99 of the Swiss Constitution allows the Swiss National Bank to be engaged in retail business. Furthermore, the fundamental question occurs as to whether the issuance of retail CBDC by the Swiss National Bank would not contradict the economic liberty principle as enshrined in Art. 94 of the Constitution.

¹⁶ Wang/Gao, 3.

¹⁷ Dionysopoulos et al., 14 et seq.

Model 1 can achieve programmability and high throughput to the detriment of security, in model 2 throughput is jeopardized and model 3 abandons programmability.

II. Technical Design of CBDC Networks

1. Network Decentralization

Traditional payment systems, expressed in national or regional currencies, do have a technically centralized structure and the settlement between different currencies is done by central institutions such as clearing banks or SWIFT. In contrast, CBDC, technically issued on the distributed ledger technology (DLT) infrastructure, are based on a decentralized infrastructure having a large number of so-called nodes which are likely to increase over time.¹⁸

The DLT architectures consist of the mentioned technical nodes which are interconnected to form a network; the nodes are run independently and represent the participants on the platform. In other words, the nodes that include interests, values, perceptions, knowledge, and legal sources interact with each other and form those ties that shape the network structure.¹⁹

According to economic theory, centralized networks are arguably the most efficient structures; centralization leads to positive network externalities.²⁰ Nevertheless, it cannot be overlooked that centralized networks are also vulnerable if the hub fails (for example in case of a heavy cyberattack).²¹ Therefore, decentralized networks based on the DLT infrastructure do have some operative advantages; however, the decentralized access structure also offers potential access points for any kind of cyberattack.

For technical reasons the CBDC network is suitable to be divided into clusters (sub-networks). The different types of networks can be expressed in the form of the following charts:²²

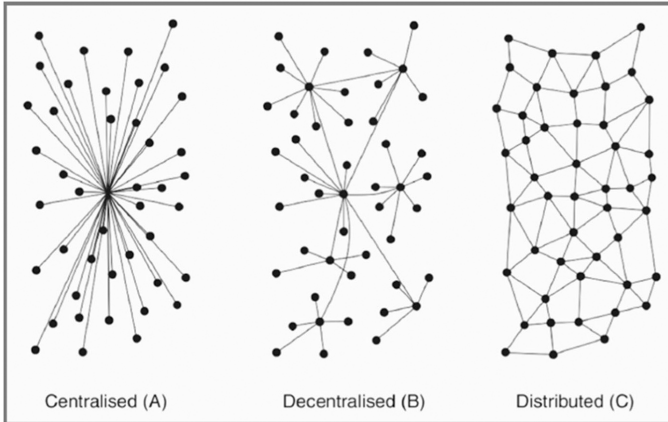
¹⁸ Wang/Gao, 4 with further references.

¹⁹ See also Eberlein et al., 1 et seq., <<https://doi.org/10.1111/rego.12030>>.

²⁰ Sheng, 4.

²¹ See in general Weber/Yildiz, 7 et seq.

²² Sheng, 4.



The most appropriate form would likely be a decentralized network; this structure, even if less efficient, has the advantage of enhanced resilience since the network does not depend on a single network or node.²³ But theoretically, the form of the distributed network would also be an option even if it is less probable that such a network will be implemented. At any rate, however, the network structure will be flat or multipolar.²⁴

For the time being, it appears to be uncertain how exactly the different decentralized CBDC networks will be linked to each other on a cross-border scale, i.e., how the interoperability is to be globally established.²⁵ This aspect depends on the number of nodes, on how often those nodes interact, and on the network structure (i.e., the network “density”); in addition, clusters (sub-groups) may not necessarily be based on a model of hubs if interoperability can be guaranteed otherwise.²⁶

2. Network Forms

Irrespective of the degree of structural decentralization, networks can be designed in two different forms, namely in the form of networks-as-actors or in the form of networks-as-structures.²⁷ In the first case, international governance among key actors is given, in the second case, the behavior of the actors remains uncoordinated. The CBDC networks are likely to have elements of

²³ Wang/Gao, 5, also include the notion of ties into their description of networks.

²⁴ See Oatly et al., 135-137.

²⁵ See below ch. [IV.3](#).

²⁶ For additional details, see Wang/Gao, 6.

²⁷ For a detailed discussion of the network forms, see Wang/Gao, 7 with further references.

both forms even if a higher proximity to the networks-as-structures is probable²⁸ since a coordination as foreseen in the Bretton Woods Agreements is unlikely occurring.

III. Theoretical Approach: Competition or Coordination?

1. Introduction

After the description of the CBDC networks' technical design, the following section analyzes the possible regulatory approaches from a model-theoretical point of view. Traditionally, academics distinguish between two models, namely the concept of regulatory competition and the concept of regulatory coordination.²⁹

Regulatory competition, partly also called “concept of conflict”, follows the assumption that it has advantages to implement a preferable regulatory environment for the national businesses. Subsequently, private enterprises evaluate which regulatory regime would offer the best commercial environment.³⁰ The regulatory competition model is premised on regulatory arbitrage and on the effective discovering of the different features of regulatory regimes; this approach can ease the informational asymmetry and improve the quality of regulatory interventions.³¹ According to a general academic assessment, different forms of regulatory competition and possible typologies can be designed from manifold perspectives (for example competition among jurisdictions or among legal actors).

In contrast, the approach of regulatory coordination attempts to create internationally harmonized norms; the coordination model, partly also called “concept of cooperation”, is based on the standardization principle, i.e., coordination avoids the risk that similar activities are treated differently due to geographical borders.³² As a consequence, the concept of coordination leads to substantive convergence. Coordination as the alternative approach can occur between standard-setters or standardization organizations attempting to introduce harmonized provisions in certain markets.³³ Coordination by harmonized norms has the potential to restrict regulatory innovations but leads to a standardization of rules and, thereby, facilitates market behavior.

²⁸ For a general overview to network structures, see Sikkink, 229, 232, 245.

²⁹ For a general discussion, see Weber, 2015, 605 et seq.

³⁰ Weber, 2015, 605.

³¹ See Wang/Gao, 10 with further references.

³² Weber, 2015, 605.

³³ Wang/Gao, 10.

2. Chances and Risks of Regulatory Competition

Regulatory competition (or the model of “conflict”) between CBDC standards can lead to incompatibility of different technical standards, the uncoordinated networks-as-structure form might give rise to potential conflicts due to lack of interoperability.³⁴ At least to a certain extent, the implementation of “genuine standards” for example related to smart contracts and algorithms would facilitate cross-border transactions in different CBDC.³⁵ Divergence of standards causes conflicts, particularly in respect of cross-border interoperability; only the interconnection between national CBDC systems, ideally with common or homogenous standards, increases the interoperability and improves network efficiency.

Regulatory competition includes the risk that lower regulatory standards might be introduced to achieve a competitive cross-border advantage. Incongruent regulations can develop from differing regulatory objectives, tools, and thresholds (for example from differing minimum standards in respect of privacy protection).³⁶ Another aspect concerns the question as to whether the CBDC should have different capacities domestically and in international transfers. Such a situation is likely to occur if the interests of national end-users in retail businesses are prioritized. In contrast, efficiency and the interoperability of data are more important in cross-border payments.³⁷

The leading nations issuing CBDC (such as China with the digital Renminbi) are well placed to export their technology to other countries and thereby impact their standard setting. Regulatory competition is also possible regarding other relevant factors of payment systems, for example in connection with the implementation of a CBDC-related digital identity system or cybersecurity provisions. Further topics are the rectification of erroneous CBDC-payments based on smart contracts and/or algorithms as well as the warranty for data quality.³⁸

³⁴ For further details to the competition model, see Weber, 2015, 606/7.

³⁵ Wang/Gao, 11/12, referring to “conflict” instead of “competition”, the latter giving a more negative touch to the regulatory model.

³⁶ For further details, see Kitt et. al., 1 et seq. <<https://www.imf.org/en/Publications/WP/Issues/2020/06/26/A-Survey-of-Research-on-Retail-Central-Bank-Digital-Currency-49517>>.

³⁷ See below ch. IV.3.

³⁸ For a more detailed analysis, see Wang/Gao, 12.

Regulatory competition can also concern constitutional issues such as monetary sovereignty and CBDC issuance powers;³⁹ in respect of these challenges, interoperability is more difficult to achieve than regarding technical requirements.

3. Chances and Risks of Regulatory Coordination

Cooperation usually leads to regulatory coordination. Undesirable outcomes such as a race to the bottom and regulatory arbitrage can be avoided. Regulatory cooperation is likely occurring within clusters and improving cross-border interoperability.⁴⁰

The cooperation approach substantially promotes financial stability and integrity. From a technical perspective, the interoperability based on common standards might support transparency and efficiency of payments' execution and reduce transaction costs by limiting the complexity arising from regulatory compliance.⁴¹ Particularly international organizations such as the Committee on Payments and Market Infrastructures and the International Monetary Fund advocate for standardization of the IT-related aspects of CBDC and for harmonized regulatory frameworks (for example also in view of adjacent legal topics such as privacy and AML/CTF regulations);⁴² the coordination approach could also pool rather than duplicate resources.

Cross-border interoperability requires cooperation and regulatory coordination at least within clusters by groups of Central Banks attempting to achieve similar objectives such as to reduce transaction costs or to improve regulatory compliance. For example, the G7 has developed public policy principles for retail CBDC.⁴³ The promotion of interlinkages should look at the type of formats and messages in foreign exchange transactions and attempt at integrating CBDC into the GFA structure.⁴⁴

³⁹ The respective challenges are not addressed in this article; for a detailed discussion, see Zellweger-Gutknecht/Geva/Grünewald, 284 et seq.

⁴⁰ Weber, 2015, 607.

⁴¹ Wang/Gao, 10.

⁴² See International Monetary Fund Inter-Departmental Staff Team, Digital Money Across Borders: Macro-Financial Implications, Policy Paper No. 2020/050, 8.

⁴³ G7, Public Policy Principles for Retail Central Bank Digital Currencies, 2021, <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1025235/G7_Public_Policy_Principles_for_Retail_CBDC_FINAL.pdf>.

⁴⁴ Wang/Gao, 11.

Regulatory cooperation and coordination could help to develop joint resources that share problems, promote interactions, and build consensus in areas of common interest; thereby, the building of trust between the actors is strengthened.⁴⁵ A CBDC network containing sufficient trust between actors could be “a repository of information on the availability, competences, and reliability of the respective partners.”⁴⁶

4. Model of Co-opetition

A relatively recent conceptual alternative to regulatory competition and coordination is the model of regulatory co-opetition.⁴⁷ The term is used to show the dynamics of the competition and coordination models taking place among governments and private actors both in horizontal and vertical dimensions. The main purpose of this model is to acknowledge that legal actors should not only compete but also cooperate. Optimal governance requires a flexible mix of competition and coordination between governmental actors as well as between governmental and non-governmental actors.

Three forms of regulatory co-opetition can be distinguished, namely inter-governmental (horizontal or vertical efforts among governments), intra-governmental (efforts among different branches of governments) and extra-governmental (co-opetition between governmental and non-governmental actors).⁴⁸ New CBDC projects, for example the below mentioned Jura project, are conducted in a specific setting of co-opetition.⁴⁹

The co-opetition approach can become important if the CBDC networks lead to a disordered situation within the GFA because a flat decentralized structure does not work, for instance due to regulatory challenges, unreasonably high operation costs or not resilient infrastructures. A further problem concerns the tensions between the decentralized CBDC networks and the need for a standardized governance regarding interchange mechanisms⁵⁰ and digital identity frameworks. These issues call for joint efforts in a co-opetitive manner.

⁴⁵ On the aspects of consequences and trust, see also Silvers, 1278/9.

⁴⁶ Van der Heijden, 729, <<https://doi.org/10.1111/rego.12295>>.

⁴⁷ For more details, see Weber, 2015, 608 with further references.

⁴⁸ Weber, 2015, 608.

⁴⁹ See below ch. [IV.1](#).

⁵⁰ See also Wang/Gao, 11.

IV. Practical Implementation: Designs of Ongoing Projects

1. Increased Activities of Central Banks

Private cryptocurrencies exist since more than ten years and have gained acceptance in society. A disadvantage of private cryptocurrencies is certainly that they are quite volatile and less trustworthy than CBDC. The Central Banks did not react spontaneously subsequent to the “invention” of private cryptocurrencies, however, in the meantime the increasing wish of having a stable digital currency has induced many Central Banks to invest into CBDC projects (Sweden, Estonia, China). The efforts were intensified during the last four years; most projects do have an involvement of several institutions across borders.

The Report “Options for access to and interoperability of CBDCs for cross-border payments”, submitted to the G20 in July 2022 by different units of the BIS,⁵¹ lists thirteen completed and ongoing CBDC projects, inter alia Prosperus, MAS, Helvetia, mBridge, HSBC, Jura, Dunbar. The BIS Innovation Hub (BISIH) Report “Using CBDCs across borders: lessons from practical experiments” of June 2022⁵² discusses four particular projects, namely *Inthanon-LionRock2* (encompassing BISIH Hongkong Centre, Hong Kong Monetary Authority, Bank of Thailand), *Jura* (composed of Banque de France, Swiss National Bank and a private sector consortium, incl. SIX Digital Exchange), *Dunbar* (executed by Reserve Bank of Australia, Bank Negara Malaysia, Monetary Authority of Singapore, South African Reserve Bank) and *mBridge* (including People’s Bank of China, Central Bank of the United Arab Emirates, working on a third face of the *Inthanon-LionRock2* project under the umbrella of the BISIH).

In Switzerland, following the “internal” (CHF-related) project “*Helvetia*” that encompasses several phases so far, the more recent project “*Jura*” is most relevant: The latter project explored the direct transfer of Euro and Swiss Francs wholesale CBDC between French and Swiss commercial banks on a single DLT platform operated by a third party. Tokenized assets and foreign exchange (FX) trades were settled using payment versus payment and delivery versus payment mechanisms. The successful “*Jura*” project was conducted as co-opetitive model in a near-real setting, complying with current regulatory requirements; “*Jura*” also explored a new approach including subnetworks and dual-notary signing.⁵³

⁵¹ BIS Innovation Hub, July 2022, Annex 6, 42 et seq. <<https://www.bis.org/publ/othp52.pdf>>.

⁵² BIS Innovation Hub, June 2022, 5 et seq. <<https://www.bis.org/publ/othp51.pdf>>.

⁵³ BIS Innovation Hub, June 2022, 6/7.

2. Common Key Features

The aforementioned ongoing projects attempting to allow the exchange of multiple currencies by mitigating frictions in cross-border payments within a single system have dealt with the following common key features:⁵⁴

- *Platform design*: Digital ledger technologies allow to build platforms on a common infrastructure offering efficiency gains in comparison to the existing payment systems; it is not necessary anymore to interlink discrete centralized systems; however, challenges of operational and technical interoperability cannot be overlooked.
- *Access to wholesale CBDC by non-resident financial institutions*: Compared to the existing payment systems making access often conditional on local supervision or licensing, the DLT systems broaden direct access to Central Bank money. This means that direct access to CBDC from abroad enables the execution of cross-border payments without intermediaries on a single system.
- *Teams*: Experience has shown that all experiments included regional partners involving public-private sector cooperation; thereby, a co-regulatory approach is realized. This approach has been taken irrespectively of the fact that the ongoing projects are differing as far as technical designs, currencies and use cases are concerned.

The ongoing projects had to consider several aspects when designing a cross-border CBDC arrangement as well as different ways in which these could be accommodated. At the forefront, five evaluation criteria were decisive:⁵⁵

- The *do not harm* principle in the context of CBDC refers to designing CBDC ecosystems that support public policy objectives and do not impede Central Banks' ability to carry out their mandates. Positive aspects are currency substitution and increased capital flows.
- The objective of *enhancing efficiency*, both wholesale and retail, is characterized by low cost and high speed, without compromising other relevant aspects, such as ease of use, accessibility, availability, and safety.
- The principle of *resilience* encompasses the ability to identify, to protect against and to recover from adverse shocks and from other disruptive

⁵⁴ For further details, see BIS Innovation Hub, June 2022, 9/10.

⁵⁵ For a detailed discussion of these evaluation criteria, see BIS Innovation Hub, July 2022, 7-10 and 19-23.

events; an ecosystem is resilient at system level if weaknesses of its individual participants do not undermine the resilience of the entire ecosystem.

- The assurance of *coexistence and interoperability* with non-CBDC systems means that different types of Central Bank money (i.e., new CBDC and existing banknotes or balances in reserve or settlement accounts) should complement each other and coexist in a wider payment landscape that supports public policy objectives.
- The principle of *financial inclusion* attempts to enhance the access of individuals and businesses to affordable financial products and to services that meet their needs (transactions, payments, savings, credit and insurance) and are delivered in a responsible and sustainable way.

