



# FINTECH

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## NOTES

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## **How Should Central Banks Explore Central Bank Digital Currency?**

**A Dynamic Decision-Making Framework**

Gabriel Soderberg, John Kiff, Herve Tourpe, Marianne Bechara, Stephanie Forte, Kathleen Kao, Ashley Lannquist, Tao Sun, and Akihiro Yoshinaga

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September 2023

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A Dynamic Decision-Making Framework**  
NOTE/2023/008

Prepared by Gabriel Soderberg, John Kiff, Marianne Bechara, Stephanie Forte, Kathleen Kao, Ashley Lannquist, Tao Sun, Herve Tourpe, and Akihiro Yoshinaga\*

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## Glossary

AML/CFT ... anti-money laundering and  
combating the financing of terrorism

CBDC ..... central bank digital currency

DLT..... distributed ledger technology

KPI..... key performance indicators

PoC ..... proof of concept

PSP ..... payment service provider

SMS.....short message service

# 1. Introduction

As digitalization of the economy accelerates, a majority of central banks across the world are exploring retail central bank digital currencies (CBDC).<sup>1</sup> Since CBDC projects take time to come to fruition, central banks need to have a vision for the structure of their monetary and payment systems beyond the medium term (for example, a time horizon of at least 5 to 10 years). Even if the case for CBDCs as a solution to existing challenges may not currently be compelling in some jurisdictions, CBDCs could become necessary as the economy becomes more digitalized.

Exploring CBDC is a significant undertaking that involves complex decisions and considerations in a rapidly changing digital environment. Central banks have significant experience in operating payment systems, but CBDC would entail breaking new ground by offering digital central bank money to the public and by potentially using new technology. Further, some central banks face resource constraints with little room for costly trial and error. Above all, the future is inherently difficult to predict, and central banks need to navigate under considerable uncertainty.

CBDC should therefore be approached with caution, and central banks should carefully assess whether and how it should be implemented. But the same uncertainty also calls for exploring CBDC proactively—there is a risk that central banks will find themselves unprepared in the future and increasingly unable to carry out their basic functions without CBDC. Central banks therefore also need to consider risks arising from *not* exploring CBDC.

To address these challenges, this paper, along with its companion paper, “A Guide to CBDC Product Development”—henceforth referred to as the companion paper—present a structured framework to guide decision makers and analysts in their exploration of CBDC (Tourpe and others, 2023). Acknowledging the uncertainty and remaining unknown factors surrounding CBDC, this framework builds on existing insights and experiences.

The framework is presented as one option to organize CBDC exploration that could help policymakers. Depending on circumstances, policymakers can consider applying parts of it when appropriate. It is also consistent with and can complement the principles of CBDC already published by the G7 (2021) and a coalition of central banks together with the Bank for International Settlement (BIS; Bank of Canada and others 2020).

Each of these two papers focuses on one of the two main aspects of CBDC: policy management and product development. Policy management, covered in this paper, refers to the process of answering the overarching questions, including policy questions such as whether to issue CBDC and what purpose it should fill. The companion paper, however, assists product development managers in experimenting and developing a technical product that will support and operationalize the policy decisions.

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<sup>1</sup> This paper does not cover wholesale CBDC. Wholesale CBDC is limited to a set of predefined user groups, typically banks and other members of national payment systems, whereas retail CBDC is widely accessible to the public. The reason for a focus on retail CBDC is that offering digital central bank money to the general population adds a layer of complexity, which warrants extra analysis compared with wholesale CBDC. However, much of this paper can also apply to the process of exploring wholesale CBDC. See World Economic Forum (2020) for a detailed decision-making process and for a broader analysis of CBDC issuance considerations that includes wholesale CBDC; also see BIS (2019) for an extensive discussion of wholesale CBDC.

This paper focuses on the policy management aspect of CBDC. It considers the unique circumstances and requirements of each jurisdiction, ensuring that the decision to issue a CBDC is an unbiased and informed policy choice. Further details will be explored in subsequent IMF publications, which will ultimately form the CBDC Handbook ([IMF 2023](#)).

The decision framework incorporates the 5P CBDC management methodology, developed by IMF staff. The 5P divides the CBDC project into five distinct phases (the “5 Ps”): preparations, proof of concepts, prototype, pilot, and production. Each phase addresses multiple considerations to minimize risks and maximize benefits.

