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CENTRAL BANK DIGITAL CURRENCY--PROGRESS AND FURTHER CONSIDERATIONS

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Delete options which do not apply:

- The **Staff Report** prepared by IMF staff and completed on October 10, 2024.

The report prepared by IMF staff has benefited from comments and suggestions by Executive Directors following the informal session on November 1, 2024. Such informal sessions are used to brief Executive Directors on policy issues and to receive feedback from them in preparation for a formal consideration at a future date. No decisions are taken at these informal sessions. The views expressed in this paper are those of the IMF staff and do not necessarily represent the views of the IMF's Executive Board.

The documents listed below have been or will be separately released.

[Fintech Note: Positioning Central Bank Digital Currency in the Payments Landscape](#)

[Fintech Note: Cyber Resilience of the Central Bank Digital Currency Ecosystem](#)

[Fintech Note: Central Bank Digital Currency Adoption—Inclusive Strategies for Intermediaries and Users](#)

[Fintech Note: Central Bank Digital Currency Data Use and Privacy Protection](#)

[Fintech Note: Implications of Central Bank Digital Currency for Monetary Operations](#)

[Fintech Note: Cross-Border Payments with Retail Central Bank Digital Currencies](#)

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CENTRAL BANK DIGITAL CURRENCY: PROGRESS AND FURTHER CONSIDERATIONS

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EXECUTIVE SUMMARY

This paper informs the Executive Board of recent global developments in central bank digital currency (CBDC) and summarizes the main takeaways from a new wave of CBDC virtual Handbook chapters to be released in November 2024.

Countries' interest in exploring both retail and wholesale CBDC remains strong. Questions remain in the areas of CBDC objectives, fundamental requirements, design considerations, and macro-financial implications. The second wave of chapters address key policy questions commonly raised by IMF member countries in those areas.

How to position CBDC vis-à-vis fast payment systems and e-money networks?

- CBDC's distinguishing value lies in its property as public money in an increasingly digitalized economy. Retail CBDC could address medium-term issues such as maintaining monetary sovereignty, bolstering trust in domestic money and payments, and ensuring interoperability of public and private money in the digital age.
- Central banks should address existing pain points in payment systems while preserving capacity to adapt to a multi-instrument multi-infrastructure future landscape, where a CBDC system could coexist with fast payment systems and e-money networks.
- But the transition path will be country specific. While some central banks position themselves as leaders in exploring CBDC, others may opt to be observers for now due to various constraints.

How can CBDC be resilient to cyber risks?

- Cyber resilience is fundamental to trust in CBDC, which could face sophisticated cyber-attacks. And CBDC could be susceptible to cyber risks that are not necessarily encountered by other digital payments.
- Delivering a cyber-resilient CBDC requires appropriate designs, foundational principles, and good practices that should be built into it at an early stage.

Will CBDC be adopted?

- Realizing the policy objectives of CBDC hinges on attaining sufficient adoption and managing adoption over time, though not necessarily maximizing it. Central banks should not take it for granted that CBDC, once launched, will be adopted and scaled up rapidly.

- As country experiences indicate, CBDC adoption could face hurdles, including the classic chicken-and-egg problem wherein adoption by consumers is dependent on the participation of merchants and vice versa.
- CBDC adoption requires a strategic approach adapted to country circumstances based on four elements—regulation, education/communication, design, and incentives.

How to leverage CBDC data while preserving privacy?

- CBDC may allow for a “digital trail” of data to be collected and stored. CBDC data may have economic value and could help central banks achieve policy objectives. However, CBDC data use could pose risks to privacy, which in turn can undermine trust in central bank money.
- Central banks need to strike a balance between CBDC data use and privacy protection depending on norms, legal and regulatory frameworks, and preferences.
- CBDC offers an opportunity to improve the trade-off between data use and privacy protection as compared to private digital payment systems, including through robust institutional arrangements and technological solutions. CBDC can be designed to cater to the privacy needs of different users.

Will CBDC interfere with monetary policy operations?

- When CBDC is issued and adopted, it will substitute for other forms of money and change reserve balances in the banking system, which in turn may influence short-term interest rates. CBDC may affect central banks’ ability to forecast liquidity, draw market rates away from the policy target, and complicate banks’ liquidity management. CBDC may therefore affect how central banks conduct monetary policy operations.
- However, effects can be attenuated by adapting monetary operations—engaging in fine-tuning operations and providing more liquidity to the banking sector. CBDC design can also be altered by imposing criteria on access, as well as holding or transaction sizes.

How to design CBDC to help improve cross-border payments?

- When designing and implementing CBDC systems, it is beneficial to factor in cross-border implications from the start. By doing so, central banks can diminish risks of having to redesign or adjust their domestic CBDC system at a later stage. CBDC could help overcome frictions in cross-border payments if they are designed bearing five interrelated elements in mind: access, communication, currency conversion, compliance, and settlement.
- Should a central bank decide to enable the cross-border use of its CBDC, international collaboration is critical to realize efficiency gains, while containing potential risks.

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Glossary

AE	Advanced Economy
AI	Artificial Intelligence
AML/CFT	Anti-Money Laundering and Combatting the Financing of Terrorism
AFR	African Department
APD	Asia & Pacific Department
B2P	Business-to-Person
BCH	Banco Central de Honduras
BIS	Bank for International Settlements
BISIH	BIS Innovation Hub
BOK	Bank of Korea
BSP	Bangko Sentral ng Pilipinas
CBDC	Central Bank Digital Currency
CD	Capacity Development
CFMs	Capital Flow Management Measures
CPMI	Committee on Payments and Market Infrastructures
DLT	Distributed Ledger Technology
DT	Digital Tenge
ECB	European Central Bank
ECCB	Eastern Caribbean Central Bank
e-CNY	Digital Yuan
EMDE	Emerging Market and Developing Economy
FPS(s)	Fast Payment System(s)
G2P	Government-to-Person
IMF	International Monetary Fund
KPI	Key Performance Indicator
MCD	Middle East & Central Asia Department
NRV	Nepal Rastra Bank
P2P	Person-to-Person
PET	Privacy Enhancing Technology
RBI	Reserve Bank of India
SARB	South African Reserve Bank
SNB	Swiss National Bank
rCBDC	Retail Central Bank Digital Currency
wCBDC	Wholesale Central Bank Digital Currency