In conclusion, the ongoing projects have proven (i) the technical feasibility of the interoperability mechanisms allowing multiple currencies to be settled and (ii) the achievement of the described evaluation criteria.⁵⁶

3. Options for Interoperability

As mentioned,⁵⁷ the success of CBDC for cross-border transactions depends on the access and interoperability choices made by Central Banks when designing their CBDC. Thereby, two issues play a role, namely the making available of CBDC to non-residents (for retail CBDC) and to foreign payment services providers (for both retail and wholesale CBDC) for direct use as well as the facilitation of transactions' execution through interoperability mechanisms between different countries' CBDC systems.⁵⁸

As far as the access to wholesale CBDC systems by foreign payment services providers is concerned, three options do exist,⁵⁹ namely closed access (domestic payment services providers only), indirect access (possibility of foreign payment services providers to access the wholesale CBDC network via an intermediary) or direct access (opportunity for foreign payment services providers to directly transact in wholesale CBDC issued by a Central Bank without an intermediary participant).⁶⁰

⁵⁶ BIS Innovation Hub, July 2022 28/29; BIS Innovation Hub, June 2022 12/13.

⁵⁷ See above ch. II.1.

⁵⁸ See also BIS Innovation Hub, July 2022, 18; to the convertibility issue, see Dionysopoulos et al., 30/31.

⁵⁹ BIS Innovation Hub, July 2022, 12/13.

⁶⁰ On the access issue, see also MIT Media Lab/Maiden, 28 et seq.; Dionysopoulos et al., 22 et seq.

Furthermore, in case of a retail CBDC regime, Central Banks have to decide on two issues,⁶¹ impacting the flow of cross-border CBDC transfers: (i) Who will be able to hold and transfer retail CBDC and under what conditions? (ii) If access to retail CBDC is allowed for non-residents, how will they be able to access it?

The ongoing projects have also explored different types of interoperability between different CBDC systems as well as between CBDC and non-CBDC systems. Thereby, three models of multiple CBDC arrangements achieving interoperability have been tested:⁶²

- *Compatibility model*: This approach refers to individual CBDC systems that use common standards (such as message formats, cryptographic techniques and data requirements). Although the compatibility model does not link different CBDC systems, it has the potential to improve current cross-border payments by enhancing efficiency of payment processing and compliance protocols as well as by facilitating participation in different systems and different jurisdictions.
- *Interlinkage model*: This system links different CBDC systems with a set of technical and contractual arrangements that not only facilitate communication and exchange of data but could also facilitate compliance, foreign currency provision and settlement. Technical designs are (i) a single access point, (ii) a bilateral link or (iii) a hub and spoke solution.
- *Single system model*: This design refers to CBDC that use a single common technical infrastructure and potentially also a common rulebook. The single system model has some similarities with the interlinkage model, in particular regarding the question of which entities provide the common services.

Experiences made in the execution of the different projects coordinated by the BIS Innovation Hub have shown (as also acknowledged by the World Bank Group) that all types of applied interoperability models do work and that policy considerations are relevant for concrete choices.⁶³

⁶¹ BIS Innovation Hub, July 2022, 13/14.

⁶² For further details, see BIS Innovation Hub, July 2022, 14-17.

⁶³ See BIS Innovation Hub, July 2022, 18 and 19-23; see also World Bank Group, Central Bank Digital Currencies for Cross-Border Payments, A Review of Current Experiments and Ideas, November 2021 <<https://documents1.worldbank.org/curated/en/369001638871862939/pdf/Central-Bank-Digital-Currencies-for-Cross-border-Payments-A-Review-of-Current-Experiments-and-Ideas.pdf>>.

4. Legal and Regulatory Issues

As mentioned at the beginning,⁶⁴ a robust and viable legal framework is required for the establishment of a stable financial market infrastructure; the rights need to be clearly defined in order to reach an adequate normative environment and to realize an appropriate governance structure. However, legal topics related to the issuance and transfer of CBDC as well as to the finality and validity of the settlement may lead to challenges depending on the currencies and jurisdictions involved.⁶⁵ By their very nature payment flows have a cross-border character and cannot be kept within a single legal regime.

In the given reality, for example payment, data-sharing, privacy and tax laws differ across jurisdictions. Therefore, interlinkages between infrastructures located in different countries may be regulated by divergent normative frameworks which could result in legal uncertainties. In particular, data protection regulations being an important element for a viable CBDC framework substantially differ around the world. Consequently, technical measures assuming a legal function must be established.

In addition, difficulties increase if a multitude of links is implemented; further complexities are caused by the potential hub and spoke models since the participants must adhere to manifold regulatory policies.⁶⁶ Technological and legal interoperability becomes key if a CBDC regime should be successful.

In an ideal world it would be desirable to develop common rulebooks and contingency procedures as well as to monitor the respective capabilities. However, payments are a key element of national interests (mainly based on the sovereignty concept) and directly related to national policies. Therefore, far-reaching harmonization by way of common rulebooks is not likely to be realized in the near future.

Furthermore, multiple CBDC arrangements should be embedded into a commonly agreed governance framework that determines the rules, rights and obligations of all parties.⁶⁷ The respective standards could partly draw on the rulebooks of SWIFT for payments and the Continuous Link Settlement (CLS) for foreign exchange transactions; nevertheless, the development of new provisions is unavoidable and requires a common understanding of cross-border digital payment systems.

⁶⁴ See above ch. [1.1](#).

⁶⁵ BIS Innovation Hub, June 2022, 13, and BIS Innovation Hub, July 2022, 24/25.

⁶⁶ BIS Innovation Hub, July 2022, 24.

⁶⁷ See also BIS Innovation Hub, July 2022, 25.

V. Outlook: Adaptation of the Global Financial Architecture

Due to the decentralized structure and form, the (different) CBDC networks will very likely profoundly change the GFA. Indeed, the role of the governmental actors in the development of CBDC scenarios as well as in the design of the GFA CBDC has relevant implications for the international financial system, particularly in the segment of payments, i.e., a substantive impact is unavoidable.⁶⁸ The technologically decentralized structure of CBDC networks might lead to sub-networks and clusters of the GFA. Thereby, the CBDC network will add an additional and complex layer to the existing relations between the manifold actors in the GFA.

In addition, competition between currency blocks might occur⁶⁹ and potential power imbalances of existing payment schemes due to the strong position of the US Dollar might erode which US policymakers want to obviously avoid.⁷⁰ Since the conclusion of the Bretton Woods Agreements, the US Dollar has operated as primary currency of the most important markets and the US currency system was the core of the centralized system of payments. This situation is possibly going to change: CBDC denominated in another currency, for example in Chinese Renminbi (RNB), are likely to play an increasingly important role.⁷¹

To the extent that CBDC might potentially replace traditional currencies,⁷² the previously centralized structure will also have to encompass decentralized CBDC networks. Along with private cryptocurrencies, CBDC networks could create increased currency competition. But if several CBDC networks operate in parallel, it might become difficult to maintain an incumbent global reserve currency system.⁷³ In other words, the decentralization of currency transac-

⁶⁸ Wang/Gao, 13.

⁶⁹ See Didenko et al., 5.

⁷⁰ For this reason US authorities are now more intensively looking into the development of a digital US dollar, see for example Board of Governors of the Federal Reserve System, Money and Payments: The U.S. Dollar in the Age of Digital Transformation, January 2022, 13 et seq., <<https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf>>.

⁷¹ Wang/Gao, 14.

⁷² The replacement of traditional currencies by CBDC is not going to happen within a short time; recently, The Economist (May 20th 2023, Special report Digital finance, 11) correctly assessed the following: "The roll-out of central-bank digital currencies is proving slower than expected".

⁷³ See Zang, <<https://www.imf.org/en/News/Articles/2020/10/30/sp103020-new-forms-of-digital-money>>.

tions has the (potentially negative) consequence that a global reserve currency such as the US Dollar is not available anymore; this disadvantage might become important if a country is confronted with liquidity constraints.⁷⁴

In principle, cross-border CBDC transactions could be executed through new alternative digital platforms, at least if such platforms are capable of handling multi-CBDC exchanges. These platforms are usually of centralized nature. The growth of alternative international payment “rails” might shift CBDC-denominated trade invoicing and financial intermediation. Again, the development of interoperability standards is essential.⁷⁵

Furthermore, CBDC networks potentially cause the risk of increased uncertainties.⁷⁶ The decentralized structures make it difficult to implement strong governance measures in order to stabilize the interchange mechanisms and the digital identity frameworks. However, CBDC networks could also improve financial inclusion (being particularly important for countries in Africa and Asia)⁷⁷ if broad public access to safe digital money and interoperability with other currencies is ensured.

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⁷⁴ See Didenko, 39, and Zhang.

⁷⁵ See Wang/Gao, 14.

⁷⁶ See also Kitt et al., 12/13 and 18; for a general discussion of uncertainties and trust, see Brummer, 134.

⁷⁷ For an overview to the financial inclusion challenges, see Arner et al., 1 et seq.

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The Shift from Private Money into “Unlimited” CBDCs: An Unviable Development or a Chance for Reform and New Opportunities?

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I. Introduction

Central Bank Digital Currencies (CBDCs) stand as one of the most compelling topics of interest for central banks globally. Virtually all central banks are delving into the potential benefits presented by CBDCs, with some embarking on feasibility assessments for introducing a digital rendition of their currency within their respective jurisdictions. China’s pilot programme notably stands as one of the most advanced trials of its kind.¹ Consequently, a substantial vol-

* This chapter draws on the author’s previous works ‘Which markets need Central Bank Digital Currency?’, (2023) 18:3 Capital Markets Law Journal 281-302; ‘The impact of a digital dollar on Singapore’s society, banking sector and monetary system’ (2023) 39:3 Banking and Finance Law Review 381-407; ‘Unlimited Central Bank Digital Currency: The Case for a Public Good in the Euro Area and its Regulatory (and Deregulatory) Implications for Modern Finance’, (2023) 48:1 North Carolina Journal of International Law 1-77 (co-authored with Iris Chiu); ‘Digital Euro: An assessment of the first two progress reports: The case for unlimited holdings of digital euros’, European Parliament: In-depth analysis requested by the ECON committee (2023), <[https://www.europarl.europa.eu/RegData/etudes/IDAN/2023/741511/IPOL_IDA\(2023\)741511_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2023/741511/IPOL_IDA(2023)741511_EN.pdf)>.

¹ For details on the pilot, see Soderberg et al., 22.

ume of discourse has emerged surrounding CBDCs, encompassing their rationales for introduction, the dichotomy between centralised and decentralised technological frameworks as potential foundations, the roles that private intermediaries might play in CBDC distribution and management, and the benefits or ramifications they could bring to financial markets and societies.²

The collaborative endeavours among central banks in the domain of CBDCs, orchestrated by the Bank for International Settlements (BIS), have tackled pivotal questions and ushered in much-needed clarity.³ Central banks assert that CBDCs hold the potential to address the inefficiencies inherent in financial services and transactions, notably by advancing financial inclusion. CBDCs could provide access to central bank money for regions of the world that are unbanked or underbanked, thereby fostering greater inclusion.⁴ Additionally, CBDCs have the capacity to enhance the diversity, accessibility, and efficiency of payment systems.⁵ Particularly, the pace and complexity associated with cross-border payments and domestic transactions involving foreign currencies are frequently regarded as sluggish and intricate. The desire to rectify this lack of efficiency commonly motivates the pursuit of CBDC introduction.⁶ Furthermore, certain central banks highlight the potential benefits of CBDCs in relation to the realisation of their monetary policy objectives.⁷

² For discussions of CBDC concepts, see Barontini and Holden; Mancini-Griffoli et al.; Skingsley; Guzmán Calafell; Kumhof and Noone; Berentsen and Schär; Adrian and Mancini-Griffoli.

³ Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features'. For a summary of the manifold objectives, Soderberg et al., 4-7.

⁴ Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features' 5 (at 2.1.2) and 6 (at 2.1.4). For these and other reasons that motivates central banks to consider CBDC concepts see also Bindseil, 5 (at Introduction); Berentsen and Schär, 101-104; Guzmán Calafell, 2 seq.; Adrian and Mancini-Griffoli, 3; Barontini and Holden, 8 seq.; Skingsley, 6 seq. Underbanked areas are a fertile breeding ground for shadow payment systems, see Awrey and van Zwieten. An example are the Bahamas where the population is widely dispersed across the archipelago and private providers of financial services are absent on far-off islands, prompting the central bank to fill the void with CBDC, see Wyss.

⁵ Bank of England, at 2.4; Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features', 5 seq. (at 2.1.3). An example is China where payments with Alipay and WeChat Pay account for more than 94% of all electronic payment transactions in China, see Bloomberg Business Week of 25 June 2021, 'China crushed Jack Ma, and his Fintech rivals are next'; Yao, 3: prompting the central bank to advance its CBDC project.

⁶ Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features' 6 (at 2.1.5) and 9 (at 2.3.2); ECB, 'Report on a digital euro', 14 (at 2.2).

⁷ For China's PBOC see Fan. For the Eurosystem see references to potential monetary policy transposition advantages in Bindseil, 173.

Amidst this array of motivations, two stand out distinctly. The first rationale is rooted in the phenomenon of diminishing usage of physical cash in everyday transactions⁸—a trend that has garnered support from central banks and other governing bodies. The shift toward cashless transactions serves central banks by affording them enhanced control over payment transfers and facilitating efforts to counteract money laundering and illicit financial activities.⁹ The decrease in cash payments has persisted even throughout the Covid-19 pandemic. This trend, however, contrasts with the concurrent uptick in private households stockpiling cash since the pandemic's onset.¹⁰

Financial stability concerns often prompt the public to turn to cash for store of value, and such concerns have been on the rise since many businesses were forced to close due to pandemic-induced lockdowns which led to rising liquidity and solvency issues across a wide range of sectors. It shows that access to cash remains important to the public since it is their only alternative to commercial bank money, an alternative that becomes especially important in times of distress for the banking sector. CBDC could theoretically allow central banks to promote further reductions of cash usage or even to phase it out without depriving the public of its access to central bank money.¹¹

The second rationale originates from the introduction and triumph of digital tokens. These tokens are data representing value, existing solely in digital format, stored within electronic addresses without geographical constraints. Their transfers are systematically logged on a public decentralised ledger like blockchain and secured against tampering via encryption grounded in cryptographic algorithms.¹² The ascendancy of Bitcoin and other cryptocurrencies

⁸ For details on global trends of phasing out of cash, Zellweger-Gutknecht et al., 285 seqq. For CBDC motives in general and the focus on a cash equivalent, see Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features', para. 2.1.1. However, exceptions exist. In the Eurozone, cash has so far remained the preferred means of payment, see ECB, 'Study on the payment attitudes of consumers in the euro area (SPACE)', 5 (Executive Summary). See also Lalouette and Esselink. For 2023 numbers that show that the trend continues, see Deutsche Bundesbank, 'Cash: Fact and Figures', at 1, <<https://www.bundesbank.de/en/bundesbank/history/20-years-euro/cash-facts-and-figures-772080>>.

⁹ While this is not a primary objective of central banks, it is important that CBDC comply with these requirements and support the competent authorities in their efforts, see Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features', para. 2.1.6.

¹⁰ Caswell et al. For the choice of the public to move to cash as store of value in times of uncertainty, see, *ibid*, 284-286.

¹¹ Bindseil, 7 (para. D.2). In general terms on seignorage, see Lönnberg and Sullivan.

¹² Dabrowski and Janikowski, 7 seqq.

has notably stirred unease among regulators and central banks.¹³ This concern is founded on the fact that transactions conducted using cryptocurrencies evade their oversight. If the adoption of these unconventional payment methods were to notably expand, cryptocurrencies could potentially undermine central banks' authority over money supply and their capacity to manage economies. Apprehension heightened when e-commerce and social media entities began discussing plans for stablecoin concepts built upon distributed ledger technology. Central banks began to express concern that these proposals could trigger substantial transformations in the financial and monetary landscape, eroding central banks' control over money supply.¹⁴

This chapter centres around the premise that the public could reap advantages from CBDC, chiefly due to its potential to provide universal access to cashless central bank money—something unprecedented in the modern history of currency. This accessibility could empower all segments of society to sidestep the limitations associated with both cash and bank money, a point discussed further in [Section II](#) below. Simultaneously, it is crucial to acknowledge that CBDC could furnish the public with an alternative to bank deposits. This alternative could potentially trigger reduced liquidity within the banking sector, particularly during crisis periods.¹⁵

However, our contention is that the indirect consequences of liquidity drainage from the banking sector due to CBDC are uncertain. The inquiries regarding whether these outflows might trigger challenges within the loan sector (commonly referred to as 'credit crunches') and induce financial stability concerns have, as of now, gone unanswered. On a positive note, outcomes that benefit financial stability and enhance access to financial services appear equally plausible. This is attributed to the fact that the presence of CBDC renders liquidity movements more foreseeable, thereby allowing for a streamlined crisis response of central banks and resolution authorities.