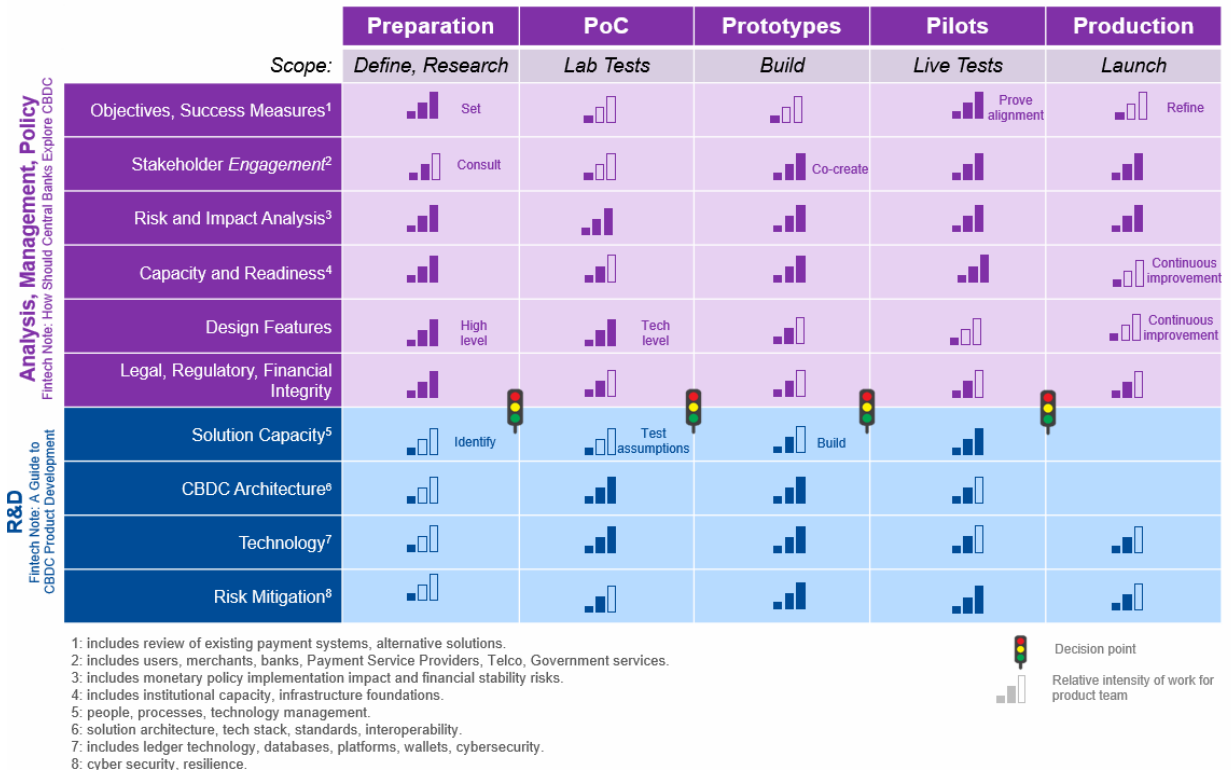
CBDC is still an emergent field, and this is reflected in the structure of the paper. There is more knowledge in the early phases; the closer exploration gets to the question of actual launch, the less we know. The first sections of the paper are therefore more voluminous, whereas there is less established knowledge to draw on in the latter sections. As more knowledge is generated, through experimentation and experience, subsequent IMF publications will cover the later phases in greater detail.

The structure of the paper follows Figure 1, which provides a visualization of the different phases of the CBDC project and the key activities and areas of exploration within each one. The first section discusses the principles of decision making in CBDC projects, including considerations for moving from one phase to the next. The next section discusses the preparation phase. The subsequent section delves into the experimental and developing phases, in which the central bank systematically builds a CBDC solution based on the requirements identified in the preparations phase.

While the paper is written in a sequential order, work on many of the issues are carried out across several phases of the CBDC project. This is depicted in Figure 1 as varying degrees of intensity of the work streams throughout the phases. For example, stakeholder engagement is covered mainly for the preparation phase, because this is where a first plan for stakeholder engagement is created, but it will largely be executed—and potentially revised—in later phases of the project, even though the paper does not discuss it at the same length as in the preparation phase.

Although the principles of sound policy and project management provided in this guide apply to all jurisdictions, the path and destination of each journey is likely to be different given the diversity of jurisdictional contexts, objectives, and challenges.

Figure 1. A Roadmap of the CBDC Process



Source: Authors



## 2. Policy Management and Decision Making

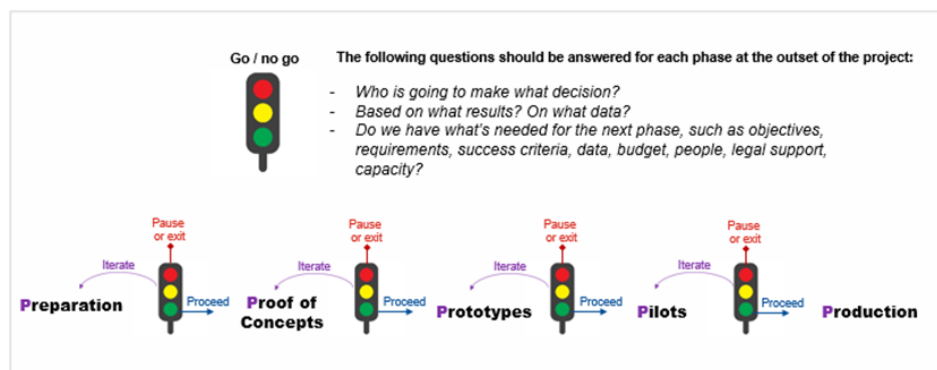
A key task of policy management of the CBDC project is to make decisions within each phase and decide when to progress from one phase to the next. Although the phases are in sequential order, each involves continuous iterative cycles, and central banks can move back from one phase to a previous one. Decision making is therefore dynamic and continuously executed as more information becomes available during the systematic exploration.