INTRODUCTION

- 1. CBDC is still an emergent field.** Central banks need to approach CBDC exploration carefully and methodically. The IMF’s CBDC virtual Handbook (Handbook) aims to guide and support policymakers in their CBDC explorations. The Handbook is intended to be a reference for policymakers and experts, in both advanced economies (AEs) and emerging market and developing economies (EMDEs). It is a “living” document reflecting evolving experiences, findings, and policy views. Each individual Handbook chapter is first published as a Fintech Note to solicit and incorporate views of IMF member countries. This procedure ensures that the Handbook has support among members, and that member views and insights from countries in their respective CBDC explorations can be incorporated (IMF 2023).
- 2. Staff briefed the Board in September 2023 of the key findings of the first wave of Handbook chapters published in November 2023.**¹ Two chapters provided a methodology for thinking through CBDC (“How should central banks explore CBDC?”) and developing CBDC as a product. The other three chapters covered three important aspects of the macro-financial implications of CBDC: CBDC’s implications for monetary policy transmission, capital flow management measures, and financial inclusion.
- 3. The first wave of Handbook chapters prompted positive responses from IMF member countries.** In total, the number of pageviews was over 60,000 during November 2023 and September 2024. Countries provided constructive suggestions. For instance, the chapter on implications for monetary policy transmission led to a question on CBDC’s implications for monetary operations. Countries also asked how to promote a suitable level of adoption of CBDC after a potential launch. Frequently, countries expressed an interest in more guidance on handling of data use and privacy protection.
- 4. Importantly, fruitful synergies have emerged between the Handbook chapters, capacity development (CD) activities, and surveillance work.** IMF staff have used the first wave of Handbook chapters as the basis for CD missions, and shared knowledge on frameworks for exploring CBDC, country experiences, and policy lessons. These CD activities, backed by strong analytical work, greatly raised the interest in requesting Fund’s CD. To date, over 50 countries have approached the IMF to request assistance through CBDC capacity development. Equally important, countries’ feedback and questions received from CD missions have also been useful to guide the selection of future Handbook chapter topics. Therefore, the synergies between the Handbook chapters and CD activities supported the implementation of Fund’s CD Strategy (IMF 2022). Moreover, the Handbook chapters paved the way for more informed policy discussions during Article IV consultations. Future chapters such as on financial stability will continue doing so.
- 5. The second wave of the Handbook chapters addresses important analytical and operational questions raised by central banks in their ongoing CBDC explorations.** The six Fintech

¹ See “[Central Bank Digital Currency—Initial Considerations](#)”, IMF Policy Paper No. 2023/048, November 2023.

Notes, to be published as Handbook chapters in November 2024, cover the objectives of CBDC, foundational requirements, design considerations, and macro-financial implications. They include the following topics: (i) positioning CBDC in the payments landscape; (ii) cyber resilience of the CBDC ecosystem; (iii) strategies for CBDC adoption; (iv) CBDC data use and privacy protection; (v) implications of CBDC for monetary operations; and (vi) cross-border payments with retail CBDC. The Government of Japan is a major partner and donor and has funded this second wave of Handbook chapters.

6. This paper summarizes the findings of the second wave of the Handbook chapters. As before, findings are preliminary and may be updated in the future as new knowledge and experience emerge.

CURRENT CBDC LANDSCAPE

7. The global interest in CBDC remains strong, and exploration continues around the world. The Bank for International Settlements' (BIS) most recent CBDC survey shows that the proportion of the 86 responding central banks that are exploring CBDC has risen to 94 percent. The survey indicates that up to fifteen CBDCs will likely have been issued by 2030 (BIS 2024a). The pace, motivations, and scale of CBDC exploration remain jurisdiction specific. Over the course of 2023, there was an uptick in experiments and pilots with wholesale CBDC (wCBDC).

8. Some central banks in large economies are devoting considerable resources to retail CBDC (rCBDC) exploration. The European Central Bank (ECB) is moving forward with the digital euro project. It moved from the initial phase into the preparation phase in November 2023. This preparation phase aims to lay the foundation of a potential future digital euro, by finalizing its rulebook and selecting providers that could help develop a technical platform. A first draft of the rulebook and a first call for providers were presented in January 2024 (ECB 2024)—the ECB has earmarked significant funds to work with the private sector to develop a digital euro. The next phase involving an actual development and rollout of the digital euro could start in November 2025 at the earliest. In the UK, the Bank of England (BoE) together with His Majesty's Treasury continue to explore a potential digital pound. The project is currently in the design phase, in which technological and policy requirements for a potential digital pound are being investigated.

9. Several central banks are fine-tuning their rCBDC pilots or starting new ones. The Chinese e-CNY has been circulating in seventeen Chinese provinces in pilot form for several years. Government agencies and, increasingly, corporations are now using the e-CNY for payroll purposes which helped increase the e-CNY transactions. The e-CNY has integrated the current QR code system, which simplifies its use in stores. The D-Cash pilot, run for several years by the Eastern Caribbean Central Bank (ECCB), was discontinued in January 2024. The ECCB is now preparing to launch a second pilot, dubbed D-Cash 2.0 which aims to be more advanced and user friendly (ECCB 2024). In India, the rCBDC pilot currently has a user base of around five million and has integrated the standard QR code system for interoperability with other payments methods (RBI 2024a). Currently, work is ongoing to add functionalities to the pilot that are deemed important. Multiple ways to achieve offline capacity to enable payments in rural and far-off areas will be tested (RBI 2024b). The Bank of Korea (BOK) explores

both rCBDC and wCBDC in collaboration with other government authorities. Together, these authorities are currently developing a pilot to allow the public to test CBDC (BOK 2024).

10. No new rCBDCs have been officially launched since three central banks launched CBDC in 2023. The three CBDCs that are currently officially issued—the Sand Dollar in The Bahamas, the eNaira in Nigeria, and Jam-Dex in Jamaica—are used for payments in their respective economies, albeit with a low level of adoption. This initial slow uptake is not surprising, as the adoption rate of new technologies and innovations tends to be slow at first. Reasons contributing to the initial slow uptake include insufficient public education, lack of merchant participation, and lack of engagement with and incentives for intermediaries. Most central banks are carefully assessing lessons from peer experiences, noting the importance of conducting user education campaigns, engaging stakeholders early, and setting appropriate regulatory frameworks. For example, the Central Bank of Bahamas is reportedly considering mandatory participation by commercial banks to offer access to the Sand Dollar.