This discussion is pertinent within the framework of the digital euro initiative. The ECB's existing cautious approach to CBDC, which involves imposing caps on holdings of a digital euro, is aimed at ensuring banking sector stability. However, a limitation on the quantities of digital euros that individuals can possess could erode its most significant advantage for the public: its role as a secure haven for storing value during times of crisis. This could ultimately un-

¹³ The market capitalisation of cryptocurrencies exceeds the amount of USD 1.26 tn (as of April 2023). For updated numbers see at <<https://www.statista.com/statistics/730876/cryptocurrency-market-value/>>.

¹⁴ Didenko et al., 28. See also Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features', para. 2.3.2.

¹⁵ See the discussions below at [II](#) and [III.2](#).

determine the very rationale behind its introduction, as a digital euro with holding caps might fail to surpass cryptocurrencies and stablecoins as a superior store of value.

As reiterated throughout this chapter, the Eurozone needs a comprehensive dialogue regarding the necessity of such holding caps. The existing literature does not arrive at definitive conclusions as to the indirect consequences associated with unrestricted access to CBDC, thereby lacking unequivocal support for the ECB's cautious stance.¹⁶ This underscores the need for deeper insights before central banks make decisions on this crucial policy facet. Finally, we delve into how the presence of (unlimited) CBDC could potentially facilitate the attainment of monetary policy objectives for the Eurosystem.

II. Benefits of a digital euro for the public

Currently, the general public's access to money is limited to cash, specifically central bank-issued banknotes, and digital funds held in commercial bank deposit accounts, commonly referred to as bank money. These forms of money possess the core attributes commonly associated with money: Cash and bank money are effective stores of value, preserving their worth for future use; they also serve as units of account, providing a standard measure against which the value of goods and services is assessed; finally, cash and bank money are ubiquitously accepted as mediums of exchange in payment transactions.¹⁷

Furthermore, cash is typically issued by government authorities, while bank money is issued and managed by private entities such as commercial banks. However, the activities of commercial banks are subject to stringent regulatory standards imposed by government authorities. Central banks also indirectly influence the issuance of bank money through their monetary policies, which interact with the money creation capabilities of banks.¹⁸ One might contend that the public's need for money is sufficiently covered by these two types of money, but this chapter will argue that an additional form of money – a cashless type of central bank money – is in fact needed to prepare the public, including both natural and legal persons, for the challenges of the future. In or-

¹⁶ Brunnermeier and Landau; Bank for International Settlements, 'Central Bank Digital Currencies: financial stability implications - Report no 4 in a series of collaborations from a group of central banks'.

¹⁷ These three components constituting money are discussed in detail in Proctor, paras. 1.49-1.60; Sáinz de Vicuna, paras. 25.04-25.14; Cargill, p 30 seqq.

¹⁸ For definitions of money, the state theory of money and the money-creation powers of banks, see McLeay et al., 'Money creation in the modern economy' 1; McLeay et al., 'Money in the modern economy: an introduction' 4; Bank of England, para. 1.1; Proctor, para. 3.17; Zellweger-Gutknecht et al., 284, 285 and 317.

der to establish the context for advocating the necessity of a digital euro, it is essential to first comprehend the current monetary framework and its inherent limitations. At the core of this situation lies a notable paradox: while cash remains the favoured mode of payment in the euro area, bank money is the preferred choice as a store of value.¹⁹ The public has valid reasons for this split in preferences. Cashless payment transactions are initiated by a payment instrument whose usage entails the risk of fraudulent transactions and consequently the loss of bank money. Cash is highly exposed to the risk of loss as well, but the quantum of loss is limited to the face value of the lost, stolen, or destroyed banknote. In contrast, payment instruments such as cards, mobile apps, and internet banking carry the potential for much larger losses. Fraudulent transactions might be initiated with the payment instrument and lead to losses that are only curtailed by the payment and transfer limits agreed between the holder of the payment instrument and its issuer.²⁰ It is even more concerning that there are substantial risks inherent in bank money. Bank money represents nothing more than a claim against a bank and is always subject to the bank's ability to honour these claims.²¹ Holders of bank money are therefore exposed to the solvency and liquidity risks inherent in the banking business,²² and deposit insurance can only partially mitigate these risks because of caps on insured amounts²³ and factual limits as to what such insurance can achieve in a large-scale crisis affecting the entire banking sector.

¹⁹ For numbers on cash and cashless transaction in the Euro area, see ECB, 'Study on the payment attitudes of consumers in the euro area (SPACE)', 5 (at Executive Summary). See also Lalouette and Esselink. For 2023 numbers that show that the trend continues, see Deutsche Bundesbank, Cash: Fact and Figures, at 1, <<https://www.bundesbank.de/en/bundesbank/history/20-years-euro/cash-facts-and-figures-772080>>. For numbers on cash in circulation and commercial bank money, see ECB, Manual on MFI balance sheet statistics (January 2021), at <<https://www.ecb.europa.eu/pub/pdf/other/ecb.manualmfibalancesheetstatistics201901-d2ebf72987.en.pdf>>. For numbers in the UK, McLeay et al., 'Money in the modern economy', 5 and 10.

²⁰ Directive (EU) 2015/2366 on payment services in the internal market of 26 November 2015, OJ L 337/35, limits the risk of loss by reducing payment services users' liability to cases of gross negligence, see *ibid.*, art. 74, but risks of loss remain, nevertheless.

²¹ For details on bank money, see Gleeson, paras. 1.27-1.35; Bank of England, para 1.1; Proctor, para 3.17; Zellweger-Gutknecht et al., 284 seq. and 317; McLeay et al., 'Money in the modern economy: an introduction', 4 and 7-11.

²² On this process in general terms, see Gabilondo, 11-22 and 27-37; Armour et al., 290-293.

²³ The required minimum coverage level in the EU is EUR 100,000 according to Directive 2014/49/EU of 16 April 2014 on deposit guarantee schemes (recast), OJ EU (2014) L 173/149. In detail on the essential features of deposit insurance, see Financial Stability Board; Baudino et al.; Lastra, chapter 10.

The inherent riskiness of bank money is self-evident in times of crisis. Bank runs occur when depositors lose confidence in a specific bank or the banking sector as a whole, and typically manifest nowadays in the mass transfer of funds from a troubled bank to healthier banks.²⁴ If the entire banking sector is under stress, money might even be shifted away from banks altogether, to other (potentially less regulated) parts of the financial system or across borders to banks and other financial institutions abroad.²⁵ Even if the contagion from a banking crisis can be stymied through regulatory intervention, the consequences are still undesirable. Following a run event, unviable banks are often absorbed by other banks, which exacerbates the inexorable trend towards consolidation in the banking sector by increasing the scale and number of systemically important banks. This results in a vicious cycle: the stakes for future banking crises can only get higher after each round of consolidation, since the newly merged entities are even more systemically important than their pre-crisis predecessors. Seeing that these institutions are “too big to fail”, governments are often willing to do whatever it takes to protect the integrity of the financial system whenever trouble arises, even if it creates moral hazard risks that may cost taxpayers dearly in the long-term. The March 2023 banking crisis involving the US Silicon Valley Bank²⁶ (SVB) and Swiss bank Credit Suisse²⁷ are recent examples of these typical developments.

At least from a depositor’s perspective, CBDC provides a solution to the risks and deleterious consequences of bank failures.²⁸ For depositors, CBDC serves as an indisputably secure store of value option because it represents a liability of a central bank.²⁹ Central banks cannot default on their payment obligations since they have unlimited money-creation powers in their own currency.³⁰ When viewed in totality with the assurance of at-par convertibility of all types of money (the so-called principle of unity of money),³¹ it is clear that central

²⁴ Temzelides, 3.

²⁵ Brown et al.; Brunnermeier and Landau, 27 seq.

²⁶ Board of Governors of the Federal Reserve System; Cox.

²⁷ Credit Suisse.

²⁸ For potential positive effects on financial stability, see below at [III](#).

²⁹ On this core legal element of CBDC, see ECB, ‘Report on a digital euro’, 6; Bank of England, 31 (Box 3); ECB, ‘Digital euro experimentation scope and key learnings’, 7, 8 and 10; Bossu and others, paras. 15 seqq. See also ECB, ‘Progress on the investigation phase of a digital euro – second report’, 4 (at 1).

³⁰ Armelius et al., 19 and 25; Nabilou, 306; Zellweger-Gutknecht et al., 295 seqq.

³¹ For this principle and plans of central banks to adhere to it with the introduction of CBDC, Bank of England, 7-9; ECB, ‘Digital euro experimentation scope and key learnings’, 7; Mersch; Bank for International Settlements, ‘Central bank digital currencies: foundational principles and core features’, 11 (Table 1).

banks can always deliver on the promise underpinning their digital currency — they can always execute payments in digital currency and convert digital currency into cash or bank money.

For the public, this could herald new opportunities. Holdings in CBDC would become the baseline store of value option for everyone because it is a risk-free means of holding money, provides access to cashless payment transactions, and allows for conversions into cash. Any other store of value would be measured against the yardstick of a zero-risk CBDC.

Despite these considerations, it is likely that financial services such as the facilitation of investments would remain the primary domain of banks. Banks could also be anticipated to retain their pivotal roles as leading lenders and creators of bank money.³² As a result, bank money would likely stay the primary choice for store of value.³³ However, depositors would probably demand adequate risk compensation since CBDC would serve as a risk-free alternative. If CBDC storage were available at zero cost, depositors would expect banks to offer interest rates that are commensurate with the risks inherent in bank money. The era of zero-interest deposit funding for banks might therefore come to an end with the introduction of CBDC.³⁴ Concerns about increased costs of deposit funding due to CBDC have prompted the ECB to propose only limited access to a digital euro, such that holdings of digital euros would not exceed “cash-like” volumes.³⁵ Both ECB Progress Reports reiterate these plans and adopt the working assumption that holdings of digital euros would be capped.³⁶ This proposed cap is problematic on several counts. Firstly, it suggests that the digital euro is meant as a cash replacement which is not the case as central banks have repeatedly emphasised.³⁷ Secondly, it would defeat the

³² For the process of bank lending and the inherent creation of money in customers' accounts, see McLeay, 'Money creation in the modern economy'.

³³ Although the ultimate effects of a digital euro are difficult to predict, see Brunnermeier and Landau, 27.

³⁴ Except, maybe, during times of extreme monetary loosening that see the Eurosystem charging negative interest on digital euros (especially for holdings exceeding certain thresholds), thereby boosting the attractiveness of zero interest bank money. For the concept of tiered interest paid on digital euros, see Bindseil, 4 (as also discussed below at [Section V](#)). However, we would caution against such deterrents against (large) holdings of digital euros because they could damage the public's trust in digital euros and thereby defeat their stabilising effects (as argued at [Section III](#)).

³⁵ ECB, 'Report on a digital euro', 17 (for the potential risks of an unlimited digital euro) and 28 seq. (at para 5.1.3); Bindseil, 172 and 175 (at para 3.3).

³⁶ ECB, 'Progress on the investigation phase of a digital euro', 9 seq. (at 2.3); ECB, 'Progress on the investigation phase of a digital euro – second report', 8 seq. (at 1.3).

³⁷ Bank of England, 7 seq.; Bank for International Settlements, 'Central bank digital currencies: foundational principles and core features', 10.

purpose of CBDC to serve as a risk-free store of value option for the public although compelling reasons that would require such restrictions are not evident (as argued at [III.1](#) and [III.2](#)) and render the digital euro ineffective as a response to growing usage of cryptocurrencies (as assessed at [III.3](#)). Thirdly, a restricted access to a digital euro would also impede benefits which could otherwise result for central banks' monetary policy transactions (as explained at [V](#)).

III. Benefits of a digital euro for financial stability

The discussion about the value of a CBDC available to everyone could not have come at a more opportune time. In March 2023, banks in the US and Switzerland faced such grave difficulties that interventions by the supervisors, resolution authorities, central banks, and fiscal authorities were necessary to mitigate the spread of contagion to other banks and the rest of the financial sector.³⁸ It seems plausible that a considerable portion of these challenging developments could have been averted or their consequences alleviated through the presence of a CBDC, as detailed in the upcoming sections.

1. Less concern about depositor protection

A CBDC could serve as a perpetual last resort option for depositors seeking a secure store of value. By introducing a digital euro without any restrictions on individual holdings, the public would gain the ability to determine the proportion of their funds allocated to dependable digital euros, bank money backed by deposit insurance, and unprotected deposits or investments. This comprehensive freedom of choice across varying levels of risk could justify individuals' accountability for their financial decisions, thus obviating the necessity for governments to employ taxpayer funds to cover deposit defaults surpassing the insured amounts. Additionally, it would simplify the process of restructuring unviable banks, as depositor protection would cease to be the primary concern for resolution authorities.³⁹

³⁸ See references in FN 26 seq.

³⁹ In detail on the simplification of such restructurings, Chiu and Hofmann, 49-55.

2. Better control over bank runs

The ECB's plans to cap individual holdings of a digital euro depict the easy convertibility of bank money into CBDC as a threat to the funding model of banks and therefore a potential financial stability risk.⁴⁰ This chapter does not dispute the ECB's starting point that banks would experience large outflows of liquidity in a banking crisis, the reason being that bank runs are an unsurprising occurrence during crisis times. The existence of CBDC would not change that fact. On the contrary, at first glance, a bank run scenario would appear more concerning in terms of its potential impact on financial stability.

First, the scale of a run would likely increase with the existence of a digital euro.⁴¹ The transition to CBDC would completely eliminate the exposure to default risk for depositors who opt to convert their bank money into CBDC. In contrast, a run from one bank to another in a banking crisis does not necessarily help depositors. Historical instances demonstrated that numerous less-informed depositors opted to remain with their banks,⁴² either due to a lack of perceived alternatives or reliance on deposit insurance and regulatory interventions. This dynamic could shift with the presence of a digital euro. Smaller banks in particular could face more significant liquidity outflows during bank runs when compared to situations where the option of converting into CBDC is not available.

Secondly, runs would likely unfold much more rapidly with CBDC in place. Instead of spending time searching for information about the financial health of particular banks, and instead of engaging in multiple transfers between banks based on news updates and rumours, depositors could be expected to swiftly convert their bank money into CBDC and retain them until they perceive the crisis to be resolved.

However, we argue that neither the magnitude nor the swiftness of depositors' moves into CBDC necessarily means that financial stability risks increase. For the Eurosystem, rapid mass moves into digital euros would come with the advantage of instantaneous clarity about the scale of banks' liquidity needs. In a matter of days, central banks could ascertain which banks need which levels of liquidity support. This expeditious understanding would enable swift determi-

⁴⁰ For a more neutral assessment of the effect of a digital euro on depositor runs, Brunnermeier and Landau, 27 seq. The authors do not expect the introduction of a digital euro to make a big difference for bank runs and overall take a "benign" view on the matter, but ultimately recommend that central banks rely on caps as a possible run mitigation solution, *ibid.* Box 5.

⁴¹ In general terms on this issue, Brunnermeier and Landau, Box 7.

⁴² Avgouleas and Goodhart, 16.

nations regarding the extent of impromptu liquidity programs to be enacted. Similarly, the competent supervisory and resolution authorities would likely have the relevant data forming the basis for their viability assessments sooner than in current run scenarios, in which liquidity shifts among financial institutions are likely to continue until depositors believe that the crisis is resolved. That would allow them to take resolution actions sooner than currently. Unviable banks could promptly be restructured, and viable banks robustly supported with central bank liquidity.

This liquidity support from central banks would remain necessary since, in this regard, CBDC would not prompt any change. To prevent a bank collapse resulting from the liquidity drainage experienced during a bank run, central banks customarily provide liquidity support to the banking sector or individual banks, as was the case following the March 2023 collapses of SVB and Signature Bank.⁴³ In instances of abrupt and severe liquidity shortages within the banking sector, central banks react with special lending programmes that provide solvent banks with extra liquidity in exchange for adequate collateral, frequently taking the form of repurchase agreements (repo transactions). Furthermore, Lending of Last Resort (referred to as Emergency Liquidity Assistance in the euro area) allows central banks to provide assistance to specific banks that, despite their solvency, are unable to access regular sources of liquidity.⁴⁴ Such liquidity support for the banking sector substantially increases the central banks' balance sheets.⁴⁵ However, during a financial crisis, balance sheet expansions are common and generally considered acceptable as long as these expansions are expected to aid in resolving the fundamental problems of the crisis and are reversible once the financial sector recuperates from the shock. Given the scale and speed of conversions predicted here, a digital euro would likely require the Eurosystem central banks to intervene more forcefully in liquidity markets, at least for as long as systemically important banks exist and are affected by liquidity shortages.

Nevertheless, it could be anticipated that these liquidity support programmes would conclude earlier if a digital euro were in use. This is because runs could be more easily reversed with the presence of a digital euro. The existence of a digital euro during runs should help retain liquidity within the euro area.

⁴³ See above FN 26 for the Federal Reserve System's lending facility.