The 5P methodology emphasizes the early specification of phase transition points, the "go/no go" points, at which a decision is made on how to progress. At each point the central bank has four options: (1) stay in the same phase, iterate to continue learning or building, (2) move forward to the next phase, (3) move forward with some elements that are ready, but stay in the same phase for some other unresolved question, or (4) pause or stop the project. The criteria for transitioning between phases and the decision-making process should be established early in the project. These criteria can be updated as more information becomes available, reflecting the dynamic nature of the decision-making framework.

Because each phase is expected to go through several iterations, the go/no go process is also an opportunity to change course if necessary (Figure 2). Iterative project management enables an organization to rapidly adapt to new data or unforeseen events (Naybour 2015; Torode and Pratt 2018). Popular methodologies include agile or scrum, which are widely recognized for their ability to promote adaptability and flexibility, especially when dealing with rapidly changing requirements. Cumbersome public procurement procedures and other institutional hindrances, however, might raise challenges to such iterative processes.

**Figure 2. The Go/No Go Decision Points**

*All phases need a predetermined go/no go governance to decide whether to iterate to the same phase, proceed fully to the next phase, proceed partially, or stop the project.*



Source: Authors

In the case of CBDC project development a particularly important factor that could affect the go/no go process is the external environment. The central bank needs to continually update its assessment of the positive and negative factors that could affect its ability to fulfill their mandates. For example, the Bank of Israel has articulated several conditions under which it would proceed with or accelerate its Digital Shekel

project. Box 1 provides a summary. As the environment changes, the CBDC team may also need to reiterate earlier phases of the project and revisit some of the design choices.

### **Box 1. Israel: Potential Scenarios for Deciding to Issue a Digital Shekel**

The Bank of Israel Steering Committee on the Potential Issuance of a Digital Shekel has outlined a number of potential scenarios that could lead to deciding to issue a digital shekel. These scenarios might not be compelling for other jurisdictions. These scenarios are as follows (Bank of Israel, 2023):

- Other countries issue CBDCs. A decision by the United States or the euro area, or by a significant number of other developed economies, to issue CBDCs would influence the decision in Israel.
- The legitimate use of cash, and its acceptance in transactions, declines in Israel. The use of cash as a means of payment is widely expected to decline in the future. As a result, the public's ability to make transactions using central bank money may decline rapidly.
- Significant penetration of stablecoins or other private means of payment that would be broadly used might impair the payment system. A stablecoin that isn't pegged to the shekel might also harm monetary transmission.
- Competition in the domestic payment system diminishes. Continued concentration in some segments of the domestic payments system, incomplete competition in the deposits market, and relatively high entry barriers may justify the issuance of CBDC to support competition in the payments system and in the financial system in the digital era.
- Technology in the payments system continues to develop. It may turn out in the future that there would be significant justification for issuing a digital shekel, since it would be able to serve as an efficient and secure platform for advanced technological use cases.

## 3. Preparation Phase

The preparation phase establishes the rationale and focus of the CBDC project and ensures that there are sufficient resources to execute it. Key tasks are to define the policy objectives of CBDC, begin exploring the technology, and analyze the potential risks, design features, and success criteria.

Country circumstances and jurisdictional characteristics are important determinants of the scope and focus of the preparation phase. For some countries, CBDC could directly address current obvious pain points and threats in the payment system. For example, in systems in which privately provided digital payments are not developed, a payment instrument provided by a central bank, such as CBDC, could be explored without the central bank necessarily taking a future-proofing perspective. In other countries where there are no immediate pain points and threats, the central bank's motivation is likely to be future-proofing: the case for CBDC is contingent on the need for it in the future.

### A. Designating the Policy Objectives of CBDC

The policy objectives that CBDC are intended to promote constitute the core of the project. They inform every subsequent phase and should answer both the *why* and *how* of the project, thus pointing toward the design choices to promote these objectives. Central banks should also in parallel start to consider what technology options are available and how technology could help achieve policy objectives. This subsection discusses how a central bank should navigate the designation of policy objectives.

The policy objectives could potentially be achieved through other means. Individual jurisdictions have different contexts that could impact whether CBDC would be a fruitful approach to promoting the designated policy objectives.

The central bank decision-making process should reflect both short- and long-term perspectives of their mandates and policy tools. There may or may not be compelling short-term motivations for issuing CBDC, but the central bank should also consider future developments that may argue for an immediate start of preparations. Many policy objectives are therefore about preventing or mitigating potential future risks or ensuring that key central bank functions can also successfully be carried out in a digital future (that is, future proofing). Box 2 provides an example of how central banks articulate their motivations for exploring CBDC from a future-proofing perspective.

## Box 2. UK: Motivations for the Digital Pound

The Bank of England and HM Treasury (2023) judge it likely that a digital pound will be needed in the future for the following reasons:

- To sustain access to UK central bank money, ensuring its role as an anchor for confidence and safety in the monetary system and to underpin monetary and financial stability and sovereignty
- To promote innovation, choice, and efficiency in domestic payments as lifestyles and economy become ever more digital

The CBDC decision-making process should be grounded in the central bank's official mandates, which typically include price stability and, to differing degrees, financial stability, full employment, economic growth, financial inclusion, competitiveness of financial and payment systems, consumer protection, and financial integrity.<sup>2</sup> CBDC should be designed and issued in such a way that it would contribute to the ability of the central bank to fulfill its mandate.