11. The BIS survey shows that advanced economies believe that the likelihood of issuing a wCBDC is now higher than that of a rCBDC within the next six years. Exploration of wCBDC is motivated by a number of potential use cases, such as the need to provide an efficient settlement asset for tokenized assets, safe and efficient payments between non-bank financial institutions, and cross-border payments. Tokenization of money and assets has become a notable development with active participation by global banks and financial market infrastructures. For example, as part of a pilot known as Project Helvetia III, the Swiss National Bank (SNB) has issued tokenized Swiss franc wholesale CBDC. The pilot is unique in making wCBDC available for settling commercial transactions on the same third-party platform run by the SIX Digital Exchange where tokenized assets are held. Other examples of active wCBDC exploration in the context of asset tokenization include projects run by Brazil, Hong Kong SAR, and Singapore.

12. Interest in both rCBDC and wCBDC remains strong in EMDEs. For instance, Kazakhstan has already taken a decision to issue a rCBDC, and the Digital Tenge (DT) was launched in ‘pilot mode’ in November 2023 (National Bank of Kazakhstan 2023). The central bank of Nepal (Nepal Rastra Bank) envisions a phased pilot by 2026 (Nepal Rastra Bank 2024). The central bank of Honduras (Banco Central de Honduras, BCH) published a report on its CBDC exploration in 2023, discussing the potential role of CBDCs for financial inclusion and improved remittances (BCH 2023). The central bank of Philippines (Bangko Sentral ng Pilipinas) has selected the underlying technology of and is conducting a proof-of-concept on a wCBDC, Project Agila (Bangko Sentral ng Pilipinas 2023). Likewise, the South African Reserve Bank is embarking on a series of trials on wCBDC in the Project Khoka2x (South African Reserve Bank 2024). Many other projects are also ongoing globally, at different levels of intensity.

13. International organizations are also supporting global CBDC exploration. They are engaging in analytical work, technical experimentation, capacity development and facilitating discussion and information-sharing between countries. For instance, the Bank for International Settlements Innovation Hub (BISIH) conducts a wide range of technical explorations in collaboration with national central banks. Recent developments include a cross-border wCBDC project mBridge which has now reached the minimum viable product stage—it is now able to support basic functions for real value transactions. Consequently, mBridge is now broadening its scope and inviting new participants (BIS

2024b). Project Rialto was announced in July 2024 to explore how to improve instant cross-border payments using wCBDC settlement (BIS 2024c). Project Aurum 2.0, Project Hertha and Project Tourbillon demonstrate central banks' efforts to explore and scale up privacy enhancing technologies (PETs) for privacy protection (BIS 2024d). The World Bank, like the IMF, continues to provide analytical support and technical assistance for member countries.² The World Bank also actively engages in technical experimentation, for instance recently partnering with the SNB and SIX Digital Exchange to further scale efforts in the use of Distributed Ledger Technology (DLT) and wCBDC in capital markets (World Bank Group 2024).³

MAIN MESSAGES FROM NEW HANDBOOK CHAPTERS

A. Objectives and Requirements

14. This section summarizes two chapters that relate to the objectives and foundational requirements of CBDC. As explained in previous publications, central banks need to have a clear view on the policy objectives of a CBDC, as well as potential alternatives that could promote the same goals (Soderberg and others 2023). Likewise, they need to ensure that foundational requirements are fulfilled. In this context, these two chapters explore the role of CBDC versus other forms of digital payments, and cyber resilience of the CBDC ecosystem.

Positioning CBDC in the Payment Landscape

15. Country authorities often raise the question of how a rCBDC compares to fast payment systems (FPSs) and e-money, and which to prioritize in the context of constrained resources. Exploration of rCBDC requires a comprehensive assessment of legal, macro-financial, and operational considerations. The growing body of work across central banks, academics, and international organizations evidences the sustained focus on CBDC's potential implications for monetary and financial stability. This chapter focuses instead on the comparison of rCBDC—that is, the presence of digital central bank money available to the general public—with FPSs and e-money, from a payments perspective, and how CBDC may support a jurisdiction's vision on payments in the digital age.

16. Similar to FPSs and e-money, rCBDC is meant for retail payment but it is a payment instrument issued by the central bank and can potentially have functionalities that FPSs and e-money do not offer. At the core of all payment systems is a relationship between three components: instrument, infrastructure, and scheme. E-money systems facilitate the transfer of e-money (instrument) which is defined as a form of electronically stored money typically issued by non-bank financial institutions (an e-money institution) and is often backed by bank deposits. E-money systems are often characterized by their closed loop nature, but schemes to make them interoperable do exist. FPSs focus

² The anticipated demand for further Fund engagement on CBDCs is expected to come from all five geographical regions. The CD missions to countries in APD, AFR, MCD (Asian part), and fragile and conflict-affected states will be funded by the Government of Japan.

³ The Fund has joined forces with these institutions, such as the BISIH, World Bank, and Committee on Payments and Market Infrastructures (CPMI), to develop more in-house expertise, technical assistance, and analytical work.

more on the infrastructure and scheme as they are designed to bridge transfers (at speed) between instruments of different private issuers. CBDC systems are being designed with all three components—instrument, infrastructure, and scheme—in mind.

17. CBDC, FPSs, and e-money networks may all provide similar efficiency gains for economies.

Each could provide instantaneous and efficient payments, potentially lower cost of payments available to a broader set of the population and supporting further digitalization of the economy. Speed is a core design feature of FPSs and e-money networks. These two systems can deliver strong improvements to payments efficiency in some countries. For example, both India and Brazil have been able to increase payment efficiency through successfully establishing FPSs. China has been able to increase payment efficiency through developing e-money schemes such as Alipay and WeChat Pay. In the same vein, CBDC can also be designed to increase payment efficiency by taking advantage of technological innovations.

18. CBDC's distinguishing value lies in its property as public money in an increasingly digitalized economy.

The fundamental difference between CBDCs, FPSs, and e-money systems is that CBDCs are first and foremost a form of central bank money that help ensure the availability and choice of publicly issued money, as well as a public payment solution, in a retail payments landscape that may otherwise trend toward complete reliance on private money. In contrast, FPSs are payment arrangements to smooth and speed the transfer of private liabilities, and e-money are private liabilities which act as an alternative to bank deposits with a lower access threshold in many markets. In this way CBDCs are more likely to be a complement to other systems, bolstering trust in money and payments by preserving choice and fostering interoperability of public and private money and payment systems. As such, the provision of central bank money serves as a mechanism for market discipline and supports the uniformity—or singleness—of money which are crucial for maintaining monetary and financial stability.