⁴⁴ For the principles governing the provision of Lending of Last Resort by central banks, see Tumpel-Gugerell, 513-525; Hofmann, 'Reconsidering Lending of Last Resort', 898-916.

⁴⁵ Brunnermeier and Landau, 31.

Cross-border runs are particularly feasible in the euro area due to the single currency and the efficient, secure, and cost-effective transfer options enabled by the rules and technologies of the Single Euro Payments Area (SEPA).⁴⁶

However, with all Eurosystem central banks offering the unlimited option to convert bank money to digital euros, cross-border transfers and flights into other currencies (as witnessed during the Global Financial Crisis)⁴⁷ would not only become unnecessary but even counterproductive. This is because a digital euro could be perceived as a robust contender among global currencies, making it one of the securest choices for store of value on a global scale. With funds securely remaining in digital euro accounts provided by the local financial sector of depositors' respective jurisdictions, runs could be quickly and easily reversed. As quickly as depositors would reconvert their digital euros in bank money when confidence in the banking system is restored, central banks could withdraw their liquidity support.

In conclusion, the introduction of a digital euro could likely grant euro area authorities, including bank supervisors, resolution authorities, finance ministers, and central banks, more effective control during periods of market turmoil. If one embraces the theory posited here that the freedom to choose how to securely and adequately store financial resources justifies reduced levels of depositor protection, then the emphasis of these authorities' rescue efforts would no longer necessitate prioritising retail depositor safeguarding. Given that depositors would enjoy unrestricted access to CBDC, the rationale for holding these depositors accountable for their informed and independent financial decisions becomes apparent. Depositor protection would consequently be confined to the coverage offered by deposit insurance schemes (e.g., a payout of up to EUR 100,000 in the euro area). Liberated from the concerns of depositor protection due to the presence of a digital euro – an infallible alternative to bank money for both secure store of value and cashless payment transactions – resolution authorities and central banks could fully focus on addressing matters in the interest of financial stability.⁴⁸

⁴⁶ For information on SEPA, see at <<https://www.ecb.europa.eu/paym/integration/retail/sepa/html/index.en.html>>.

⁴⁷ On the cross-border liquidity flows during the Eurozone sovereign debt crisis, see Hofmann, 'Digital Euro: An assessment of the first two progress reports', box 6.

⁴⁸ Ultimately, many regulatory mechanisms could be due for review because of the much-reduced need for retail depositor protection. For a detailed analysis of the effect that a digital euro could have on bank regulation in the euro-area, see Chiu and Hofmann.

3. Reducing the allure of cryptocurrencies and stablecoins

A digital euro would also be an effective response to the rising attraction stemming from cryptocurrencies and stablecoins. It has long been discussed whether digital tokens based on crypto technology might be perceived by depositors as an alternative to bank money, especially during banking crises.⁴⁹ The temporary surge in Bitcoin's price in reaction to the collapse of SVB⁵⁰ indicates that a run from bank deposits into digital tokens is not beyond the realm of possibility for depositors that are dissatisfied with the existing monetary landscape that only offers them the option of moving money from one bank to another, not knowing whether this means going from bad to worse. However, these tokens are questionable havens for store of value. Their dangers lie in the complexity and high risk of substantial losses which are often misunderstood and underestimated by retail investors and make them highly unsuitable as "money-alternatives".⁵¹ The existence of a digital euro would provide security-focused depositors a perfect alternative to bank money and reduce (if not eliminate) the attraction of cryptocurrencies and stablecoins as supposedly safer store of value options in bank crisis scenarios, provided that the ECB abandons its intentions to limit the holdings of digital euros to cash-like levels.⁵²

IV. Capping CBDC holdings: (legal) feasibility

Whether caps are practically and legally feasible is another issue stemming from the plans of central banks like the ECB. In practical terms, the overflow/waterfall solution proposed by the ECB would ensure that no single account or wallet could hold more than the predetermined maximum allowed amount.⁵³ Any credit exceeding this cap would be converted into commercial bank money and then credited to the payee's commercial bank account.

⁴⁹ Awrey and van Zwieten, 779; Grünewald et al., 1029; Nabilou and Prüm, 12-15; Brunnermeier and Landau, Box 7.

⁵⁰ Kharpal.

⁵¹ The story of the algorithmic stablecoin TerraUSD bears witness of the complexity and risks, see Bank for International Settlements, 'BIS Annual Economic Report', 78-79 and 82 (Box A). In general terms on the risks, see Arner et al.

⁵² In more detail on this argument that caps on CBDC holdings defeat their purpose as weapons against the rise of cryptocurrencies and stablecoins, Hofmann, 'Which markets need Central Bank Digital Currency?.'

⁵³ This waterfall concept was embraced by other central banks, see Monetary Authority of Singapore, 43.

However, there is the question of whether caps would essentially function as transfer restrictions and if such restrictions would hold legal validity. From the standpoint of property law, transfer restrictions that extend beyond the contractual agreement between the seller and the immediate buyer are generally unenforceable. The Common Law might recognise CBDC as a form of property, in line with recent judgments that establish the property status of digital tokens like cryptocurrencies and non-fungible tokens (NFTs).⁵⁴ However, the Common Law does not acknowledge transfer restrictions that are tied to the title of chattel in a manner that would obstruct title transfers between the re-seller, who is bound by contractual terms established between her and the original seller, and the subsequent acquirer.⁵⁵

As a result, transfer restrictions *in rem* are *ex lege* non-existent. This implies that ownership transfers of CBDC would still be valid even if central banks compelled all CBDC holders to agree to terms that prohibit transferring ownership to individuals who, after the transaction, would hold more CBDC than the prescribed maximum limit. Attempts to hold CBDC holders liable on the basis of such contractual terms would also likely be unsuccessful because CBDC transferors would often be unaware whether their transactions would result in CBDC holdings surpassing the central bank's prescribed caps. Consequently, it is reasonable to assume that courts would invalidate such provisions in standard terms under the principles of the EU unfair terms directive.⁵⁶

In civil law systems, the result would ultimately be identical, albeit grounded in slightly different rationales. Taking German law as an illustrative example of the civil law perspective, it is important to note that it does not recognise intangible property rights. This is because ownership is exclusively associated with tangible items.⁵⁷ Without legislative changes that would expand the *numerus clausus* of property rights to include a new category of ownership

⁵⁴ Strongly pointing in this direction the recent decisions Singapore International Commercial Court SICC of 14 March 2019 B2C2 Ltd v Quoine Pte Ltd, [2019] SGHC(I) 03 (B2C2 v Quoine); Singapore Court of Appeal SGCA of 24 Feb 2020 Quoine Pte Ltd v B2C2 Ltd [2020] SGCA(I) 02 (Quoine v B2C2); Singapore High Court SGHC of 4 March 2022 CLM v CLN and others [2022] SGHC 46 (CLM v CLN).

⁵⁵ In detail on this point for digital tokens in general, Gleeson, 'Mann on Cryptocurrency', at VII.

⁵⁶ Council Directive 93/13/EEC of 5 April 1993 on unfair terms in consumer contracts, OJ L 95 of 21 April 1993, p. 29–34.

⁵⁷ Civil Code (Bürgerliches Gesetzbuch) §§ 929, 90. An exception for intellectual property exists insofar as intellectual property rights are protected by the law of delict, but they are nevertheless no rights *in rem* and therefore not subject to the law of property. For an English version of the German Civil Code, see at <https://www.gesetze-im-internet.de/englisch_bgb/>. See also Birne et al., 5.

rights,⁵⁸ CBDC would be treated as claims and transferred through assignment.⁵⁹ Assignment restrictions are valid under German law,⁶⁰ but it is important to note that capping CBDC holdings would by itself not constitute an assignment restriction. Instead, central banks would need to explicitly forbid in their user agreements any CBDC transfers in cases where the recipient's holdings would surpass the prescribed caps. In principle, this prohibition would prevent an effective assignment of CBDC from the transferor to the transferee. However, the same considerations as mentioned earlier apply to these cases. Given that transferors would generally lack awareness of the recipient's volume of CBDC holdings and would have limited means to acquire such information, it is highly likely that courts would deem such terms unfair and invalidate them.⁶¹

Transfer restrictions based on holding caps would also prove unenforceable. If only transactions resulting in holdings below the permitted thresholds were deemed valid assignments of the underlying claims against central banks but CBDC movements from account to account were technically possible nevertheless, CBDC could move between accounts without concurrent transfers of the underlying claims against the issuing central bank. Consequently, the outcome of CBDC transfers regarding the extinguishment of debt and therefore the achievement of payment finality would become uncertain. In essence, CBDC subject to transfer restrictions would introduce legal ambiguities that would render them unsuitable as mediums of payment and, consequently, unsuitable as a form of currency altogether.

These findings prompt the discussion to shift towards the technical considerations. In order for holding caps to be effective, central banks would need to depend exclusively on their overflow/waterfall mechanisms. To eliminate the aforementioned uncertainties, any CBDC transfers must lead to the finality of payment and result in an increment in the payee's holdings of CBDC or commercial bank money. Central banks could achieve these outcomes only by maintaining comprehensive control over all CBDC movements. However, central banks have not yet clarified how they intend to prevent individuals or legal entities from opening multiple CBDC storage facilities. If CBDC could be

⁵⁸ Potentially along the lines of the newly introduced rules for the registration and transfer of electronic securities in the German Electronic Securities Act (eWpG). On the latter, see Birne et al., 5.

⁵⁹ Civil Code (Bürgerliches Gesetzbuch) §§ 413, 398.

⁶⁰ Civil Code (Bürgerliches Gesetzbuch) § 400.

⁶¹ In the meaning of Directive 93/13/EEC, art. 3(1).

stored anonymously—an idea being discussed for a digital euro but unlikely to be implemented due to concerns about illicit activities⁶²—it would seemingly become impossible to prevent the circumvention of holding caps.

For personalised accounts, a straightforward solution would be if central banks themselves provided all accounts. However, since central banks have announced plans to delegate account-providing services to financial intermediaries,⁶³ such a centralised approach to CBDC account services seems unrealistic. With account services offered by multiple private intermediaries, adhering to the caps and waterfall mechanisms would necessitate real-time data exchanges among all account providers and the central bank, especially if individuals could open CBDC accounts with two or more account service providers. Once the aggregated CBDC amounts across all accounts reached the cap, all accounts would need to simultaneously enter waterfall mode until the aggregated amounts fell below the cap again. The plans of central banks to involve intermediaries in providing accounts and wallets could therefore not include reliance on their data storage and payment approval mechanisms. All data pertaining to CBDC holdings and transfers would need to be centrally stored in the servers of the central banks, and all transfer requests would require centralised approval by the central banks.

Alternatively, central banks could attempt to prevent individuals from opening multiple accounts, but this approach would also demand complex organisational efforts and likely result in significant delays in account openings. Each application would need to be cross verified against the existence of prior accounts for the same beneficiary. Furthermore, even the most stringent and advanced system might still be unable to completely prevent individuals from exploiting the separate legal personality of legal entities for circumventing these restrictions.

This is not the appropriate context to evaluate whether such a model would be technically feasible or if distributed ledger technology could offer a resolution to the predicament that follows from the necessity for intricate and costly centralised data storage and transaction authorisation. It is sufficient to note that the intentions to implement holding caps for CBDC trigger an array of subsequent inquiries that central banks have yet to address. Central banks must exercise caution to ensure that their CBDC designs do not run counter

⁶² ECB, 'Progress on the investigation phase of a digital euro', 6 seqq. (at 2.2).

⁶³ ECB, 'Progress on the investigation phase of a digital euro - second report', 5 seq. (at 1.1); ECB, 'Digital euro experimentation scope and key learnings', 8; ECB, 'Report on a digital euro' (n 6), 25; Bindseil, 4.

to the fundamental purpose behind introducing CBDC—enhancing the convenience of using central bank money and elevating its competitiveness relative to other store of value and payment options.

V. Digital euro as a facilitator of monetary policy

Beyond its contributions to financial stability, CBDC holds the potential to enhance central banks' effectiveness in conducting monetary policy operations. Particularly during periods of expansive monetary policy, when central banks reduce interest rates to levels near zero, banks cease offering interest on demand and term deposits. Consequently, depositors are left with no option but to provide funds to commercial banks without compensation. In the absence of CBDC, depositors lack an alternative to zero-interest bank money unless they are willing to assume the risks associated with investments (such as money market funds, other investment funds, shares and bonds).

In times when central bank interest rates turn negative (as was witnessed in the euro area between 2014 and 2022),⁶⁴ the environment for depositors deteriorates further. Negative interest rates imply that central banks impose penalty rates on banks' excess reserves. Consequently, banks pass on these costs to depositors who find themselves with little recourse but to bear these penalties on their deposits (as was observed in Germany and some other countries within the euro area from 2014 to 2022). Depositors are compelled to remain with their banks if better safe store of value options and access to cashless payment systems are unavailable.⁶⁵ However, the introduction of a digital euro would provide depositors with the ability to shift their savings from bank accounts to digital euro accounts. This action would enable them to evade negative interest rates and simultaneously release banks from the burden of excess liquidity within their reserve accounts, for which they are subject to punitive interest payments to the central bank.

Central banks could exert control over these shifts between deposits and CBDC by implementing positive or negative interest rates on CBDC holdings. If transitions into CBDC were to clash with central banks' monetary policy ob-

⁶⁴ See the tables showing current and past interest rates of the Eurosystem at ECB, 'Key ECB Interest Rates', <https://www.ecb.europa.eu/stats/policy_and_exchange_rates/key_ecb_interest_rates/html/index.en.html>.

⁶⁵ For the implications of negative interest rates in general, Claeys, 15-22. In detail on the punitive interest rates charged by German and other euro-area banks until 2022, Chiu and Hofmann, 18-23.

jectives, potentially subverting their expansionary policy aims, central banks could introduce tiered interest rates for CBDC holdings, similar to the tiered interest rates applied to banks' reserve accounts.⁶⁶

For CBDC holdings exceeding specific thresholds, central banks could contemplate the implementation of negative interest rates as a means of discouragement, motivating affluent CBDC holders to channel their resources toward expenditure or investment. However, the utilisation of these discouraging interest rates should be limited to situations where they correspond with the central banks' monetary policy objectives, rather than during times of crisis when their purpose would be to avert an excessive shift of bank money towards CBDC.⁶⁷

During periods when central banks engage in contractionary monetary policy operations, often involving raising interest rates, similar negative outcomes can emerge for depositors. If an extended period of expansionary policy operations with low funding costs for banks precedes a phase of elevated central bank interest rates, banks will not be immediately burdened by higher financing expenses. The accumulation of substantial excess reserves during times of monetary easing obviates the need for them to rapidly acquire new and more expensive liquidity.

Once again, depositors are left to bear the unfavourable consequences. In the absence of a viable alternative, depositors remain with their banks, even though these banks persist in offering minimal to zero interest rates. This situation is presently observable in the euro area. For instance, German banks garner a 4.00% return on their excess reserves held with central banks,⁶⁸ yet several of them still extend no or minimal interest to depositors, while also imposing fees for account services. A study conducted in 2023, based on prior overnight bank deposit interest rates of 2.5%, revealed that *“while eurozone lenders can now earn 2.5 per cent by depositing liquidity overnight at the European Central Bank, German retail banks on average pay only 0.07 per cent in interest to retail depositors”*.⁶⁹

⁶⁶ Bindseil, 22-26.

⁶⁷ However, explicitly in favour of such tiering, Bindseil, 24: “The central bank would need to communicate clearly at an early stage that the remuneration of tier-two CBDC is not meant to be attractive, and may be made particularly unattractive in a crisis, as needed”.

⁶⁸ As of 20 September 2023. See the current rates for the Eurosystem's standing facilities at <https://www.ecb.europa.eu/mopo/implement/sf/html/index.en.html>.

⁶⁹ Storbeck. It should be noted that German banks do not hold reserves with the ECB, but with the Bundesbank as the competent national central bank of the Eurosystem.

While indications in mid-2023 suggest that the Eurosystem's policies are contributing to an increase in interest rates for retail deposits even in Germany,⁷⁰ the past practices of banks underscore the extent to which the Eurosystem relies on the banking industry to carry out its monetary policy objectives. Over an extended period, German depositors lacked significant incentive to save, as the interest rates on their savings remained notably low. This circumstance meant that the Eurosystem's policy of monetary tightening was not effectively translating into reduced consumer spending.

The introduction of a digital euro could enable the Eurosystem to directly target depositors by providing more attractive interest on CBDC compared to banks on commercial bank money deposits. This strategy would prompt banks to either raise interest rates on deposits, should they wish to retain depositors as one of their principal sources of liquidity, or confront the possibility of depositors shifting from bank money to digital euros due to the more appealing conditions offered by the latter option. This movement would effectively erode banks' excess reserves.

VI. Conclusions

In summary, the chapter advocates for the introduction of a digital euro that complements, rather than replaces, cash in the euro area. It underscores the central role of a digital euro as a viable store of value option for the public. The chapter argues that a digital euro can only fulfil this role if it genuinely serves as an alternative to bank money, particularly during periods of financial market instability, and if it surpasses the allure of cryptocurrencies and stablecoins as perceived safe havens of store of value.