Policy objectives need to be prioritized and different technology options identified early in the process. The reason is that there might be later trade-offs when developing specific features and also resource constraints that make it difficult to develop certain features. Stating and justifying the policy objectives in a specific and granular way will facilitate the analysis. The more information the central bank has about the issues that give rise to the problem the central bank needs to solve, the more capable it will be of deciding whether CBDC would be the right solution.

Designating policy objectives should be accompanied with an analysis of suitable success metrics. Not all policy objectives require a significant degree of daily usage of CBDC, whereas others do.

The following subsections discuss the most common policy objectives of central banks when considering CBDC. They are grouped in the following broad categories: promote access to payments and financial inclusion; facilitate payment system competition, efficiency, and resilience; and maintain the access to central bank money in the digital age to safeguard monetary sovereignty, monetary policy effectiveness, and financial stability.

### Access to Payments and Financial Inclusion

CBDC could improve or safeguard the ability of individuals to make payments by overcoming challenges such as cash shortages and merchants' unwillingness to accept cash. In jurisdictions where cash usage is declining, CBDC can provide public access to risk-free central bank money in digital form. Jurisdictions in which cash usage is not currently declining can similarly explore CBDC to prepare for the future. It can also be designed with an accessible user interface to cater to individuals with physical or cognitive disabilities who face difficulties in using other forms of payments. CBDC could be designed

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<sup>2</sup> Financial integrity is a broad concept that covers measures to prevent and combat money laundering, its predicate offenses, terrorist financing, and proliferation financing, as well as measures that, although not specifically covered by the anti-money laundering and combating the financing of terrorism (AML/CFT) standards, are nonetheless indispensable to support an effective AML/CFT system. The internationally recognized standards setting body for AML/CFT efforts is the Financial Action Task Force, whose standards comprise the 40 Recommendations, their Interpretive Notes, and the accompanying Glossary.

specifically to address these issues even if the target population is too small to warrant the development cost for a private firm.

CBDC could potentially help lower barriers to financial inclusion in countries with underdeveloped financial systems, low financial penetration, and limited access to affordable and safe financial products and services (Auer and others 2022, Alliance for Financial Inclusion 2022; Lannquist and Tan 2023). Such barriers include high costs of being banked, low appetite for risk by financial institutions, and distrust of financial service providers.

CBDC could be used to channel government payments directly to households, for instance, subsidies or fiscal stimulus payments. Likewise, CBDC can provide an additional means of payment for individuals for government services, fees, or taxes. In many countries such payments are currently made in cash, which is costly, carries risk, and lacks transparency. CBDC for fiscal transfers could possibly mitigate these concerns.

CBDC systems can also potentially be designed to help reduce frictions in cross-border payments (BIS 2021a, 2022b; World Bank Group 2021). Cross-border payment systems for CBDC could coexist with existing or other future types of cross-border payments or share a common system with other non-CBDC forms of digital money. Domestic CBDC systems can be interlinked (for example, Project Icebreaker of the BIS Innovation Hub) or common platforms could be developed for cross-border payments in multiple CBDCs (for example, Project mBridge of the BIS Innovation Hub). However, to realize the potential of CBDCs to enhance the efficiency of cross-border payments, central banks have to work together from an early stage to achieve interoperability of their CBDCs.

The central bank needs to evaluate the alternative and complementary solutions to achieving the objective of payment access and financial inclusion. For instance, many central banks are weighing whether instant payment systems could promote cheaper and faster digital payments and if they could fruitfully coexist with CBDC.<sup>3</sup> Likewise, digital and financial literacy programs are likely needed as a complement to CBDC to address financial inclusion goals.

### **Payment System Competition, Efficiency, and Resilience**

Payment systems exhibit economies of scale and network effects, which could result in digital payment networks becoming dominated by a few payment service providers (PSPs) in some jurisdictions over time. That could result in a lack of contestability, resulting in high fees and large social consequences of potential service disruptions, particularly in emerging markets. CBDC could serve as a “redundancy” system to complement non-CBDC payments, thereby potentially increasing payment system resilience. This would not necessarily require a high degree of adoption—as long as the CBDC is available, it would fulfill a useful role.

CBDC could also complement cash. Physical cash distribution can be challenging sometimes, for example, during and after natural disasters. CBDC could potentially complement cash and reduce the need for cash distribution infrastructure. Of course, that approach shifts the burden to the resilience of

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<sup>3</sup> Instant payment systems enable domestic account-to-account payments, with the recipient being credited in real time (or near-real time) on a 24/7 basis (Khiaonarong and Humphrey 2022). However, CBDC allows access to a wider set of the unbanked population and offers programmability features that an instant payment system may not provide (Kosse and Mattei 2023).

cellular networks and internet services provisions. Again, promoting resilience to natural disasters or wars does not necessarily require a high degree of adoption in normal times.

In addition, CBDC could be designed as a platform for private sector PSP initiatives to stimulate innovation and competition that could lower payment fees and improve payment system efficiency. Ensuring that there are proper incentives and low barriers of entry for firms will be key. This could be done by designing the CBDC as a platform open to private PSPs. Introducing competition needs to be balanced, however, with the risk of fragmentation, for instance, through introduction of noninteroperable systems. Therefore, CBDC could also be designed as an infrastructure that could help achieve standardization and interoperability of private systems.