19. In considering various payments innovations, central banks should address existing pain points whilst preserving capacity to adapt to a multi-instrument multi-infrastructure future landscape.

In the future, it is possible to envisage the coexistence of CBDC, FPSs, and e-money in many payment systems across the world. Many central banks are pursuing CBDC explorations alongside improvements to the existing landscape. Central banks who choose to prioritize a “flagship” project may also retain a monitoring role in other initiatives to avoid falling behind on global progress. A strategy for exploring CBDC or any payments development should take a holistic approach and consider the payment landscape as a whole, including (but not limited to) the existing role of card schemes and automated clearing houses.

20. The transition path towards a multi-rail future could be very different across jurisdictions, and the relative importance of these rails could differ from country to country.

When crafting a CBDC strategy, central banks should assess the current performance and future potential of existing non-CBDC systems. Developments in the private sector should also factor into the central bank's strategy—today's landscape is strongly characterized by the strength of private innovation. Emerging innovations such as tokenized deposits and stablecoins may need to be considered within a landscape assessment. Existing systems, such as FPSs and e-money may still be struggling to gain adoption, or their benefits (e.g., lower costs) are not being realized and passed on to the end-users. This raises two

core considerations: (i) whether there is potential to improve the current landscape through better regulation or coordination of the private sector; and/or (ii) whether a new system or service by the central bank itself is needed. The answer to these questions will have implications for the decision on CBDC development in different countries.

21. CBDC exploration could be a catalyst for the further development of FPSs and e-money systems. FPSs or e-money schemes are present in many jurisdictions, however some experience low usage, some systems do not interoperate well with other systems, and overall costs of payments services in these countries remain high. CBDC systems, if designed appropriately and implemented in partnership with the private sector, could facilitate a higher degree of interoperability of the payments landscape in an economy. CBDC exploration itself may also support research that develops interim improvements to existing systems and incentivizes private sector coordination and innovation.

22. While some central banks position themselves as leaders in exploring CBDC, others may opt to be observers for now due to various constraints. Central banks need to balance horizon scanning and policy analysis with the practical considerations of where to invest time and resources. Once countries have a strong assessment of their core policy priorities and ideal vision, an examination of the existing market, institutional capacity (both public and private), and timing considerations may determine the most appropriate path forward. Here central banks confront the likely trade-off between what is most desirable from a policy perspective and what is practically feasible to implement.

23. A strategy for supporting the payments landscape must consider practical constraints of each jurisdiction. CBDC systems and publicly owned FPSs both require high levels of public sector involvement and may have similar types of development costs. However, a jurisdiction's mandate and ability to apply their powers around payments may ultimately determine how well a system can fulfill its objectives. Practical capacity may constrain the ability of central banks to implement change today, even if they have a clear long-term vision. While not all central banks can pursue multiple initiatives at once, investing time in monitoring and engaging internationally on payment system innovation remains a minimum essential for resource-constrained central banks given the pace of developments.

Cyber Resilience of CBDC

24. Cyber resilience is fundamental to the trust in CBDC. Trust is pivotal in the realm of digital money, which is inherently susceptible to digital risks throughout their lifecycle. CBDC provides a novel opportunity to modernize legacy payment systems with new, frontier technologies to improve functionality, efficiency, and user experience. However, its issuance and underpinning operations create a vast and complex ecosystem that amplifies existing risk exposures and surface new ones.

25. The cyber risk perimeter of a CBDC has three broad elements. The first is the currency itself throughout its lifecycle—creation, storage, dissemination, and destruction. The second is transactions or movement and transfer of currency between individuals and merchants. The third element relates to sensitive information that a CBDC collects on the users, merchants, and transactions. This information needs to be protected both in transit, and at rest.

26. A CBDC ecosystem will be a high value target for a range of threat actors including nation states and cyber criminals. An operational failure resulting in a service outage, data breach or fraud will erode public trust and confidence with systemic implications. A well-functioning CBDC system therefore requires a resilient and efficient infrastructure, and an architecture that is flexible, scalable, expandable for future functionalities, with cyber security at its core.

27. CBDC could face unique cyber risk exposures that are not necessarily encountered by other forms of digital money. Its issuance could be seen as a fundamental change in the way the central bank operates. In an interconnected and vast ecosystem such as the one surrounding a CBDC with multiple points of exposure to cyber risk, securing all elements for resilience is a complex endeavor but one that must be achieved to ensure a successful deployment.

28. EMDEs may face more pronounced challenges in securing a CBDC ecosystem. Many EMDEs are exploring CBDC and may lack the foundational requirements for its resilient operations and sustained adoption. For instance, many have legacy and out of date IT environments and have not developed modern technologies such as smart devices and cloud services. New services and controls are often layered in response to user demand or to real or perceived weaknesses or cyber threats. This can create conflicts between tools, and vulnerabilities in interfaces leading to unintended outcomes. Although such conditions may exist in advanced economies, issues in EMDEs are exacerbated due to a paucity of skilled resources.

29. Different design options could have diverse cyber security implications. CBDCs can be designed in different ways and with different functionalities, such as programmability, smart contracts, and offline services. They could use new technologies such as DLT and Artificial Intelligence (AI). The intrinsic features of such new technologies, although promising for transactional efficiency and expanded capabilities, introduce complex cyber risk. They could also use traditional technologies, such as centralized ledgers which are also attractive targets for hackers and represent a single point of failure as a successful attack can disable the entire system and lead to data breaches and leakages on many users via a single attack. Therefore, developing a cyber resilient CBDC ecosystem requires careful evaluation of all elements and challenges associated with the design options.

30. Sustained adoption requires building security into the design from initial stages of the CBDC project. Countries should analyze cyber security gaps and prepare mitigating strategies from the start, to avoid expensive roll backs and bolt-on measures. This analysis should consider the clear demarcation of responsibilities for all stakeholders in the ecosystem given that some are supervised by other authorities other than the central bank.