Furthermore, the chapter advances the notion that achieving all of this hinges on ensuring the public's unrestricted access to a digital euro. In doing so, it challenges the ECB's presumption that unbounded access to a digital euro might destabilise the financial system. Instead, it proposes that such unimpeded access could serve to safeguard depositors, amplify central banks' control over liquidity provision to banks, and bolster the resolution endeavours of competent authorities. The chapter also posits that unlimited access to digital euros could potentially enhance the efficiency of certain monetary policy operations.

⁷⁰ Especially Direct Banks started raising their interest rates in mid-2023 in Germany whereas more traditional retail banks such as savings banks and cooperative banks kept their interest rates for deposits at close to 0%.

To implement a digital euro, a cap could be imposed to facilitate its phased introduction. This approach would allow banks to adapt to the new landscape of diverse and unrestricted store of value options available to the public. However, this cap should be removed after an initial phase, which could span two or three years.

The chapter posits that the introduction of a digital euro should occur either without any holding caps or should be guided by further research to determine the necessity of holding restrictions. A comprehensive analysis of the potential adverse consequences stemming from unrestrained access to a digital euro for all individuals, juxtaposed with an evaluation of whether these drawbacks would outweigh the benefits promised by an unrestricted digital euro version, is imperative to justify the imposition of holding caps.

Should this analysis ultimately advocate for holding caps—an outcome that, considering all the points raised in this chapter, seems improbable—it is recommended that the ECB delineates specific objectives that the Eurosystem aims to achieve with a digital euro featuring limited holdings of digital currency (e.g., a few thousand euros at any given time). Given that the Eurosystem's intent is not to supplant cash with a digital euro, the advantages stemming from such restricted access to digital euros are not evident. Its added value for store of value would be marginal, as it would not offer a safer alternative to bank money for amounts exceeding the cap. Consequently, it would lack the capability to rival the appeal of cryptocurrencies and stablecoins. While it could be positioned as an alternative to existing cashless payment systems, the current body of research on CBDCs does not indicate any deficiencies in the prevailing landscape of private payment services across the entirety or portions of the euro area.

Hence, the chapter reaches the conclusion that, based on the current standpoint, the pursuit of a digital euro can be deemed worthwhile only if the Eurosystem (ideally in combination, but at the very least in one of the following ways) is prepared to design it as an optimal secure store of value option for the public, recognises its potential in a banking crisis, and adopts it as a monetary policy instrument.

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A Macroeconomic Perspective on Retail CBDC and the Digital Euro

Dirk Niepelt*

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I. Introduction

The emergence of retail Central Bank Digital Currency (rCBDC) has sparked a global conversation about possible advantages and drawbacks. In the European Union these discussions center around the digital euro project of the European Central Bank (ECB).

Some commentators describe rCBDC as a solution in search of a problem. They argue that (at least in some countries) households have access to a variety of efficient private sector payment solutions and that it is far from clear whether rCBDC could improve on those. While this statement appears factually accurate, the argument can be misleading since the potential role of rCBDC transcends improvements in payment solutions for households. On the one hand rCBDC could benefit businesses in addition to households, an aspect I will not focus on here. On the other hand, and more importantly, rCBDC could play a useful role for citizens and taxpayers even if it were only marginally attractive from a consumer point of view. In the following, I would like to clarify this point.

* This note summarizes the author's presentation at the conference, drawing heavily on Niepelt (2022, 2023) without indicating individual quotations. The two papers contain detailed references.

II. Monetary Architecture

From a macroeconomic perspective the debate around rCBDC primarily concerns monetary architecture. Under the status quo this architecture has two tiers: Households transact using commercial bank deposits (in addition to cash) whereas banks pay each other with central bank money. A future architecture with rCBDC would have a single tier or be mixed, i.e., non-banks would digitally transact using (also) central bank liabilities rather than (solely) bank deposits. The key macroeconomic question then is: Which system – two-tier, single-tier or mixed – is best suited to efficiently provide liquidity to the economy?

On first sight, the contemporaneous two-tier system promises maximum efficiency. After all, private sector solutions often outperform public sector alternatives in terms of cost and quality. However, banks provide liquidity in an environment full of frictions and those frictions risk undermining efficiency. For example, bank money creation breeds fragility as a natural consequence of so-called “maturity transformation” and this fragility can cause bank-external social costs. Rescue operations by the central bank or the treasury to avoid bank failure in times of financial stress (specifically of “too-big-to-fail” institutions) can be costly for taxpayers whereas the private rents from bank money creation are collected by the banks, so that the “polluter-pay” principle is violated.

Furthermore, deposit markets in many economies suffer from high barriers to entry, resulting in a lack of competition. And fiscal and regulatory interventions to correct market failure in the banking sector cause collateral damage, e.g., due to distortions caused by the tax collections to fund the interventions. Taking these sources of inefficiency into account, the effective social costs of liquidity provision in the contemporaneous two-tier system may well be higher than in a single-tier or mixed system, even if a single-tier architecture creates its own problems such as giving more power to the central bank and thus enabling graver policy mistakes and more damaging political interference.

III. Fears of Bank Disintermediation, and Precautionary Measures

A common counter argument is that rCBDC adoption might give rise to “bank disintermediation” and that disintermediation in turn might undermine credit and growth. A good example of this logic is evident in a recent progress report

on the digital euro by the ECB.¹ The ECB notes that a digital euro held in large amounts could result in structural substitution of bank deposits. It further emphasizes that undesirable consequences of a digital euro should be minimized. From there, the ECB jumps to the conclusion that structural substitution of bank deposits is undesirable. The report also discusses instruments to address the purported substitution risk, namely “limit- and remuneration-based tools” to curb digital euro holdings as a form of investment.

Both the ECB’s conclusion and the derived policy implications appear premature. First, as discussed above, it is not obvious that structural substitution of bank deposits would be harmful. While certain groups benefit from a monetary architecture that heavily relies on bank deposits and while risk averse central banks hesitate to make any changes to it, taxpayers and other groups bear the costs. Leading economists have discussed the costs of bank money creation and proposed change. In the words of Andy Haldane on his last day in office at the Bank of England (June 2021): “On financial stability, a widely-used digital currency could change the topology of banking fundamentally. It could result in something akin to narrow banking, with safe, payments-based activities segregated from banks’ riskier credit-provision activities. In other words, the traditional model of banking familiar for over 800 years could be disrupted. While the focus of debate so far has been on the costs of this disruption, largely in the form of disintermediation of existing agents, there are significant potential benefits to be had too. Specifically, this could lead to a closer alignment of risk for those institutions, new and old, offering these services—narrow banking for payments (money backed by safe assets) and limited purpose banking for lending (risky assets backed by risky liabilities). This radically different topology, while not costless, would reduce at source the fragilities in the banking model that have been causing financial crises for over 800 years. Given the costs of those crises—large and rising—this is a benefit that needs to be weighed.”²

Second and related, universal banks in their current size and structure could in principle continue to operate without deposit finance, for banks can inter-mediate between savers and investors without creating liquidity. For example, depositors could swap all their deposits for rCBDC and central banks could pass the funds raised from rCBDC issuance through to banks, replacing the deposits on the liability side of bank balance sheets by central bank loans. Subject

¹ <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov220929.en.pdf>.

² Thirty years of hurt, never stopped me dreaming – speech by Andy Haldane, available at <<https://www.bankofengland.co.uk/speech/2021/june/andy-haldane-speech-at-the-institute-for-government-on-the-changes-in-monetary-policy>>.

to appropriate terms and conditions such pass-through funding would eliminate bank liquidity creation while at the same time fully insulating banks and their lending from the rCBDC-deposit substitution. The general point is that the central bank possesses instruments to ensure banks' ability and willingness to continue lending to the real economy following the rCBDC issuance. Of course, this does not imply that the central bank would actually choose to employ its instruments in such a way – it might rather try to improve outcomes relative to the status quo. Banks therefore face political risks from rCBDC issuance.

Third, the ECB's "limit- and remuneration-based tools" might cause collateral damage. Restrictions on digital euro holdings such as a EUR 3,000 cap or negative interest rates on digital euro balances exceeding a particular threshold would likely reduce the demand for digital euros. After all, depositors in the euro zone currently benefit from deposit insurance protection up to amounts far higher than EUR 3,000; if this protection is credible, it is unclear why depositors would opt to exchange a small part of their savings into digital euros. Consequently, the "limit- and remuneration-based tools" might depress digital euro adoption and this would run counter to the objectives of the digital euro project.

Fourth, caps on digital euro holdings would also have undesirable consequences for monetary stability. They would imply that constrained users who have reached the threshold but wish to hold a larger quantity value a digital euro more highly than a bank deposit although officially, and in trades of unconstrained users, deposits and digital euros trade at par. (Similar situations arise when countries declare official exchange rates that deviate from fundamental values.) Shadow exchange rates different from unity would create incentives to circumvent the cap and might unleash other destabilising forces. They would run counter to the ECB's explicit objective of providing a solid monetary anchor.

Finally, curbing the digital euro's use as a form of investment would be difficult to reconcile with the Euro system's cash strategy of ensuring the availability of banknotes as payment instruments and store of value. The ECB would struggle to convincingly explain to the public the disparity between accepting physical forms of public money as stores of value and rejecting digital ones. A perceived lack of consistency could affect the credibility of the Euro system's cash strategy.

IV. Concluding Thoughts

Summarizing the discussion so far, rCBDC opens the possibility to rethink the monetary architecture, and the common argument according to which rCBDC use would have to be curbed to minimize harmful bank disintermediation is not convincing. Let me conclude with a couple of additional observations. First, from user, financial stability, and government finances perspectives it is key whether rCBDC pays interest; an interest rate of zero is almost surely not the optimal one as monetary theory robustly suggests. Second, the implications of rCBDC depend significantly on the central bank's investment strategy for the funds obtained through rCBDC issuance. Proposals range from injection by transfer in the spirit of the Swiss so-called "Vollgeld" initiative to injection by open market operations exclusively in exchange for government bonds. In either case the introduction of rCBDC would likely expand the central bank's balance sheet and this could increase political pressure and reduce effective central bank independence. The political economy repercussions of rCBDC might be more substantial than the macroeconomic ones. Finally, the decision about the introduction of rCBDC should not be taken by a central bank. It is a political decision since the repercussions far exceed the central bank's mandate. Consider the ECB, whose core competences include monetary policy, foreign-exchange operations, reserves management, and the promotion of payment systems.³ They do not include Europe's strategic autonomy, competition policy, or protection of bank business models, which are or relate to some of the ECB's digital euro motivations and considerations. Since the issuance of rCBDC transcends the domains of monetary and financial stability as well as payments, responsibility for its introduction and its implications for the national and international monetary architecture should lie with parliaments. Central banks in countries such as Canada or Sweden, which are thought leaders in rCBDC discussions, recognize and acknowledge this.

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³ Art. 127 TFEU.

Part II:
Central Banking Perspectives

Central Bank Digital Currencies: Central Bank Money reaches a new frontier*

Chiara Zilioli**

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Introductory remarks

This chapter deals with the legal aspects of central bank digital currencies (hereafter “**CBDC**”), with a specific focus on the digital euro project, currently under assessment by the Eurosystem. Part I of this chapter discusses the objectives of the introduction of the digital euro, its definition, and the project’s state of play, both from the perspective of the Eurosystem and of the European Union (hereafter “EU”) co-legislators. Part II provides an overview of the key legal aspects of the digital euro, covering, *inter alia*, the legal basis for its introduction under EU primary law, its legal tender status, its legal nature, and issues related to data protection and anti-money laundering and countering the financing of terrorism rules (hereafter “**AML/CFT**”), as well as certain competition law considerations. Part III looks at the possible design options and the interoperability of the digital euro with other potential CBDCs. Part IV concerns the potential impact of the digital euro on monetary policy and financial stability, as well as the role supervised intermediaries can play in the distribution of the digital euro. Finally, Part V concludes with some parting thoughts and outlines the envisaged way forward for the project.

I. Digital euro – Why, When, What?

As highlighted in its website, the European Central Bank (ECB) “is working with the national central banks of the euro area to investigate whether to introduce a digital euro. It would be a central bank digital currency, an electronic equivalent to cash. And it would complement banknotes and coins, giving people an additional choice about how to pay”¹. The digital euro is framed as “an anchor of stability for our money in the digital age”. According to comments by ECB President Christine Lagarde, already in 2019: “[m]y personal conviction is that given the developments we are seeing, not so much in the bitcoin segment but in the stablecoin projects, we’d better be ahead of the curve if that [i.e. the digital euro] happens. Because there is clearly a demand out there that we have to respond to”².

¹ ECB, Digital euro website: <https://www.ecb.europa.eu/paym/digital_euro/html/index.en.html> .

² Press release of the ECB of 12 December 2019, <<https://www.ecb.europa.eu/press/press-conf/2019/html/ecb.is191212-c9e1a6ab3e.en.html>> .

1. WHY?

There are multiple reasons for launching a central bank digital currency in the euro area.

First, because this would respond to the need to guarantee the provision of central bank money to the public, in a digital era. Currently, such function is performed by cash (banknotes and coins), which is the only form of money issued by public entities³ available to the public. However, this scenario might change in a society with an increasing demand for safe and trusted electronic payments, whereas the cash demand is declining⁴. The issuance of a digital form of money by the central bank would provide an anchor of stability for the payment and monetary system. The “monetary anchor function” relates to the function carried out by central banks in a two-tiered monetary system, in which both private money and central bank money co-exist. Private money is money issued by private entities in their books, as their liabilities. Their value is based on the promise of convertibility at par with public money, issued by the monetary authority. Central bank money, on the other hand, is money issued by the central bank as liability on its balance sheet and guaranteed by the sovereign (State or, in the case of the euro, the ECB). This is the foundation of its credibility, authority, and sovereignty. Central banks, by being the sole issuer of central bank money, retain the role of *monetary anchors* in any given society.

However, in a digitally developed society, this role may be impaired by two factors. The first one is the tendency emerged particularly in the midst and the aftermath of the covid pandemic, to pay more and more using digital payments and to buy goods online. The second one is the surge of the use of dig-

³ See Article 128 TFEU: “1. The European Central Bank shall have the exclusive right to authorise the issue of euro banknotes within the Union. The European Central Bank and the national central banks may issue such notes. The banknotes issued by the European Central Bank and the national central banks shall be the only such notes to have the status of legal tender within the Union. 2. Member States may issue euro coins subject to approval by the European Central Bank of the volume of the issue. The Council, on a proposal from the Commission and after consulting the European Parliament and the European Central Bank, may adopt measures to harmonise the denominations and technical specifications of all coins intended for circulation to the extent necessary to permit their smooth circulation within the Union.”

⁴ See ECB Study on Study on the payment attitudes of consumers in the euro area (SPACE) (2022), where it emerged that “in terms of value of payments, cards (46%) accounted for a higher share of transactions than cash payments (42%). This contrasts with 2016 and 2019, when the share of cash transactions was higher than the share of card transactions (54% compared to 39% in 2016 and 47% compared to 43% in 2019)”: <https://www.ecb.europa.eu/stats/ecb_surveys/space/html/ecb.spacereport202212-783ffdf46e.en.html>.

ital assets as means of payment and/or as a unit of account (e.g., should on-line goods be denominated in digital currencies). In such a digital society, the central bank's role of the monetary anchor can be preserved by introducing a digital evolution of central bank money available to the public in a digital form.

Second, the digital euro would also protect and promote the EU's strategic autonomy avoiding market dominance of extra-EU private providers in the field of digital payments. The European retail payment market currently lacks a European based and developed solution. The digital euro, issued by the ECB/Eurosystem, would provide for such a solution, contributing to the promotion of the EU objective of strategic autonomy, in a period of continuous geopolitical turmoil and instability.

Third, a digital euro would greatly support the EU's objective of digitalization of the European society and economy in the field of retail payments, in line with the Commission's EU Retail Payment Strategy, published in 2020⁵.