CBDC could also serve as the ultimate settlement asset for tokenized finance that could open up new opportunities of the monetary and financial system (BIS 2023a). By underpinning settlement finality and providing access to risk-free money, CBDC could provide a foundation of trust. Both wholesale CBDC—not the focus of this paper—and retail CBDC could help safeguard the singleness of money by ensuring convertibility of different tokenized private money.

### **Monetary Sovereignty and Monetary and Financial Stability**

CBDC could potentially ensure that central banks can continue to not only fulfill their functions in the future, but also improve their functions by leveraging new technology. With digitalization and falling cash usage in parts of the world, central banks are considering CBDC to ensure a fundamental anchor of trust in the monetary system (Bank of England and HM Treasury 2023; Ingves and others 2022; Lagarde and Panetta 2022). Public money, being risk free, provides a benchmark for all other types of money, and backstops them through convertibility. This convertibility helps ensure monetary and financial stability. In a digital future where cash is no longer in use, CBDC could continue to serve this function.

Central banks are exploring ways to maintain the demand for central bank money in the face of widespread use of crypto assets and potentially foreign-issued CBDCs. If a significant share of domestic transactions is not denominated in the official unit of account and not settled through central bank money, monetary policy could become ineffective (He 2018; Flodén and Segendorf 2021; Bindseil, Panetta, and Terol 2021). This is the currency substitution problem that some emerging market and developing economies are already suffering.

A CBDC could potentially improve the competitiveness of the domestic currency versus foreign currencies or other privately issued digital money if it is well-designed with attractive use features. For instance, if the CBDC has considerable user convenience or reduced cost to obtain it, compared with cash issued in another jurisdiction, the domestic population might shift their usage toward domestic currency. However, the overriding factor to avoid currency substitution will still be to maintain credibility of the value of the domestic currency.

If CBDC successfully lowers the barriers to financial inclusion, it could strengthen monetary policy transmission since users would be exposed to interest-sensitive services through the banking sector (Mehrotra and Nadhanael 2016). To the extent that CBDC competes with bank deposits, whether remunerated or not, banks' incentives to track deposit rates more closely with policy rates could increase, thus potentially improving monetary policy transmission. However, that in turn could undermine the

deposit franchise value of commercial banks, thus leading to consolidation and concentration. Such trade-offs are potentially first order and need to be carefully considered.

CBDC could enable more targeted monetary policy via direct transfers in emergency situations. Such *helicopter* monetary stimulus could be used in extreme circumstances such as wars, pandemics, or natural disasters, if judged to be consistent with the central bank's mandate.

CBDC could also reduce currency substitution, thus potentially enhancing monetary policy implementation (Armas and Singh 2022). Non-interest-bearing CBDC could preserve seigniorage in the face of declining cash usage and in some countries help support financial and operational independence of the central bank.

## **B. Macrofinancial Risk and Impact Considerations**

Throughout the CBDC decision-making process, central banks should analyze the potential impact on monetary policy implementation and transmission as well as on financial stability. Crucially, the risks can be mitigated by prudent design choices. Risk analysis should therefore be carried out before or in parallel with and inform the design process. This section discusses the risks and the later section on design choices discusses the design process.

### **Impact on Monetary Policy Transmission and Central Bank Operations**

Monetary policy is at the core of central bank functions, and the implications of CBDC issuance on its transmission should be carefully assessed.<sup>4</sup> Implications are likely to depend on the degree of adoption of CBDC and the design of CBDC. Several analyses conclude that monetary policy transmission impact of CBDC is unlikely to be significant with a risk-mitigating design, such as nonremuneration and limits on holdings (Mancini-Griffoli and others 2018; Meaning and others 2018). Central banks also have means to counteract effects on monetary policy transmission by using traditional central bank operations.

As discussed in Das and others (2023), issuance of CBDC could result in a one-off tightening or loosening of the monetary policy stance. Central banks need to monitor potential effects and if necessary take measures to maintain the monetary policy stance. For instance, if there is outflow of deposits to CBDC, banks could respond by decreasing credit creation, which leads to a tightening of the monetary policy stance. Central banks would then need to respond by loosening monetary policy to keep the policy stance unchanged.

Additional effects include entrenching the zero lower bound in case of unremunerated CBDC as digital money, unlike cash, has no storage costs (Armeliu and others 2018).

### **Impact on Banking Sector Intermediation and Financial Stability**

A CBDC could be used not only as a means of payment but also as a store of value. As such, it could undermine commercial bank intermediation. The potential for disintermediation depends on the design of CBDC, particularly the level of CBDC remuneration via interest rates. None of the launched or piloted CBDC to date is interest bearing. But, in principle, the level of interest rate of the CBDC is a policy choice that could vary over time.

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<sup>4</sup> Monetary policy implications of CBDC is further discussed in Das and others (2023).

If an interest-bearing CBDC did lead commercial banks to raise deposit rates, theoretical models suggest that the magnitude of effects on the banking sector depend on the structure of the banking system and might be small in some circumstances. Much depends on banking sector concentration and banks' loan market power (Agur, Ari and Dell'Arriccia 2019). In some settings higher bank deposit rates could lead to more deposits and lending (Chiu and others 2022). However, potentially commercial bank disintermediation could be meaningful, and that is an important policy consideration.