31. Countries should prepare a holistic approach to mitigating cyber risk in CBDC ecosystem. A commitment to CBDC implementation presents a novel opportunity for countries to rethink the resilience and security of their critical IT systems, develop solutions using frontier technologies, and safeguards that are future proof. Beyond considering technical solutions, such as quantum resistant cryptography, air-gapped data centers, and mutable tokens, countries should prepare a holistic approach to cyber risk management across all areas of the ecosystem.

32. Countries should consider foundational requirements and good practices that span across its participants. Countries should consider four overarching principles: (i) the resilience of the CBDC ecosystem should be at least to the highest standards that apply to existing payment systems; (ii) the protection afforded to elements of the ecosystem should be proportional to the systemic risk they pose, considering severe but plausible threats; (iii) the attack surface should be minimized through proper design and implementation; (iv) resilience requirements of a CBDC should be comprehensive. In addition, a protection framework would be useful listing foundational requirements and good practices based on established risk management, regulatory and supervisory frameworks.

33. Countries should also consider the critical role of the human element which includes users, system or solution designers, developers, operators, custodians, and auditors. Human behavior and practices can impact the effectiveness and efficiency of processes and technology, and lead to unintended outcomes that impact public trust. Countries need to highlight project management to navigate the complex landscape of CBDC development and deployment, advocating for ongoing training and risk awareness.

34. Specific frameworks to secure CBDC ecosystems are still emerging. Experience to date, from live implementations and experimentation, has not yet provided sufficient insights to develop specific frameworks or guidance for resilient CBDC. However, as CBDC is a critical infrastructure based on technology, existing frameworks designed to protect similar systems can be adapted for its use. In addition, initiatives such as the BIS-led projects Polaris and Sela and outputs of active experiments in advanced economies could be leveraged in the future.

B. Design Consideration and Choices

35. Central banks must manage several important design and policy choices as they explore CBDC. This section summarizes two chapters that shed light on two such issues: CBDC adoption and data use and privacy protection.

CBDC Adoption

36. Realizing the policy objectives of CBDC hinges on attaining sufficient levels of adoption and managing adoption over time. That does not necessarily mean maximizing adoption, just attaining a level of adoption commensurate with policy objectives. CBDC adoption can be broadly defined as the extent and manner in which CBDC is utilized by end-users and intermediaries within a given jurisdiction. When, where, and to what extent CBDC should be used will be jurisdiction-specific and vary based on the policy objectives. For example, a jurisdiction aiming to foster financial inclusion might prioritize the adoption of CBDC in rural or underserved areas, focusing on easy access and user education. In contrast, a country seeking to enhance the efficiency of its payment systems might concentrate on integrating CBDC within its existing financial infrastructure, ensuring seamless interoperability with other payment methods. Central banks should set realistic key performance indicators (KPIs) and success metrics to measure and evaluate adoption. Setting adoption goals based on policy objectives will allow policymakers to monitor project progress and adjust as needed.

37. Central banks should not take it for granted that CBDC, once launched, will be adopted and scaled up easily. Among the countries that have already launched CBDC or are conducting large-scale pilots, adoption remains slow and limited. However, this slow uptake is initially expected and does not necessarily suggest that interest in CBDC is low, or that CBDC should be seen as a failure. Indeed, the adoption rate of new technologies and innovations does not tend to be linear. Rather, adoption often follows the so-called “S curve”—slow at first, then rapidly rises before flattening out again as it reaches market saturation. As country experiences indicate, CBDC adoption faces multiple hurdles, including low public awareness, preference for existing payment instruments, privacy concerns, inadequate incentives for intermediaries, and the classic chicken-and-egg problem wherein adoption by consumers is dependent on the participation of merchants and vice versa.

38. Successful CBDC adoption hinges on technical functionality and strategic policy and design choices that encourage the involvement of end-users and intermediaries from the outset. The ongoing challenges with CBDC adoption underscore the need for policymakers to consider CBDC adoption from the start as an integral part of the project. Central banks should proactively engage with all stakeholders in the CBDC ecosystem and facilitate adoption through a variety of means, going well beyond simply creating the CBDC product. Even then, some drivers of adoption will remain exogenous, such as the deployment of CBDC in a larger foreign jurisdiction which can stoke public attention at home, as well as grow the CBDC developer community.

39. CBDC adoption requires a strategic approach adapted to the unique circumstances of each jurisdiction. Countries can consider a “REDI Framework”, which outlines Regulatory strategies, Education and communication initiatives, Design and deployment choices, and Incentive mechanisms to manage CBDC adoption. The strategies and policy tools to favor adoption will tend to be more effective if implemented together. However, not every tool will be applicable or relevant across all countries.

40. Central banks, together with other relevant policymakers, can take regulatory and legislative measures to foster CBDC adoption. Strategies include setting rules around intermediary participation, governing user fees, and establishing minimum quality standards for services. Such strategies are dependent on each jurisdiction’s respective regulatory and legal frameworks.

41. Education and communication initiatives should focus on the needs, preferences, and concerns of different end-users. Central banks can disseminate information and counteract misinformation on CBDC, through official portals, traditional and social media. For instance, The Bahamas has recently introduced “Sand Dollar Ambassadors” that will promote usage and knowledge about the CBDC. Central banks can also leverage industry partners, such as experts, local organizations, and community leaders, to extend the reach of user education.

42. To encourage broad adoption, CBDC design should prioritize universal access, ease of use, and security. Central banks may consider enhanced functionalities such as offline capabilities and programmable payments. Interoperability and integration with existing systems without costly upgrades can make intermediaries and merchants more likely to embrace the CBDC payment system.

43. Targeted deployment and onboarding strategies can help generate initial momentum.

Implementing selected use cases, such as P2P, G2P or B2P payments, can target certain user groups. Intermediaries should provide both physical registration and eKYC, accommodating users with varying digital/financial literacy. Utilizing local intermediaries like postal offices to provide cash-in/cash-out points can help expand the CBDC network in rural and remote areas. Iterative pilots can be conducted to validate stakeholder and operational readiness before launch.

44. Central banks can consider both monetary and non-monetary incentives to encourage participation. For intermediaries, this could include exclusivity agreements, subsidies for setup costs, and allowing for CBDC data monetization or charging for value-added services. For end-users, incentives might include sign-up bonuses, airdrops, or lotteries upon onboarding. Once onboarded, usage incentives could be implemented, such as cash-back offers and discounts on CBDC transactions.