2. WHEN?

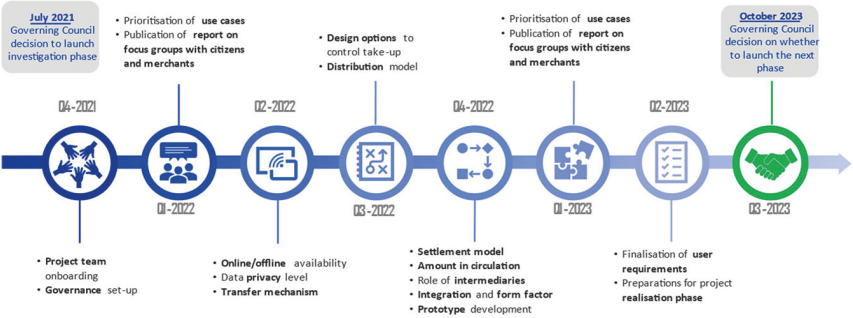
Turning to the state of play of the Eurosystem's digital euro project, the beginning of this 'journey' can be traced back to July 2021, when the Governing Council adopted a decision to launch the investigation phase on the digital euro. In Q4 of 2021 the project team and the governance structure were set up⁶. In Q1 of 2022 use cases were prioritised, and a report on focus groups with citizens and merchants was published⁷. In Q2 of 2022, the focus was on online and offline availability, the data privacy level and on the transfer mechanism for the digital euro. In Q3 of 2022, the focus shifted to design options to control take-up and the best suited distribution model. In Q4 2022, the settlement model, the amount in circulation, the role of intermediaries and prototype development were analysed. In Q1 of 2023, the compensation model was central to the discussion, as well as was the access to the digital euro ecosystem and assessing the results of prototyping. In Q2 of 2023 the finalisation of user requirements took place, and preparations for the project's realisation phase were undertaken. In Q3 of 2023, the drafting of the proposal for the de-

⁵ See Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of The Regions on a Retail Payments Strategy for the EU (2020): <<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0592>>.

⁶ For an account of the Digital euro governance, see <https://www.ecb.europa.eu/paym/digital_euro/governance/html/index.en.html>.

⁷ Kantar Public, Study on New Digital Payment Methods, (March 2022): <https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf>.

cision-making bodies to decide on whether to move to the next phase will be prepared. Finally, in the autumn of 2023, the Governing Council will decide on whether to proceed with the next phase of the project to develop and test technical solutions and business arrangements⁸.



Regarding the legislative process for the digital euro, the Commission is set to publish a proposal for a digital euro regulation in June 2023⁹. Any ECB decision to issue the digital euro will need to comply with and be posterior to the entry into force of the legislative act regulating the use of the digital euro.

3. WHAT?

What is the digital euro and how can it be defined? In answering this question, one should also differentiate the digital euro from what a digital euro is not.

The digital euro can be defined as a digital form of central bank money, available to the public. It is a direct liability of the Eurosystem in digital form for retail payments initiated by citizens and businesses in the euro area. Turning to what a digital euro is not, one should immediately differentiate it from the wholesale form of central bank money, which may or may not use a decentralised ledger technology (DLT), and is available for the settlement of transactions between financial operators that have access, directly or indirectly, to the books of the central bank for the transmission of monetary policy¹⁰.

⁸ To check all the ECB publications on the digital euro, see <https://www.ecb.europa.eu/home/search/html/digital_euro.en.html>.
⁹ The Commission Proposal was published on 28 June 2023, after this speech was given, see fn. *
¹⁰ For an account of the exploratory work conducted by the Eurosystem on new technologies for wholesale central bank money settlement, see <<https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr230428-6a59f44e41.en.html>>.

Furthermore, the digital euro should also not be confused with the so-called synthetic CBDC, which has been defined as a digital asset issued by private-sector firms (i.e. not by a central bank) and backed by central bank liabilities¹¹.

II. Key legal aspects of the digital euro

The following analysis focuses on six key legal aspects of the digital euro: (1) the potential legal basis/es for the ECB/Eurosystem to issue a digital euro, and (2) for the EU legislator to regulate its use¹², (3) its legal tender status, (4) its legal nature, (5) issues related to data protection and AML/CFT, and (6) some competition law considerations.

1. Legal basis

The starting point of any legal discussion of the digital euro is centred around the legal basis/es for the ECB/Eurosystem to issue a digital euro and for the EU co-legislators to regulate its use, respectively.

Such legal basis/es are necessarily to be found under EU primary law. In fact, the principle of conferral, laid down in paragraphs 1 and 2 of Article 5 TEU, sets out that the Union shall act only within the limits of the competences conferred upon it by the Member States in the Treaties to attain the objectives set out therein. Competences not conferred upon the Union in the Treaties remain with the Member States.

This principle also applies to the ECB/Eurosystem's competences to act, which are attributed by primary law (Treaties/ESCB/ECB Statute). Therefore, there is a need for a robust legal basis under EU primary law to underpin any action of the ECB/Eurosystem in relation to the digital euro. Such legal basis/es is inherently dependent on the choices of a specific design and pursued objectives of the digital euro.

Depending on the objectives primarily pursued by a digital euro, three potential legal bases for the issuance of the digital euro by the ECB/Eurosystem can be identified. The first is Art. 128(1) TFEU/Art. 16 ESCB/ECB Statute, if the digital euro is essentially a means of payment, i.e., a digital equivalent of banknotes. The second one is Art. 127(2) first indent TFEU/Art. 17 ESCB/ECB Statute, relating to the monetary policy mandate, if the digital euro is used as a monetary policy instrument. Finally, Art. 127(2) fourth indent TFEU/Art. 22

¹¹ A complete description of a synthetic CBDC is provided in Central bank digital currencies: foundational principles and core features, BIS (2020), p. 4 et seq.

¹² For many of the relevant considerations, see Grünewald, Zellweger-Gutknecht and Geva, 1029 et seq.

ESCB/ECB Statute can be considered, if its main function is to be used as a settlement medium. Each of these options are briefly analysed in the further section, while also mentioning the questions that remain open.

a) *Art. 128(1) TFEU/Art. 16 ESCB/ECB Statute*

Article 128(1) TFEU states that ‘The European Central Bank shall have the exclusive right to authorise the issue of euro banknotes within the Union. The European Central Bank and the national central banks may issue such notes. The banknotes issued by the European Central Bank and the national central banks shall be the only such notes to have the status of legal tender within the Union.’ Article 16 ESCB/ECB Statute stipulates that ‘In accordance with Article 128(1) of the TFEU, the Governing Council shall have the exclusive right to authorise the issue of euro banknotes within the Union. The ECB and the national central banks may issue such notes. The banknotes issued by the ECB and the national central banks shall be the only such notes to have the status of legal tender within the Union.’

These legal bases are supported if an analogy with euro banknotes, as form of central bank money currently provided to the public, is drawn. The digital euro could fulfil this function in a society where cash is declining, whereas the uptake of digital payments is rising. That said, such choice leaves open some questions that are to be addressed. First, what is the meaning of the term ‘banknote’ in Article 128(1) TFEU/ 16 ESCB/ECB Statute? Second, could this meaning possibly encompass a digital equivalent, or does it only cover the paper form?

b) *Art. 127(2) first indent TFEU/Art. 17 ESCB/ECB Statute*

Article 127(2) first indent TFEU states that “The basic tasks to be carried out through the ESCB shall be: (...) to define and implement the monetary policy of the Union”. Article 17 ESCB/ECB Statute stipulates that “In order to conduct their operations, the ECB and the national central banks may open accounts for credit institutions, public entities and other market participants and accept assets, including book entry securities, as collateral”.

Both articles concern the definition and implementation of monetary policy (*stricto sensu*), should the digital euro be construed as a monetary policy instrument and used to preserve price stability. However, the narrative of the digital euro has been so far predominant on its means of payment dimension, rather than as a monetary policy instrument. Furthermore, this choice also leaves open two questions. First, whether there is any potential contrast with

Art. 17 ESCB/ECB Statute, on account of the envisaged categories of users to the digital euro. Second, whether money can be legally remunerated, or be subject to negative remuneration, as an instrument of monetary policy.

c) *Art. 127(2) fourth indent TFEU/Art. 22 ESCB/ECB Statute*

Article 127(2) fourth indent TFEU states that “[t]he basic tasks to be carried out through the ESCB shall be: (...) to promote the smooth operation of payment systems.” Article 22 ESCB/ECB Statute stipulates that “[t]he ECB and national central banks may provide facilities, and the ECB may make regulations, to ensure efficient and sound clearing and payment systems within the Union and with other countries”.

These articles would be appropriate as legal bases for the digital euro, where the latter be considered solely as a settlement medium. However, would this function only be sufficient, since it is well-established that the functions of money are unit of account, means of payment and store of value¹³? In this respect, two major questions arise. First, if the digital euro is only a settlement medium (and not a store of value and a unit of account), can legal tender status be attributed to the digital euro? Second, can the term “*facilities*”, included in Article 22 ESCB/ECB Statute, cater for the provision of central bank money to the public? Or can it cover only the functioning of the infrastructure used for settling the transactions in digital euro?

d) *Cumulation of legal bases*

Ex ante, it is not totally clear whether the digital euro could (or should) be used for more than one purpose. Therefore, leaving aside each individual legal basis, it is important to ponder the quandary of cumulation of legal bases. When is the cumulation of legal bases permissible? What is the verdict of CJEU jurisprudence, and does it seem applicable to the digital euro?

The litmus test in this area of law is laid out in a watershed case of the early 1990s from the CJEU. More specifically, the CJEU¹⁴ upheld that if a measure/instrument simultaneously pursues several objectives or has several components, without one being incidental to the other, i.e., when all objectives/components of the measure are of equal importance, then a cumulation of legal

¹³ Mann on the Legal Aspect of Money, Proctor (2012).

¹⁴ CJEU, Decision of 22 May 1990 in Case C-70/88, ECLI:EU:C:1990:217 - European Parliament vs Council of the European Communities, para. 12.

bases can be supported. Therefore, if the digital euro pursues different objectives of equal importance, a cumulation of legal bases may be considered, in accordance with the CJEU's jurisprudence.

Still, certain questions linger. First, can the digital euro be legally construed as a digital version of banknote *and*, simultaneously, as a monetary policy instrument? Furthermore, could this evolve over time, with the instrument being used later for a broader purpose or will this legal qualification remain static?

2. EU co-legislators' competences to act

The principle of conferral applies also to the EU co-legislators' competences to act in this field (Art. 133 TFEU). This article stipulates that “[w]ithout prejudice to the powers of the European Central Bank, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall lay down the measures necessary for the use of the euro as the single currency”. The adoption by the co-legislators of measures to lay down the rules for the use of the digital euro before its potential issuance by the ECB falls squarely within the *regulatory dimension* of monetary policy to guarantee the status of the euro as the single currency, in accordance with relevant CJEU case law¹⁵. The Commission has already announced the publication of a Proposal for an EU Regulation on the use of a digital euro based on Article 133 TFEU¹⁶.

What will the scope of the future regulation be? This is the issue of the competence of the EU co-legislators to regulate the digital euro's legal tender status, as well as provisions related to data protection and AML/CFT.

3. Legal tender status

Attributing legal tender status to a given currency is a prerogative of the monetary authority (in the Treaty, for euro banknotes; in a secondary law act, for euro coins¹⁷), as part of its power under the established principle of *lex mone-*

¹⁵ CJEU, Decision of 26 January 2021 in Case C-422/19, ECLI:EU:C:2021:63 - Hessischer Rundfunk, para. 38.

¹⁶ The proposal has in the meantime been published, see *supra* fn. *. In addition, a legal act based on Article 114 TFEU is proposed to cover the provisions for PSPs operating in Member States whose currency is not the euro – also this proposal has been published.

¹⁷ The question is as to whether the legal tender attributed by secondary legislation is constitutive or declaratory, making explicit what comes implicitly from Art. 128 of the TFEU.

tae¹⁸. In the case of the digital euro, it is evident that legal tender will be considered a key and necessary feature for its recognition as digital form of the euro currency.

Yet, what is the definition of ‘legal tender’ under EU law? According to the Commission Recommendation of 22 March 2010 on the scope and effects of legal tender of euro banknotes and coins (2010/191/EU)¹⁹, there are three minimum elements qualifying the legal tender status. The first is *mandatory acceptance*, meaning that the “creditor of a payment obligation cannot refuse euro banknotes and coins unless the parties have agreed on other means of payment”²⁰. The second is *acceptance at full face value*. As the Recommendation states, the “monetary value of euro banknotes and coins is equal to the amount indicated on the banknotes and coins”. The third necessary element is the *power to discharge from payment obligations*, meaning that a “debtor can discharge himself from a payment obligation by tendering euro banknotes and coins to the creditor”.

However, it bears noting that the Commission’s Recommendation, as such, has no binding legal force. The CJEU’s case *Hessischer Rundfunk* has represented a further development on the notion of legal tender in the EU²¹. Moreover, the considerations included in the Commission’s Recommendation and in *Hessischer Rundfunk* relate solely to the legal tender status of cash, and not to a potential CBDC. Therefore, it is worth reflecting on whether the same concept of legal tender that applies to cash should also apply to the digital euro²² and whether the specificities of the digital euro (e.g., it needs a technological tool to channel the payments, such as a POS) should be considered. Answers to these questions are crucial to ascertain the legal tender status of the digital euro.

¹⁸ See Legal Aspects of Central Bank Digital Currency: Central Bank and Monetary Law Considerations, IMF (2020).

¹⁹ Commission Recommendation of 22 March 2010 on the scope and effects of legal tender of euro banknotes and coins (2010/191/EU) (OJ L 83 of 30 March 2010, 70-71).

²⁰ There can be good faith exceptions to this rule, yet it entails general application. The CJEU, in *Hessischer Rundfunk*, fn. 14, had stressed that “it cannot be considered necessary for the use of the euro as the single currency...to impose an absolute obligation to accept those banknotes as a means of payment”.

²¹ Judgment of the Court (Grand Chamber) of 26 January 2021, Joined Cases C-422/19 and C-423/19, paras. 41-51 and 61-63.

²² Grünewald, 13.

4. Legal nature of the digital euro

Given the novelty of this form of money, the question as to what the legal nature of a digital euro is and how it can be legally transferred between the different users is a very relevant one.

From the outset the legal nature of a digital euro will primarily depend on its design characteristics. It can be already safely assumed that the digital euro will be a direct liability of the Eurosystem; that it will be issued for an amount equal to the face value of the corresponding liability on the consolidated balance sheet of the Eurosystem; and that the end-users will need to establish a contractual relationship solely with the respective payment service providers (PSPs) for the use of the digital euro.

Against this backdrop, it is still to be analysed how the digital euro may be considered from a private law perspective and how it can be legally transferred. As already mentioned, this will mostly depend on its design. Admittedly, there are *three* design options for construing the digital euro: account-based, token-based, or a third new category (*tertium genus*), bearing characteristics of both previous options.

In an account-based digital euro, the key issues to take into consideration will be to analyse whether the end-user will have *rights in personam* and vis-à-vis which entity, yet bearing in mind that, under any circumstances, the digital euro is to be deemed as a liability of the central bank. Should the digital euro be construed as a token-based solution, it is to be carefully assessed whether it would fall under the civil law category of *incorporeal res*, giving rise to *rights in rem* to its users, and potentially being transferrable by possession and/or registration. Finally, it might be worth considering whether the digital euro should be deemed a *tertium genus* representing a central bank liability and giving rise to a monetary power to its users linked to its underlying value. Like banknotes today, this would entail the user's right to exchange damaged or torn units for their full-face value.

To avoid fragmentation across the euro area in the qualification of the legal nature of the digital euro and the rights of its holders, the EU co-legislators would need to clarify the legal effects of the digital euro under private law.

5. Issues related to Data protection and AML/CFT

Although a complete analysis of data protection and AML/CFT considerations related to the digital euro falls outside the scope of this chapter, few remarks are apposite. First, the digital euro will need to comply with the relevant EU

legislation on data protection²³ and AML/CFT (and its national implementation), i.e., most notably with GDPR²⁴ and the EUDPR²⁵, and with the Anti-Money Laundering Directive (AMLD)²⁶. That said, the legislative act on the digital euro may introduce specific provisions related to data protection and AML/CFT, which may be considered as *lex specialis*.

It is also worth noting that privacy and AML/CFT are identified as key concerns for the digital euro by the public, as emerged in public consultations²⁷ conducted by the ECB and the EU Commission. It can be assumed that the digital euro infrastructure must enable intermediaries to comply with their data protection and AML/CFT regulatory obligations. No obstacle should be created by such technical infrastructure that would impede or render more burdensome for the intermediaries to fulfil those regulatory obligations.

²³ The right to protection of personal data is a fundamental right, enshrines in the EU Charter of Fundamental Rights (Article 8 – Protection of personal data), available at <<http://fra.europa.eu/en/eu-charter/article/8-protection-personal-data>>.

²⁴ Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119 of 4 May 2016, pp. 1-88).

²⁵ Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC (OJ L 295, 21.11.2018, p. 39–98).

²⁶ Directive (EU) 2015/849 of the European Parliament and of the Council of 20 May 2015 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing, amending Regulation (EU) No 648/2012 of the European Parliament and of the Council, and repealing Directive 2005/60/EC of the European Parliament and of the Council and Commission Directive 2006/70/EC (OJ L 141 of 5 May 2015, pp. 73–117). 25 ECB, Eurosystem report on the public consultation on a digital euro (April 2021), <https://www.ecb.europa.eu/pub/pdf/other/Eurosystem_report_on_the_public_consultation_on_a_digital_euro-539fa8cd8d.en.pdf>. These concerns can also be identified in the EU Commission's 2022 targeted consultation: European Commission (2022), Consultation document – Targeted consultation on a digital euro: <https://finance.ec.europa.eu/regulation-and-supervision/consultations/finance-2022-digital-euro_en>.