An additional consideration is the riskiness of commercial bank loans. Renumerated CBDC could push banks to invest in riskier projects, increasing total financial system risk. Banks could also turn to wholesale short-term money markets. Because wholesale funding tends to be more volatile, banks may have to reduce lending and hold more liquid assets under current regulatory liquidity requirements (BIS 2013, 2014a; Bank of England 2021). Also, smaller banks could be disproportionately affected because they lack access to alternative funding markets and could find it more difficult to compete in a higher interest rate setting, ultimately leading to a more concentrated banking sector (Garratt and Zhu 2021).

CBDC may become an attractive *safe haven* in times of financial turmoil by offering a safe and liquid alternative to deposits and could thus be an attractive destination of a potential run on banks. Such run risk from commercial bank liabilities to CBDC could occur even when CBDC is not interest bearing. In theory, CBDC design may limit such run risk in times of crisis. Furthermore, crisis management tools including deposit insurance and discount window policies can—at least in principle—limit run risk. However, these are serious concerns and risks that have to be carefully considered. Many jurisdictions consider limits on CBDC holdings to limit run risk, and state contingent policies including potentially negative rates on bank digital currency holdings in times of crisis. A further serious concern is if foreign CBDC is easily available—runs toward foreign CBDCs could make it more difficult to manage a currency and liquidity crisis, particularly in emerging market and developing economies. Such flight to foreign CBDC could potentially destabilize domestic monetary policy and the banking system. In such cases jurisdictions could consider capital flow management measures in the design of CBDC (He and others 2023).

Central banks need to make a careful assessment of the ability of the financial sector to adjust to CBDC issuance. This assessment should cover both potential initial effects as the CBDC is issued, as well as longer term effects when the CBDC could affect the structure and functioning of the financial system and the economy more broadly. This will involve assessing banking sector robustness, competitiveness, bank reserve levels, and funding structures. The central bank should conduct a thorough scenario analysis with a spectrum of different CBDC adoption outcomes, tracing banking sector impacts based on the data and parameters discussed previously, for each scenario. This exercise gives the central bank a landscape of potential outcomes that can guide design choices, for instance, a hard cap on holdings of CBDC or conversion limits, which is discussed in the section on design choices, could limit disintermediation risk.

### **C. Foundational Capacity Assessment**

The central bank needs to assess early on what is required to execute a CBDC exploration process and successfully implement a CBDC in the jurisdiction. This foundational capacity assessment includes the internal capacity of the central bank as well as that of the jurisdiction's economy and infrastructure.



No universally applicable best practices or prescribed rules exist that guarantee the success of CBDC, but capacity assessment can facilitate the decision-making process and help policymakers identify and address any gaps or deficiencies in crucial elements. Coordinating with line ministries and government agencies will ensure consideration of foundational elements outside the central bank purview.

The following subsections discuss the critical foundations of a successful capacity assessment by the central bank and, where relevant, other stakeholders.

### **Infrastructure Foundations**

Issuing a CBDC requires an adequately developed, available, and resilient nationwide technological infrastructure, including electricity grids, mobile networks, and internet coverage.<sup>5</sup> If the technology infrastructure is found to be lacking, it may be best for the central bank to pause its CBDC project and work with the government to accelerate the filling of the gaps identified. Achieving a high level of digital infrastructure, however, is likely to require a significant investment (Oughton, Amaglobeli, and Moszoro 2023).

### **Institutional Capacity**

For a successful CBDC project, the identification of adequate human resources is crucial, including for central bank and stakeholder personnel, all other competent authorities, and private sector collaborators. It must be assessed whether the central bank has sufficient know-how among its staff to design and run the technological solutions and, if not, what role third-party technology service providers will play. The skills and knowledge required for all aspects of the project must be assessed, including experimentation, development, and finally operation if the CBDC would be issued. This includes not only technical expertise, but also proficiency in areas such as law, communication, and change and risk management. Policy capacity is also needed to assess the financial stability and macroeconomic implications.

If institutional capacity is insufficient, central banks can explore how to fill the gap. A thorough analysis of the existing capacity and constraints will provide guidelines for such capacity enhancement. For instance, if it is found that cybersecurity capacity is lacking, the central bank can analyze whether more cybersecurity experts can be hired and whether cybersecurity processes could be improved.

Central banks should also consider the impact of CBDC issuance on central bank internal operations. Staff need to perform ongoing monitoring and respond quickly to urgent technology issues after deployment to ensure business continuity, security, and operational resilience. Redundant systems and business continuity will need to be established for critical operations. The 24/7/365 nature of a CBDC operation will require a security operations center working around the clock with the capability to quickly address and mitigate security events. From a governance perspective, quick-response decision making is required to address urgent issues and ensure business continuity and operational resilience.

While the CBDC technology platforms include recent innovations and initially require external assistance, there must be a proactive strategy to build internal expertise to reduce overreliance on

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<sup>5</sup> Sources for digital connectivity data include the [Global System for Mobile Communications](#), which conducts and publishes country- and region-specific reports on various aspects of mobile economies. National governments and telecommunication industry associations are often good sources of such data.