45. Countries need to continue to explore certain policy issues. Such considerations include ensuring sustainability of the CBDC system while navigating cost recovery, ensuring integrity of the system, and balancing adoption with financial stability. To implement CBDC as a sustainable public good, central banks will need to carefully navigate the issue of cost recovery, as it directly influences the formulation of pricing strategies that are fundamental to facilitating adoption. The challenge lies in devising a pricing model that recoups the substantial costs associated with developing and maintaining the CBDC infrastructure, while simultaneously ensuring that the pricing does not act as a deterrent to potential users.

Data Use and Privacy Protection

46. CBDC, as a digital form of central bank money, may allow for a “digital trail”—data—to be accessed, collected, processed and stored. In contrast to cash, CBDC could be designed to potentially include a wealth of personal data encapsulating transaction histories, user demographics, and behavioral patterns. Personal data could establish a link between counterparty identities and transactions.

47. CBDC data may have economic value for private actors and could help central banks achieve policy objectives. CBDC data could potentially be harvested by financial institutions and help develop data-driven businesses. It could help reduce information asymmetries, potentially assist in supporting financial inclusion, facilitate payment system interoperability, and promote innovation and market contestability. It could provide more timely information about the state of the world and help improve macroeconomic policymaking and enhance regulatory compliance. Data use by central banks differs from that by law enforcement and other competent authorities which may be vested with powers under national legal and regulatory frameworks to lawfully access and use personal data in the conduct of their functions.

48. CBDC data use, however, could pose risks to privacy, which in turn can undermine the trust in central bank money. Privacy can include the protection of someone’s personal space and the right to be left alone, the control over and safeguarding of one’s personal information, and an aspect of dignity, autonomy, and ultimately human freedom (Acquisti, Brandimarte, and Loewenstein 2015). If poorly

designed or managed, CBDC personal data use could pose risks to privacy, arising from events such as data leakages, data abuses, and cyber-attacks, thus also negatively affecting CBDC adoption.

49. While privacy concerns are already apparent in existing digital payment systems, CBDC could present new challenges. CBDC could be perceived as an instrument for state surveillance. Some may worry that the government or the central bank could use it to control or restrict payments users can make with CBDC, thereby undermining public trust in central bank money. This can be a particular concern in countries with severe governance and corruption vulnerabilities. In contrast, the private sector often has extensive access to data, and this access to data is generally widely accepted and uncontested in comparison to concerns raised about official sector data gathering and usage. In addition, public attitudes toward state surveillance versus commercial surveillance also differ across countries. While some societies trust commercial entities more than government institutions, it could be the other way around in other societies.

50. Central banks thus need to strike a balance between CBDC data use and privacy protection. Like other digital payments, such a trade-off for CBDC may differ from country to country, depending on cultural norms, societal preferences, legal requirements and traditions, and the degree of public trust in public institutions versus private ones. In addition, the degree of trade-off could depend on the degree of the granularity of data: where aggregate grouped data is sufficient to extract value, the trade-off could be inexistent—to the extent that users can understand that their individual data will not be used. Where granular personal data is needed to extract value, the trade-off could be much higher.

51. CBDC offers an opportunity to improve the trade-off between data use and privacy protection as compared to private digital payment systems. Facing a similar trade-off to private digital payment systems, central banks may have several potential advantages in striking a balance. They have strong convening powers and are well positioned to clearly articulate principles and policies to privacy protection and coordinate the adoption of a privacy-by-design approach in the CBDC ecosystem. Central banks could strengthen communication and consumer education to reduce privacy concerns. They could offer a diverse set of CBDC design choices to cater to different preferences for privacy. At a given level of preference for privacy, central banks can facilitate better use of CBDC data through robust transparency and accountability arrangements, sound policies, and judicious adoption of privacy-by-design approaches including the use of PETs. Finally, central banks are also in a better position to coordinate with other competent agencies to ensure consistency in legal and regulatory frameworks.

52. Given the diversity of preferences for privacy among users, central banks could offer a variety of CBDC designs to cater to the privacy needs of different users. For small value, low-risk transactions, CBDCs could be designed as close substitutes for cash, providing a higher degree of privacy to users. Such privacy enhancing designs require less information on identity and transactions. A variant of this design choice for small value, low-risk transactions could allow for better identification of personal information of the user, if the user so requests. For instance, such users may be interested in allowing their payments data to be used for credit scoring purposes if they have a higher chance of obtaining credit. Policymakers can communicate with the public to provide information on the implications of different CBDC design choices for privacy. It should be noted that a certain degree of

information on the identity of users and transactions is required to satisfy anti-money laundering and combatting the financing of terrorism (AML/CFT) requirements; therefore, countries need to carefully consider whether privacy by design choices allow for effective mitigation of money laundering and terrorism financing risks.

53. Technology can help protect privacy. Different technologies and modules could be leveraged to protect privacy. Technology offers flexibility in design to share data legitimately by accommodating diverse preferences and situations. Technology can allow a range of privacy options. And technology can help users understand what data can be accessed for regulatory or law enforcement purposes, for instance, through “proofs of correct execution.” These “proofs” can be audited and communicated to users to build trust.

54. But technology needs to be complemented by rigorous institutional arrangements and legal frameworks. Policymakers should set up institutional arrangements and legal frameworks to ensure that established principles, policies, and laws for privacy protection are implemented, stakeholders are compliant, and violators are held accountable. Having appropriate frameworks in place can ensure CBDC data use be in accord with other regulatory regimes, such as anti-money laundering (AML) and combating the financing of terrorism (CFT) laws and regulations.⁴

55. A coordinated approach should also be considered for cross-border data flows associated with CBDC data use and privacy protection. CBDC cross-border data flows face similar privacy risks as other private digital cross-border payments. While it is understandable that data use and privacy standards differ across countries, overly stringent data localization regulations will likely be an impediment for cross-border CBDC data use. The international community is addressing these issues, striving for harmonization of standards to promote free cross-border data flow while ensuring privacy protection.

56. Overall, the appropriate degree of privacy in a CBDC system is a political and social question. While some countries will likely opt for a high degree of privacy⁵ in the design of CBDC and the central banks involved will choose not to give much weight to the economic value of CBDC data, other countries will likely take advantage of CBDC data use for certain policy objectives such as fostering financial inclusion and promoting competition in the payment systems. Data use and privacy protection do not have to constitute an insurmountable trade-off. The trade-off can be managed through application of laws and regulations that reflect adequate privacy principles and policies, careful CBDC designs, and adoption of the privacy-by-design philosophy and judicious use of PETs.