²⁷ ECB, Eurosystem report on the public consultation on a digital euro (April 2021), <https://www.ecb.europa.eu/pub/pdf/other/Eurosystem_report_on_the_public_consultation_on_a_digital_euro-539fa8cd8d.en.pdf>. These concerns can also be spotted in the EU Commission's 2022 targeted consultation: European Commission (2022), Consultation document – Targeted consultation on a digital euro: <https://finance.ec.europa.eu/regulation-and-supervision/consultations/finance-2022-digital-euro_en>.

Finally, as signalled by the ECB in numerous occasions²⁸, it is highlighted that central banks are not interested in the use of personal data for commercial purposes. The two extremes are to be avoided: full anonymity and full transparency of personal data are not to be pursued. The former would preclude any possibility to perform checks in case of fraud prevention and on-boarding of new customers, whereas the latter would not guarantee the sufficient level of privacy requested by the end-users. Instead, limited data will need to be transparent to intermediaries, for customer onboarding and AML/CFT purposes, as is the case for electronic payments today.

6. Issues related to competition law

The final issue to be briefly examined in this Part II is whether the Eurosystem will be subject to the competition law related provisions (i.e., Articles 101-102 TFEU), under the Treaties.

In this regard, it is worth clarifying up-front that the pursued public tasks (ensuring availability of central bank money to the public, monetary policy *lato sensu*, promoting smooth operation of payment systems) are not to be considered ‘economic activities’²⁹, according to the established CJEU jurisprudence. It derives from the foregoing that the Eurosystem Central Banks, when pursuing such public tasks, should not be deemed ‘undertakings’³⁰. This is why the Eurosystem Central Banks are not subject to the specific obligations of Articles 101-102 TFEU (restrictive agreements and abuse of dominant position). Yet, this does not exempt the Eurosystem Central Banks from complying with the obligation to act in accordance with the principle of an ‘open market economy in free competition, favouring an efficient allocation of resources’, enshrined in Art. 127(1) TFEU, and with the general principles of competition law.

As a general remark, it is expected that the digital euro will not restrict competition in the ecosystem of retail payment markets. Instead, it may foster the competition between PSPs and between payment instruments, by allowing distribution of digital euro – in principle – to all PSPs (unless posing a major threat for the infrastructure).

²⁸ See, for instance, Digital euro privacy options, ECB (2023), <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov220404_privacy.en.pdf>.

²⁹ CJEU, Decision of 16 June 1987 in Case 118/85, ECLI:EU:C:1987:283 - Commission v Italy, para. 7.

³⁰ The CJEU has consistently defined undertakings as entities engaged in an economic activity, regardless of their legal status and the way in which they are financed. See inter alia CJEU, Decision of 10 January 2006 in Case C-222/04, ECLI:EU:C:2006:8 - Cassa di Risparmio di Firenze SpA and Others, para. 107.

III. Foundational design choices for the digital euro

The design and characteristics of the digital euro will have a substantial bearing on its legal qualification. For this reason, it is worth recalling the foundational design choices of the digital euro, as approved by the ECB Governing Council. Among these design choices, conditional payments (which differ from programmable money) and the potential interoperability with other CBDCs deserve particular attention.

1. Foundational design choices³¹

Regarding connectivity options, the main design choice is between online and offline. In particular, the ECB Governing Council approved that an offline functionality should be transferred peer-to-peer via secure hardware devices, with cash-like features. The online solution should instead be validated by a third party, to be able to perform the necessary AML/CFT checks, required by the relevant legislation. This option is closer to the current design of retail payment instruments, but solutions to increase its resilience to connectivity outages need to be further investigated. Another option that has been subject to investigation is the possibility to develop online payments transferred peer-to-peer, which would allow remote payments. However, this option would allow the relevant AML/CFT checks to be performed only at the time the device would go online to top up the relevant account/wallet. For this reason, this solution has been deemed too experimental and, for the time being, has been set aside.

As regards the fundamental privacy principles, in general respect for personal data is mandated, in accordance with the highest possible level of privacy. Intermediaries will need to see transaction data to comply with AML/CFT, except for lower value payment from these checks. From the Eurosystem's perspective, there would be a minimisation of personal data, to the extent possible, and privacy-enhancing techniques will be deployed.

Finally, in relation to limits to the use of the digital euro as a store of value, holding limits are considered necessary to avert the possibility that an excessive amount of commercial bank holdings is converted into digital euro. In addition, the 'waterfall' functionality would permit that a payment goes through even if exceeding the holding limit of the digital euro account. This functional-

³¹ See ECB first and second progress report: <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov220929.en.pdf> and <<https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews221221.en.html>>.

ity would ensure full applicability of the legal tender status of the digital euro. Finally, due to the inherent different characteristics and use cases, the limits for online and offline use will differ.

2. Conditional payments in digital euro

Another possible design feature being analysed for the digital euro is the possibility to allow for conditional payments. *Conditional payments* are defined as payments that are instructed automatically when pre-defined conditions are met³². These include recurring payments, pay-per-use scenarios, payment-vs-delivery, split payments, automatic reimbursement etc.

The concept of *conditional payment* should not be confused with *programmable money*. The latter means that limitations in terms of, *inter alia*, geographical scope, duration or payee's category may be applied to the digital euro, rendering it tantamount to a voucher. Such functionality would hinder the legal tender status of a given currency, which implies the compulsory acceptance at full face value, and its fungibility at par with other form of central bank money (banknotes and coins).

The ECB Governing Council has decided that the digital euro will *not* be programmable money, for the reasons explained above, and made it clear in various public documents (see speech by Mr Panetta³³ and first progress report³⁴).

3. Interoperability of the digital euro with other CBDCs

An additional design feature under analysis by the Eurosystem during the Investigation Phase is the possibility for the digital euro to be interoperable with other CBDCs (when and if they will be issued). Interoperability between CBDCs is a topic that is carefully studied by the Bank for International Settlements (BIS) and at international level (G7, G10) to strengthen cross-border payments.

³² For a definition of conditional payments, see ECB glossary, <https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.de-docs220420.en.pdf>.

³³ Speech by Mr Fabio Panetta of 23 January 2023, <<https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230123-2f8271ed76.en.html>>.

³⁴ ECB First Progress Report on the Digital Euro, <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov220929.en.pdf>. See also the most recent progress report by the ECB on the digital euro, which was published on April 24th 2023: ECB, Progress on the investigation phase of a digital euro – third report (April 2023), <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov230424_progress.en.pdf>.

In the context of the Eurosystem, some of the settlement infrastructure that the Eurosystem owns and operates are technically designed as *multicurrency* settlement services (for instance, T2S³⁵ and TIPS³⁶). However, although a project exploring the cross-currency potentiality of TIPS in the field of instant payments is currently on-going³⁷, no cross-currency settlement service in central bank money is available to date. The outcome of such project in TIPS could also potentially be beneficial for a cross-currency service among CBDCs.

Whilst interoperability is primarily defined as a technical and operational functionality, it also possesses a legal dimension³⁸. The legal issues concerning interoperability are not trivial. *First*, a legal architecture is to be designed, depending on the operational model and the relevant governance framework. It could be a multilateral agreement among the issuing central banks or a series of bilateral arrangements. *Second*, PSPs in different jurisdictions may be subject to different AML, data protection, and civil law provisions. This may need an additional provider (cross-currency PSP) that interposes itself in the transaction and clears the risk. *Third*, the definition of when a payment is final and irrevocable is fundamental to ensure legal certainty. This definition might be difficult to align in jurisdictions with different payment system regulations. Finally, liability regimes between central banks and payment providers in case of technical malfunction, negligence or fraud are to be clearly established as well as intellectual property rights and standards for the development of the underlying technology. The above mentioned are just some of the legal issues that will need to be properly explored in a multi-CBDCs ecosystem with cross-border payments in central bank money³⁹.

IV. Potential impact of the digital euro on monetary policy and financial stability

It is worth reflecting on the potential impact of the digital euro on monetary policy and financial stability. In accordance with its powers under the Treaties, the ECB will design the digital euro in a way which avoids undue risks to the smooth and efficient transmission of monetary policy and to the safeguard of the financial system. Should an excessive amount of commercial bank deposits

³⁵ See ECB Website, T2S goes multi-currency and expands with new participants (2018): <<https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews181029.en.html>>.

³⁶ See ECB Website, Sweden completes first phase of migration to TIPS (2022): <<https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews220523.en.html>>.

³⁷ See ECB Website, ECB to explore cross-currency instant payments (2020): <<https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews201006.en.html>>.

³⁸ On legal impediments to interoperability, see Papapaschalis, p. 121.

³⁹ Papapaschalis, pp. 117-126.

be shifted into digital euro holdings, negative effects on the resilience of the banking sector might materialise. These should be mitigated to avoid knock-on consequences for both the provision of credit to corporations and private individuals, and the resilience of the banking sector. In this regard, potential mitigants include primarily a holding cap per person (e.g., EUR 3,000) and the reliance on regulated entities in the distribution of the digital euro.

As regards the role of supervised intermediaries in the distribution, PSPs will play a key role in providing end-users with payment services in digital euro. More specifically, the Eurosystem is considering a payment scheme approach, with the ECB Governing Council or a dedicated body duly delegated as governing authority. The Scheme Rulebook would allow the establishment of a set of common rules, standards, and procedures to facilitate a homogenous and harmonised use of digital euro across the euro area. This approach would ensure pan-euro area reach and strive for innovation of supervised intermediaries in developing the added-value services.

Finally, in relation to the compensation model to be adopted, the ECB presented the following four core principles⁴⁰, to reflect the public good nature of the digital euro. First, basic use by private individuals should be free of charge. This is consistent with the cash context, where people can pay, receive money, and have access free of charge. Second, network effects will generate economic incentives for acquirers and merchants. PSPs offering digital euro acquiring services would be able to charge merchants for these services, in line with cash and other payment methods, where merchants also face costs. Third, there will be economic incentives for PSPs distributing digital euro comparable to the incentives for electronic payment alternatives. Finally, it is envisaged that the Eurosystem will bear its own costs, reflecting the public good nature of the digital euro, similarly to what currently applies to cash. PSPs will face their own costs related to the distribution of the digital euro services they provide, yet they would not be charged for costs incurred by the Eurosystem in the management of the payment scheme and settlement processing.

⁴⁰ For an account of the compensation model presented by the ECB, see the following presentation <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov230222_item4compensationmodel.en.pdf>.

V. The Way Forward

The digital euro is an exciting and challenging project, and a “significant novel element in the euro area central banking”⁴¹. Due to its novelty and complexity, many questions related to CBDCs and, in particular, the digital euro arise. While some of them have been settled throughout the advancement of the project, several are still outstanding. In October 2023, the Governing Council is expected to take a decision on whether to move to the next phase of the project. Should this be the case, some of the outstanding questions touched upon in this paper would need to be further analysed by the Eurosystem.

The moment to issue the digital euro will (or might) come later. The digital euro will have to fit in a world that will have further changed, especially with a view to digital payments and towards digitalisation. Its success will depend on the extent of its use. This, in turn, will depend on how far the unique nature of the digital euro, which is central bank money for all citizens with no risk of insolvency of the issuer and is accepted for payment in the whole euro area, will be understood and valued by the citizens over private digital payment instruments.

With the introduction of the digital euro, it is clear that a new frontier of central bank money will be crossed.

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⁴¹ Gortsos, section III.1.c.

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The Simple(r) Case for Wholesale Central Bank Digital Currency

Thomas Moser*

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I. Introduction

Central Banks around the globe are actively exploring Central Bank Digital Currency (CBDC), i.e., a digital representation (token) of a banknote or an account deposit at the central bank that can be issued using Distributed Ledger Technology (DLT).¹ A survey conducted by the Bank for International Settlements (BIS) in 2022 revealed that more than 90 percent of central banks were involved in some form of CBDC research or development. The survey further suggests that there are likely to be more than 20 CBDCs circulating in 2030.² The Bahamas and Nigeria have already issued a CBDC for the public in 2020 and 2021 respectively. Taking note of these advancements, in April 2023, the International Monetary Fund (IMF) announced the launch of a CBDC Handbook to engage with member countries on this topic.³

* I would like to thank Cyrille Planner and Andreas Wehrli for their comments and suggestions.

¹ Blockchain, introduced with the Bitcoin Whitepaper in 2008, is one type of DLT.

² Kosse and Mattei.

³ International Monetary Fund.

However, CBDC is not without controversy. For instance, the British magazine *The Economist* raised the following question in its December 5, 2020 issue: “Will central-bank digital currencies break the banking system?”. The article pointed out that CBDCs could become attractive safe assets that compete with traditional bank deposits. The concern is, though, that commercial banks might lose an important source of funding. Additionally, during times of banking stress, the convenience of transferring funds into CBDCs electronically compared to physically withdrawing and storing banknotes could make bank runs more likely and more frequent.

This concern, which is widely shared by central banks and international institutions such as the BIS and the IMF, does not receive unanimous support among economists. Some economists view the potential consequences as less problematic;⁴ others would welcome more competition for commercial bank deposits and the resulting reduction in scope for risk-taking by commercial banks.⁵ Alternatively, some propose technical measures to address the issue, such as implementing a cap on CBDC holdings or applying a significant interest rate discount on CBDC compared with commercial bank deposits.⁶

Another significant concern associated with CBDC is privacy, primarily due to the potential accumulation of sensitive data in the hands of central banks or governments, which could enable extensive state surveillance. Unlike cash payments made with banknotes that allow for anonymity, or digital payments through bank accounts that distribute data across various private banks and service providers, a CBDC would centralize data within a government-controlled database. However, here too, there are technical solutions available to address the issue, such as proven cryptographic techniques.⁷ But a challenge arises from regulatory requirements that restrict much of what would be technically feasible to balance privacy protection with the prevention of money laundering and illicit transactions.

It is worth pointing out that all the controversies mentioned above pertain specifically to CBDC accessible to the public. In the current system, access to digital central bank money – in the form of accounts at the central bank – is limited to regulated financial institutions. Therefore, a CBDC that is exclusively accessible to these already established financial institutions would be

⁴ See Brunnermeier and Niepelt.

⁵ Berentsen and Schär, 102; and Niepelt in this book.

⁶ See Bindseil (2020). Holding limits are also proposed for the digital euro, see, e.g., ECB, Progress on the investigation phase of a digitaleuro – third report, <https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.de-gov230424_progress.en.pdf>.

⁷ See Chaum, Grothoff, and Moser.

significantly less revolutionary and less controversial. Nevertheless, as this article attempts to show, such a CBDC would still be useful and foster innovation.

II. Central Bank and Private Money

In the existing monetary system (see Graph 1), the central bank issues two types of money: (i) physical banknotes which are accessible to the public and used for retail payments, and (ii) central bank deposits which represent digital central bank money available exclusively to regulated financial institutions, predominantly commercial banks. These banks use their central bank deposits to conduct payments between themselves, either on their own behalf or on behalf of their customers. When, for instance, bank A makes a payment to bank B, the actual transfer of funds – the settlement – occurs through the adjustment of balances on the central bank’s books. Specifically, the central bank deducts the respective amount from bank A’s account and credits it to bank B’s account.

The total amount of money issued by the central bank is also referred to as ‘base money.’ In the current monetary system, central bank money is irredeemable, meaning it cannot be exchanged for gold or any other asset at the central bank. Instead, the receipt of payment in central bank money constitutes a final settlement.

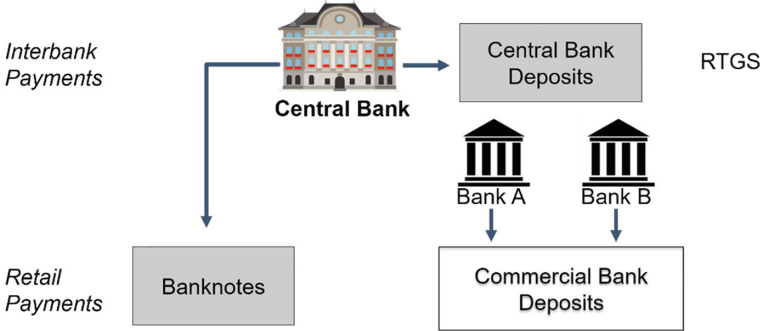
In the existing monetary system, digital money accessible to the public is issued by private institutions, primarily by commercial banks in the form of demand deposits. These deposits are redeemable in central bank money at par, allowing customers to withdraw physical banknotes or initiate transfers to third parties. Because of this redeemability, this form of money is also referred to as ‘derivative’ money, as its value is derived from the underlying base money.⁸ Redeemability at par ensures the so-called ‘uniformity’ or ‘singleness’ of money, i.e., that one unit of private money is equivalent in value to one unit of central bank money. However, one unit of private money differs from one unit of central bank money in its risk profile.