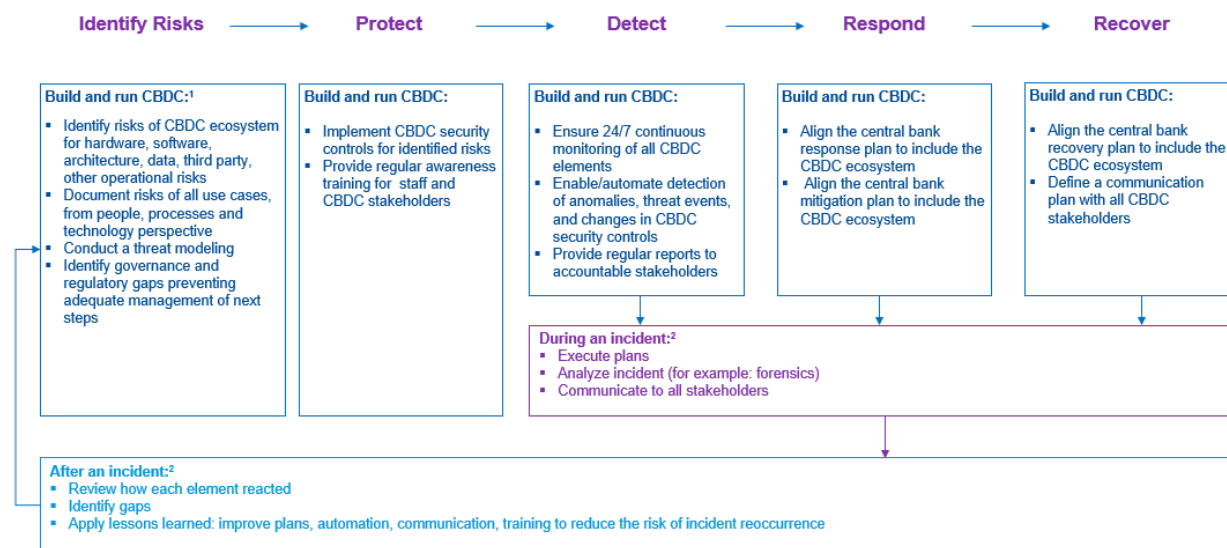
outsiders. In particular, it is important that central banks possess technology expertise to complement those of technology vendors to reduce operational risks.

### Cybersecurity Readiness

CBDC needs a strong cybersecurity posture (BIS 2023b). Cyberattacks can compromise end user data and funds, the central bank’s reputation, trust in money, and the stability of the payment system. The CBDC may be especially targeted for attacks, owing to its close affiliation with the jurisdiction’s government institutions, which certain state or nonstate actors may want to harm. Any perception of security vulnerability by the public would significantly impact adoption, and a cyberattack on a jurisdiction could negatively affect global public perceptions about CBDC.

Countries should introduce specific security assurance activities (for example, architecture risk analysis and threat modeling) to design, build, deploy, and maintain a secure CBDC ecosystem (Figure 3). They should have the capacity to maintain or upgrade cybersecurity posture constantly.

**Figure 3. Building CBDC Cyber Readiness**



1: refers to work performed during the design of the CBDC, followed with continuous improvements

2: incidents represent either an exercise (conducted frequently by a specialized team) or an actual event.

Source: Authors

### Governance

Central banks differ in their internal governance structure (Bossu and Rossi 2019), but all relevant decision-making bodies must be involved in the CBDC process. Central banks should assess and if needed strengthen their governance before embarking on a CBDC project. Nonexecutive boards of central banks, such as boards of directors or supervisory boards, need to be involved early in the process and regularly updated on progress. Oversight boards should have the necessary expertise to oversee the CBDC process, in particular, confirming the integrity of the financial controls and the robustness of risk management systems.

### D. Stakeholder Engagement and Public Communication

Central banks should identify and map stakeholders of CBDC issuance and adopt a strategy for engaging with them throughout the CBDC project from start to finish, albeit at different levels of intensity. There are multiple stakeholders, with different and occasionally conflicting perspectives on CBDC. In addition, end users—both merchants and consumers—constitute a vast and diversified group that is often not directly represented by an organization that the central bank can communicate with.

The central bank needs to devise an engagement strategy to get input from as broad a range of these groups as possible, for instance, by sending out questionnaires to random samples of individuals in a specific area or income bracket. There might also be segments of end users, such as the unbanked or functionally disadvantaged, that the central banks might want to target.

The central bank needs to map the different stakeholders and assess how to best engage with them depending on their different characteristics. Table 1 provides an overview of potential stakeholders in a jurisdiction.

**Table 1. Stakeholders Potentially Involved in the Study, Development, and Operation of a CBDC**

Central Bank Functions	Public Sector and Government	Financial and Private Sector	Payment System Infrastructure	Service Access	Beneficiaries
Payments	Regulatory/supervisory agencies	State-owned banks	Card networks	Tech providers	Banked, unbanked, merchants
Banking operations	Law enforcement agencies	Private banks	Retail systems	Standard setters	consumers
Monetary policy	Legal agencies	Cash-in/out	Wholesale systems	Support	Unconnected or underconnected users
Financial stability	Ministry of Finance	Microfinance	Mobile payments	Digital identification providers	Nonresidents
Risk management	Information and Communication	Payment service providers		Telcos	Government or public sector entities
Marketing	Technology Ministry	Fintech firms		Internet service providers	
Communication technology	Parliament	Other nonbanks			
	National identification authority				
	Academia				

Engaging with stakeholders provides crucial information for decisions and is necessary for successful CBDC implementation. Stakeholders can provide input regarding how to design a potential CBDC by communicating specific concerns that could be addressed by certain features.