C. Macro-Financial Implications

⁴ More detailed information about how AML/CFT rules and regulations are to be applied in a CBDC setting will be discussed in an upcoming Fintech Note and CBDC virtual Handbook chapter on the Financial Integrity Implications of CBDCs (to be published in 2025).

⁵ The specific degree of privacy that will be permitted under the AML/CFT standards remains to be discussed.

57. CBDC implementation requires an understanding of its potential implications for central bank operations and may require cooperation with other central banks. Two chapters summarized in this section cover potential implications for monetary operations and cross-border payments.

Monetary Operations

58. How will monetary policy be affected by the issuance of CBDC? The question requires a two-part answer. The first concerns the transmission of the monetary policy stance to the broader economy—output and inflation. Views are provided in the CBDC Handbook Chapter on “Implications of CBDCs for Monetary Policy Transmission” (Das and others, 2023). This paper aims to address the second part of the question, namely how the introduction of CBDCs would affect monetary operations—the process through which central banks use different instruments to manage the demand for and supply of reserves to achieve a desired stance of policy. Indeed, central banks need to anticipate any implications for monetary operations and improve their operational framework to address any potential challenges, as such difficulties could undermine central bank credibility and impact inflation expectations.

59. When CBDC is issued and adopted, it will, to some degree, substitute for other forms of money and may impact the reserves balances in the banking system, which in turn will influence short-term interest rates. The analysis centers around the balance sheets of the central bank, the banking sector, and the non-bank sector to illustrate the effects of CBDC on the supply of and demand for reserves and short-term interest rates. The likelihood of such substitution depends on CBDC design features, such as accessibility, holding limits, and remuneration. Market developments would also determine the substitution. For example, increased demand for tokenized deposits and tokenized assets could increase the demand for a wCBDC as settlement asset and thus induces substitution of reserves with CBDC.

60. CBDC could substitute for cash, commercial bank deposits, and reserves. These scenarios are not mutually exclusive as a single design of CBDC could lead to the simultaneous occurrence of multiple scenarios in practice. If retail users substitute cash with CBDC, the implications for interest rates are more limited, though central banks may find it more challenging to forecast the liquidity in the banking system. Retail users’ substitution of deposits with CBDC is more likely to impact operations since commercial banks would lose reserves. In this scenario, short-term interest rates may experience some upward pressure in a corridor system, though unlikely in a floor system unless substitution is significantly large. If commercial banks substitute reserves with CBDC, the implications for operations depend on the relative difference between CBDC and reserves. Short-term interest rates are unlikely to be significantly impacted if CBDC is treated the same as reserves, and the total reserves would be the sum of the traditional reserves and wCBDC.

61. However, the potential adverse impacts can be attenuated, if not avoided, by appropriately adapting monetary operations. In most cases, CBDC is not expected to overly constrain operations. If retail users substitute cash and deposits with CBDC, central banks may need to upgrade their liquidity forecasting, introduce fine-tuning facilities, or temporarily adopt operational regimes less prone to liquidity shocks. If retail users substitute deposits with CBDC, when the short-term interest rates deviate from the target level as a result of CBDC, the central bank can provide liquidity using

monetary policy instruments to ensure the rates can adjust back to the target level. If CBDC demand is large and persistent, the central bank may have to resort to asset purchases or long-term lending to the banking sector, resulting in a larger balance sheet of the central bank. Lastly, if commercial banks substitute reserves with CBDC, central banks should ensure interoperability and equivalent treatment between CBDC and reserves to prevent price distortions and undesirable liquidity fragmentation.

62. As liquidity forecasting could be challenging, especially during the initial introduction of CBDC, several solutions may be implemented. A central bank targeting short-term interest rates in a corridor system may consider temporarily switching to targeting a fixed rate with full allotment until it can forecast reserves more accurately. Alternatively, the central bank could open more intra-day windows to allow for more fine-tuning operations. Additionally, it could narrow the corridor between the ceiling and the floor rate, introduce a longer averaging period to satisfy reserve requirements to limit the volatility of short-term interest rates, or provide liquidity at long maturity. Overall, forecasting the demand for bank reserves will remain the key to effective monetary policy implementation, and the central bank would need to monitor interest rate movements more actively.

63. The potential adverse impacts can also be managed through a careful CBDC design. While the design of CBDC should primarily focus on serving its key policy objectives, central banks should nevertheless consider how the key design features can be further tailored to ensure their ability to conduct monetary operations effectively. In the case of CBDC substituting for bank deposit, in order to prevent banking disintermediation risk, central banks can adjust access criteria or impose holding limits to dampen the potential adverse operational effects. For instance, it is envisaged that the digital euro would have, if adopted, a waterfall/ reverse waterfall mechanism to ensure that CBDC users would not hold CBDC more than the limits. In the case of CBDC substituting for commercial banks' reserves, treating CBDC equivalently to reserves, such as counting CBDC towards the reserve requirement or remunerating CBDC like reserves in a floor system, could also limit operational complexity. In addition, the authorities need to manage the trade-offs arising from these remedial measures. For instance, imposing holding limits could affect adoption and financial inclusion, while remunerating CBDC would affect seigniorage and imply competition with bank deposits.

64. Exchange rate targeting and monetary targeting regimes could also be impacted. In an exchange rate targeting regime, CBDC available to non-residents could exert upward pressure on the currency, induce volatility in the exchange rate, and potentially lead to a more open capital account. In a monetary targeting regime, CBDC could alter the relationship between base money and broader aggregates, and thus with inflation, thereby complicating monetary targeting. The ultimate effect will be country-specific, although concerned central banks implementing CBDC may need to stand ready to intervene or fine tune operations more frequently, at least initially. These possible adverse impacts can also be mitigated by CBDC design. For instance, access by non-residents may need to be carefully managed to mitigate the potential impact on capital flow and exchange rate volatility.

Cross-Border Payments with rCBDC

65. When designing and implementing CBDC systems, it is beneficial to factor in cross-border implications from the start. Even if cross-border payments are not considered to be available at the

initial launch of the CBDC, avoiding unintended barriers for potential later stages is important. This importance was recognized in the G20 Roadmap to enhance cross-border payments, where Building Block 19 considers “factoring an international dimension into CBDC design” (BIS, IMF, World Bank 2021 and 2022). This paper further assists central bank in their efforts to factoring in an international dimension in their CBDC exploration. While this chapter focuses on rCBDC, many of the lessons apply also to wCBDC. If a rCBDC is not available for cross-border payments, retail users could still benefit from cross-border wCBDC arrangements. These can deliver more efficient interbank cross-border payments, which would ideally trickle down to faster and cheaper payments for end users.