Privately issued money is a promise to pay base money, introducing counterparty risk for recipients of such money. This risk arises from the possibility that the issuer may be unable to fulfil their commitment to provide base

⁸ Bitcoin and similar cryptocurrencies do not fall in this category. They are not redeemable in central bank or commercial bank money and are denominated in their own currency unit. Consequently, their value fluctuates against fiat money units like the US dollar or the Swiss franc.

money due to insolvency or illiquidity. Consequently, during times of uncertainty about a bank’s solvency, customers tend to withdraw their deposits – a phenomenon referred to as ‘bank run’ when a large proportion of customers do so. While regulated banks offering commercial bank deposits enjoy some mitigation of this counterparty risk through public backstops such as deposit insurance and lender-of-last-resort support from the central bank, the risk is not entirely eliminated.

In contrast, central bank money carries no such counterparty risks. Consequently, bank customers often opt to convert their commercial bank balances into banknotes during a bank run, particularly in situations where a crisis affects the entire banking sector. This difference between central bank money and private money makes central bank money the preferred settlement asset in large-value (wholesale) payments.



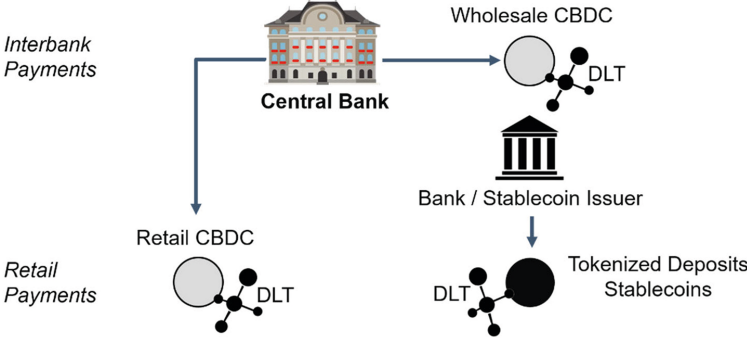
Graph 1. Existing Monetary System

While central bank deposits already represent a digital form of central bank money, the term CBDC typically refers to tokenized versions of central bank money. Such digital money tokens can be issued, stored, and transferred using a distributed ledger or Blockchain.⁹ Consequently, central banks have two options for issuing CBDCs: (i) tokenizing banknotes, i.e., issuing what is usually referred to as retail CBDC (rCBDC) available to the public, or (ii) tokenizing central bank deposits, i.e., issuing wholesale CBDC (wCBDC) which is exclusively available to regulated financial institutions with existing access to such accounts (see Graph 2).

⁹ Digital money tokens can also be issued, stored, and transferred without using DLT, see Chaum, Grothoff, and Moser.

Likewise, private entities can also issue token money. At present, it is mainly non-bank entities that issue tokenized money in the form of so-called stablecoins. Stablecoins exist in various forms but the most popular ones are so-called off-chain asset-backed stablecoins which are backed by commercial bank money and high-quality liquid assets (such as government bills).¹⁰ These stablecoins are redeemable at par for commercial bank money. For instance, 1 Tether (USDT), which is issued by Tether Limited, or 1 USD Coin (USDC) issued by Circle, are redeemable for 1 USD commercial bank money. This in turn attempts to ensure the ‘uniformity’ or ‘singleness’ of money underlying the peg.

It is natural for banks to consider tokenizing deposits, and indeed, banks are exploring this possibility.¹¹ In fact, banks have the option to choose between two models for deposit tokens.¹² On the one hand, tokenized deposits can be issued as stablecoins, thus functioning as digital bearer instruments with a transferable claim on the issuer. On the other hand, tokenized deposits could be issued as non-bearer instruments, where the transfer of the token would solely reassign a liability from one institution to another, and this transfer would be recorded at the individual bank level. Settlement, as with existing bank transfers, would take place in central bank money.



Graph 2. Tokenized Money System

¹⁰ Off-chain refers to the fact that the assets backing these stablecoins are not tokenized assets stored on a Blockchain, as it is the case with on-chain asset backed stablecoins, an example of which would be DAI.

¹¹ See, for instance, the Swiss Bankers Association’s (SBA) White Paper “The Deposit Token: New money for digital Switzerland” of March 14, 2023, or Citibank’s Regulated Liability Network (RNL).

¹² For the difference between stablecoins and tokenized deposits, see Garratt and Shin.

Like commercial bank deposits, tokenized bank deposits and stablecoins carry counterparty risk. In the case of stablecoins, this risk is significantly greater. Not only do non-bank stablecoin issuers lack the public backstops that regulated banks enjoy in the event of illiquidity or insolvency but there is also a risk that the institution where the underlying assets are held may become illiquid or insolvent. An illustrative example occurred in March 2023 when California banking regulators shut down Silicon Valley Bank, causing the USDC stablecoin to deviate from its peg to the USD when Circle, the issuer of USDC, revealed that it held a substantial amount of the commercial bank money backing USDC at Silicon Valley Bank.

One potential solution to address this issue is for the stablecoin issuer to hold the funds backing their stablecoin with a central bank, necessitating access to a central bank account. In Switzerland, for instance, SIX Digital Exchange (SDX) adopts this approach for its stablecoin, which is utilized for digital asset transaction settlements on SDX. This eliminates the risk associated with the entity holding the underlying asset facing illiquidity or insolvency, since a central bank can always pay in its own currency. However, the stablecoin issuer itself still carries the risk of becoming illiquid or insolvent. Only CBDC, as a direct liability of the central bank, eliminates the presence of counterparty risk.

The absence of credit, liquidity, and market risk in central bank money makes it the ideal settlement asset. As highlighted by Bindseil (2019), the original aim of the earliest central banks established in the seventeenth and eighteenth-century was precisely to improve the efficiency of the monetary system by offering an effective medium of exchange, especially for facilitating the settlement of trade and credit operations among merchants. In the present monetary system, central bank money is the only risk-free financial asset. Consequently, central banks and financial supervisory authorities generally recommend settlement in central bank money for systemically important payment and securities settlement systems.¹³

III. Do we need CBDC?

According to the BIS survey, the work of central banks on rCBDC is at a more advanced stage than the work on wCBDCs: almost a quarter of central banks are piloting rCBDC which is twice the share of central banks building or piloting wCBDC. As noted above, however, the controversies that revolve around CBDC primarily pertain to rCBDCs. In contrast, the case for a wCBDC appears

¹³ See Core principles for systemically important payment systems, BIS, January 2001, and Recommendations for securities settlement systems, BIS, November 2001.

to be relatively straightforward, as it would grant the same institutions as before access to digital central bank money. Moreover, the necessity for a secure settlement asset in DLT-based financial market infrastructure, should it become systemically important, is undisputed.

In Switzerland, where with SDX a DLT-based, regulated financial market infrastructure already exists, this is not merely a hypothetical consideration. The Swiss National Bank (SNB), together with the BIS Innovation Hub Swiss Center, have therefore extensively studied and tested the issuance of wCBDC, focusing on operational, legal, and policy aspects.¹⁴ Through these tests conducted in collaboration with five commercial banks and SDX, it has been demonstrated that a DLT-based system can be seamlessly integrated with traditional core banking systems, enabling end-to-end settlement of transactions using wCBDC. Additionally, these tests have confirmed the feasibility of issuing a wCBDC in accordance with existing Swiss law on a DLT platform operated and owned by a private sector company.

A wCBDC would also be useful if banks were to adopt a non-bearer instrument model for tokenized deposits, as explained earlier, where payments among commercial banks would be settled in central bank money. Having a wCBDC and the tokenized deposits available within the same shared ledger would allow commercial banks to instantly settle obligations between them on a 24/7 basis.¹⁵

Work on wCBDC has lately also picked up speed in the context the significant amount of work directed towards enhancing cross-border payment efficiency as part of a G20 Initiative.¹⁶ An example is the project 'Jura' where the SNB and Banque de France' tested the transfer of euro and Swiss franc wCBDC between French and Swiss commercial banks on a DLT platform. An innovative expansion of such cross-border transactions with wCBDC is the project 'Mariana', a collaboration between the SNB, Banque de France, and the Monetary Authority of Singapore. This project draws inspiration from decentralized finance (DeFi) innovations and employs an automated market maker for the exchange of the respective wCBDCs. The concept of automated market makers was introduced by decentralized exchanges, such as Uniswap and Curve.

¹⁴ See Project Helvetia: A multi-phase investigation on the settlement of tokenized assets in central bank money, <<https://www.bis.org/about/bisih/topics/cbdc/helvetia.htm>>.

¹⁵ See Garrat and Shin or the Proof of Concept Business Applicability Report, July 2023, of the Regulated Liability Network.

¹⁶ See G20 Roadmap for Enhancing Cross-border Payments, <<https://www.fsb.org/2023/02/g20-roadmap-for-enhancing-cross-border-payments-priority-actions-for-achieving-the-g20-targets/>>.

In summary, while the question of whether rCBDC is useful and whether its benefits outweigh the potential costs remains highly controversial, the use cases for wCBDC seem relatively straightforward.

IV. Different Models to settle tokenized assets in central bank money

While the payment system itself is not necessarily a clear use case for DLT, it is widely believed that DLT holds promise for the issuance, trading, and storage of digital assets. If this is the case, then there also needs to be a DLT-compatible settlement of money since assets are exchanged for money. The practical relevance of this question is particularly significant for Switzerland, given its position as the home state of the SIX Digital Exchange (SDX), the world’s first fully regulated DLT-based integrated financial market infrastructure for issuance, trading, settlement, and custody of tokenized assets.

Chart 3 gives a comprehensive overview of the various possible settlement models.¹⁷ Tokenized assets traded on DLT can be settled using either private money or central bank money (Row 1). Both private money and central bank money can exist in the form of deposits held in traditional bank accounts, namely commercial bank deposits and central bank deposits, or in the form of token money, such as private token money (i.e., tokenized deposits and stablecoins), or rCBDC and wCBDC issued by the central bank (Rows 2 and 3). Commercial bank deposits, private token money, and rCBDC would be accessible to the public, while wCBDC and central bank deposits would be available to regulated financial institutions, particularly commercial banks. Consequently, there are three models for settling tokenized assets traded on a DLT platform (last row):

Issuer	Private		Central Bank		
Form of money	Deposit	Token money			Deposit
	Commercial bank deposits	Private token money	Retail CBDC	Wholesale CBDC	Central bank deposits
User	General Public			Commercial banks	
Settlement model	Synchronised (Token vs. Deposit)	Integrated (Token vs. Token)		Synchronised (Token vs. Deposit)	

Graph 3. Different Settlement Models

¹⁷ The chart is taken from Maechler and Moser.

- 1) Synchronized settlement using commercial bank deposits: Tokenized assets can be settled using private money held in commercial bank deposits. This model would be suitable when retail traders have direct access to the digital exchange trading platform. In this scenario, since the settlement of digital assets (tokens) and money (deposits) would occur on separate platforms or ledgers, synchronization would be required through a link between the DLT platform and the platform(s) handling commercial bank deposits.
- 2) Integrated settlement using token money: Tokenized assets can be settled using token money deployed on the same DLT platform. This model enables fully integrated settlement, where tokens are exchanged for tokens within the same shared ledger. It offers various benefits and opportunities based on the functionalities of DLT, including atomicity and smart contracts.
 - a) The token money can be private token money. The current functioning of SDX serves as an example of this model in practice. Digital asset tokens issued and traded on the SDX DLT platform are settled using the SDX stablecoin which is issued by SDX on the same DLT platform.
 - b) The token money can also be CBDC issued by the central bank. If retail traders have direct access to the digital exchange, settling with rCBDC would be a possibility. However, if only regulated financial institutions have access, settlement would occur with wCBDC.
- 3) Synchronized settlement using central bank deposits: Tokenized assets can be settled using central bank money through the utilization of existing central bank deposits. Again, this requires a synchronization of securities and money settlement through a link between the DLT handling securities settlement and the platform handling central bank deposits.

V. Project Helvetia Phase III

At present, the precise role of DLT and tokenization in the future financial system remains uncertain. Furthermore, we are yet to determine the specific settlement models that will be sought after by private financial institutions. Therefore, the SNB is testing three models in productive payment and settlement infrastructures in the project 'Helvetia', Phase III: (i) private token money (corresponding to model 2a), (ii) wCBDC (model 2b), and (iii) central bank deposits (model 3). Consequently, 'Helvetia', Phase III consists of three distinct work streams.

1. Private token money protected under bankruptcy law

As mentioned above, digital assets issued and traded on SDX are presently settled using a stablecoin issued by SDX which qualifies as private token money. Private token money, in turn, like commercial bank deposits, carries the risk of insolvency or illiquidity on the part of the issuer. In other words, accepting such money exposes the recipient to counterparty credit risk. Unlike other stablecoins, however, the stablecoin issued by SDX is fully backed by central bank money held in an account at the SNB. This eliminates a significant risk factor, namely the potential default of the institution holding the assets backing the stablecoin. However, it does not eliminate the risk exposure to the private token issuer itself.

One possible solution to address this concern, without adopting a full-fledged CBDC, could be to subject private token money to the protection by bankruptcy law. Currently, the SNB is investigating how private token money, backed one-to-one by deposits at the SNB, can be legally structured to exhibit a comparable risk profile to central bank money in the event of bankruptcy of the token issuer.

2. wCBDC

In the case of CBDC, counterparty risk exposure for money token holders is fully eliminated, making central bank money the preferred settlement asset in large-value (wholesale) payments. The SNB has extensively examined both the technical and certain legal aspects of wCBDC issuance under the project 'Helvetia', Phase I.

Phase II expanded the scope of the project by adding commercial banks (Citi, Credit Suisse, Goldman Sachs, Hypothekarbank Lenzburg and UBS) and integrating wCBDC into both the SNB's core banking systems and the commercial banks' core banking systems. This integration allowed for end-to-end transactions where settlement instructions provided by the banks were matched and settled in wCBDC with finality on the SDX DLT platform and booked and reconciled in the respective core banking systems.

Moving forward to Phase III, the SNB plans to issue actual wCBDC on SDX for a limited period and carry out selected transactions with market participants in a real production environment. The beginning of these transactions is planned towards the end of 2023.

3. Link to central bank deposits

In the current set-up, the platforms operated or managed by central banks to settle interbank payments are called real-time gross settlement systems (RTGS). In the project 'Helvetia', Phase I, one of the Proof-of-Concepts conducted involved establishing a connection between the DLT securities settlement platform of SDX and the SNB's existing interbank RTGS payments system. The report concluded that one of the advantages of such an RTGS-link is that it requires only minor adjustments, making it straightforward from an operational, legal and policy perspective. However, a drawback is that this solution does not fully leverage the new functionalities offered by DLT and does not provide complete integration. Specifically, the current interbank payment platforms lack atomic settlement capabilities and the ability to execute smart contracts. As part of the project 'Helvetia', Phase III, the SNB is therefore exploring ways to mitigate these disadvantages by modifying either the RTGS platform or the link between the DLT and the RTGS.

VI. Conclusion

Within the current monetary system central bank money coexists with private money. For the public, however, money in digital form is only available from private issuers. Therefore, rCBDC would be a new form of money, competing with commercial bank deposits and private token money. On the other hand, wCBDC would merely provide banks with tokenized central bank deposits with few if any side effects.

If DLT can deliver the anticipated advantages as advocated by its proponents, particularly for the settlement of digital assets, then the financial market infrastructure of the future, or at least substantial segments of it, will be based on DLT. Consequently, central banks must be prepared to issue CBDC. At the very least, central banks will need to ensure the availability of central bank money on systemically important financial market infrastructures, considering that central bank money is the sole risk-free monetary asset and, thus, the preferred settlement asset for wholesale payments. This presents a simple use case for wCBDC.

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The present book contains five contributions relating to the introduction of Central Bank Digital Currencies (CBDCs), i.e., the digital form of state-issued legal tender. It is the by-product of a Colloquium jointly hosted by the Collegium Helveticum (the joint Institute for Advanced Studies of ETH Zurich, the University of Zurich and the Zurich University of the Arts) and the University of Zurich's Priority Research Program on Financial Market Regulation (URPP FinReg) on 9 May 2023.

The contributions to this book provide an in-depth analysis of the following aspects of CBDCs:

- Global Financial Architecture and Decentralized CBDC Regimes (by Rolf H. Weber),
- The Shift from Private Money into “Unlimited” CBDCs: An Unviable Development or a Chance for Reform and New Opportunities? (by Christian Hofmann),
- A Macroeconomic Perspective on retail CBDC and the Digital Euro (by Dirk Niepelt),
- Central Bank Digital Currencies: Central Bank Money reaches a new frontier (by Chiara Zilioli) and
- The Simple(r) Case for Wholesale Central Bank Digital Currency (by Thomas Moser).

The articles constitute an optimal blend between legal, institutional, and economic aspects on CBDCs by high-quality experts, combining the academic and the central bank perspectives.