66. An rCBDC has the potential to enhance cross-border payments. CBDC, as central bank-issued money, is a safe and liquid asset that reduces the numbers of financial intermediaries. This reduction lowers settlement risk and can lead to decreased costs and improved speed of cross-border payments. Furthermore, the introduction of CBDC provides an opportunity—a clean slate—to establish cross-border payment functionality from scratch. By adopting and integrating the latest technological developments, CBDC systems can also enhance the efficiency and security of cross-border payments by, for example, promoting the use of smart contracts to facilitate payment-vs-payment functionality. Additionally, CBDC, as a new means for cross-border payments, is intended to coexist with and complement existing options, thereby increasing payment diversity, and stimulating resilience, competition, and efficiency.

67. Central banks can play a pivotal role in designing CBDC systems for cross-border payments. CBDC systems face many of the same challenges, opportunities, and implications as other payment systems do in cross-border payments. That said, the roles and responsibilities might be slightly different in a CBDC system, and the central bank may play a more pivotal role given CBDC’s nature as public money as opposed to commercial bank money. In a CBDC setting, end-users would directly hold a central bank liability, just as when they hold cash, and the central bank is likely to have a large role in establishing and operating the infrastructure and scheme.

68. By factoring in cross-border considerations at an early stage, central banks can diminish risks of having to redesign or adjust their domestic CBDC system at a later stage. Central banks can consider cross-border CBDC payments through the lens of five interrelated elements: access, communication, currency conversion, compliance, and settlement. And key design choices can be considered for each element at an early stage. Access policy relates to whether non-residents should be given access to the CBDC, and what the rules and criteria are for that access. Communication relates to data and messaging standards and digital ID framework that the system adopts. Currency conversion policy considers who provides foreign exchange liquidity and the role of the central bank in facilitating foreign exchange transactions and liquidity. Compliance relates to decisions on how laws and regulations should be incorporated or implemented through different CBDC design choices and who would be responsible for various aspects of regulatory compliance. Settlement relates to design choices that will affect settlement risks, including the use of programmability functions.

69. Cross-border considerations should be carried out in a multi-dimensional setting. Assessing access policies for end-users and intermediaries is paramount. The adoption of international standards such as ISO20022 for payment initiation, data, and messaging helps. Having instant

settlement and 24/7 availability helps mitigate some risks. Programmability can deliver efficiency gains in the settlement process. Compliance with international regulatory frameworks should be factored in. Flexible or modular technical designs can help solutions that can “plug into” different arrangements can more easily adapt to the continuous evolution of the future cross-border CBDC payments landscape. For instance, the central banks of Israel, Norway, and Sweden in collaboration with the BIS Innovation Hub, demonstrated in Project Icebreaker that it is possible to design CBDCs to fit domestic priorities and still interlink them with the CBDCs of other countries for cross-border payments.

70. Prioritized international collaboration would help factor in cross-border implications when designing rCBDC systems. Information sharing, consistent messaging standards and regulatory approaches, and common infrastructure coordinated internationally would help to facilitate interoperability. Such international cooperation can be more impactful if achieved at a global level to avoid fragmentation and walled gardens.

CONCLUSION AND NEXT STEPS

71. This paper informs the Executive Board about staff’s further considerations on six of the most frequently asked questions by countries exploring CBDC. Each topic examined in this paper—the role of CBDC versus other digital payments, cyber resilience of the CBDC ecosystem, CBDC adoption, CBDC data use and privacy protection, as well as issues related to monetary policy operations, and potential use of CBDC for cross-border payments—is based on extensive deliberations by IMF staff and their interactions with central banks of the IMF membership.

72. A third installment of Handbook chapters will be published in 2025. Topics will be chosen based on countries’ needs as well as feasibility (such as availability of data and practical experience). Possible topics include implications for financial stability; CBDC and financial market structure and contestability; financial integrity considerations; differences and similarities between rCBDC and wCBDC; legal considerations; and wCBDC and cross-border platforms for payments and the transfer of assets.

Annex I: Updated CBDC Virtual Handbook Topics¹

Objectives and Framework

- Chapter 1. Digital Money: Positioning CBDC
- Chapter 2. Identifying Pain Points and Objectives
- Chapter 3. Elements of Thinking Through CBDC
- Chapter 4. Differences and Similarities between Retail and Wholesale CBDC

Foundational Requirements and Readiness

- Chapter 5. Legal Considerations of Central Bank Digital Currency
- Chapter 6. Cyber Resilience of the CBDC Ecosystem
- Chapter 7. Required Capacity within Central Banks
- Chapter 8. Regulation and Supervision

Design Process, Considerations, and Choices

- Chapter 9. Design Choices
- Chapter 10. CBDC Adoption Strategies for Intermediaries and Users
- Chapter 11. Financial Integrity Considerations
- Chapter 12. Data Use and Privacy Protection
- Chapter 13. Capital Flow Management Measures

Technology and Project Approaches

- Chapter 14. Project Management: Preparation, Proof of Assumptions, Pilots, Prototypes, and Production
- Chapter 15. Technology Landscape and Innovation

Potential Macro-Financial Impacts

- Chapter 16. CBDC's Role in Promoting Financial Inclusion
- Chapter 17. Evaluating the Impact on Monetary Policy Transmission
- Chapter 18. Evaluating the Impact on Bank Disintermediation and Financial Stability
- Chapter 19. Cross-Border Payments
- Chapter 20. Financial-Sector Market Structure and Contestability
- Chapter 21. Implications of Central Bank Digital Currencies for Monetary Operations
- Chapter 22. Wholesale CBDC and Cross-Border Platforms for Payments and the Transfer of Assets

¹ Chapters 3, 12, 13, 15, and 16 were published in the first wave of Handbook chapters in 2023. Chapters 1, 5, 9, 11, 18, and 20 will be published in the second wave in 2024. Chapters 4, 10, 17, 19, and a new topic on wholesale CBDC and cross-border platforms will be prepared for publication in the third wave in 2025. The future topics will continue to be chosen on the basis of country needs and feasibility, and the table of contents will be updated accordingly.

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