Governments, in particular, ministries of finance, are key stakeholders. The central bank should carefully coordinate with government authorities to ensure support and that the CBDC would also address their needs and challenges. For instance, authorities that carry out regular government-to-household payments, such as social security transfers, can provide important feedback on the challenges they face. In some jurisdictions CBDC exploration can even be carried out jointly with a ministry of finance. For instance, the Digital Pound project is carried out in collaboration between the Bank of England and HM Treasury (2023).

Most jurisdictions require approval from political stakeholders for legal reforms that will allow potential CBDC issuance. Political decisions should be based on information that is as accurate as possible. Other government authorities, public institutions, and stakeholders will also need to be consulted when discussing whether to give the central bank the authority to issue CBDC. Misunderstandings of the nature

of the project can become engrained and effectively block the possibility of issuing CBDC for the foreseeable future through lack of support for the project. For instance, misunderstanding of the nature of programmability of money and the ability of central banks to monitor individual transactions has generated a backlash against CBDC in some countries.

Finally, the adoption of the CBDC will rely on stakeholder engagement and communication. This entails: (1) understanding how to design a CBDC that is useful and sufficiently different from other established means of payments and (2) that these traits are efficiently and consistently communicated to the public.

Maintaining public confidence in the central bank and in the value of the CBDC is essential. Policymakers should adopt trust-building policy measures, which entails taking concerns expressed by stakeholders into design considerations. For instance, both the Bank of England and the European Central Bank have clearly expressed that their potential CBDCs will not be programmable by the central bank or the government—reflecting concerns from stakeholders that programmability could restrict the spending choices of users.

### **Stakeholder Engagement Activities**

Many central banks publish a whitepaper or a set of reports once they have reached certain thresholds or milestones, usually after an initial assessment of CBDC or after a proof-of-concept (PoC) or pilot program has run for a time. These publications fill the role of communication but could also be used to engage stakeholders. Modern central banks usually also apply digital social media channels, such as YouTube or Facebook, to communicate with the general public, most often in the form of infographics or short videos.

The central bank can also invite actors to discuss the present stage of the CBDC project or arrange open or closed discussion forums with larger groups, for instance, with representatives of the commercial banking sector. It is important to carefully map who is invited so that no actors get an unfair advantage in getting their perspectives heard.

Engaging political decision-making bodies early is also important. In some jurisdictions representatives of the central bank regularly meet with the political body they are accountable to; for instance, the financial committee of the Swedish Parliament has several meetings every year with the Riksbank's executive board for briefing and questions and answers. Such meetings provide an important opportunity to inform and discuss the central bank's progress in CBDC and any concerns the political body might have.

Surveys are used extensively by government agencies that collect information crucial for fulfilling their function. Box 3 provides a country example. Random sampling of send-out surveys can ensure that necessary information is collected without being too resource intensive. Such surveys could also target specific types of households, such as low-income households or those in a specific area.

### **Box 3. The Bahamas and the Exuma Pre-pilot Research**

In December 2019 the Central Bank of the Bahamas (CBOB) launched a CBDC pilot on the island of Exuma (CBOB 2019). Nine months prior, the CBOB conducted a survey in the region to assess the level of digitalization, financial inclusion, and willingness of the population to adopt new digital means of payments. In addition, the survey was meant to provide a benchmark to estimate future progress resulting from the potential launch of CBDC. Residents were randomly selected and invited to take part in the study, either by phone or in-person visits to their homes.

The results provided the CBOB with an affirmation that there was demand for increased use of digital payments that currently was not met and that greater ease of access to financial services—through digital payments—could increase financial inclusion. It also revealed a high rate of mobile phone ownership. The survey led the CBOB to conclude that building public awareness about security within the CBDC infrastructure was key going forward.

## **E. Design Choices of CBDC**

CBDC design choices should be aimed at meeting the designated policy objectives while minimizing the identified risks. Also, stakeholders should be consulted on their views on design features. The better stakeholder preferences are understood, the easier it will be to make design choices that will appeal to them. There might be trade-offs between policy objectives and risk mitigation measures. For instance, the wish to reduce disintermediation impact of CBDC by choosing not to remunerate holdings might diminish its attractiveness and reduce its ability to promote other goals. A solid prioritization of policy objectives and risk analysis will provide a foundation for managing such trade-offs.

It is useful to distinguish between four levels of design: (1) design choices that should be considered mandatory—we refer to these as design principles, (2) high-level design choices on the CBDC that we refer to as its operating model, (3) design features that are intended to achieve particular purposes, such as provide a particular type of user functionality, and (4) technology platform choices.

### **Design Principles**

Design principles should inform the development and testing of the CBDC at every stage of the process (Figure 4). First, the design of CBDCs should be centered around promoting the policy goals while taking into account user needs. A comprehensive understanding of user expectations in regard to usability, features, services, integration, security, and cost is a vital design principle for adequate adoption.

The CBDC should be designed to be interoperable with existing payment networks, including commercial bank and e-money networks and ATM machines. Convertibility into public money is widely accepted as a source of confidence in privately issued money. Interoperability is also important for adoption, as the ability to pay firms and individuals who have some form of digital wallet but not a CBDC wallet would increase the attractiveness of the CBDC as a means of payment.

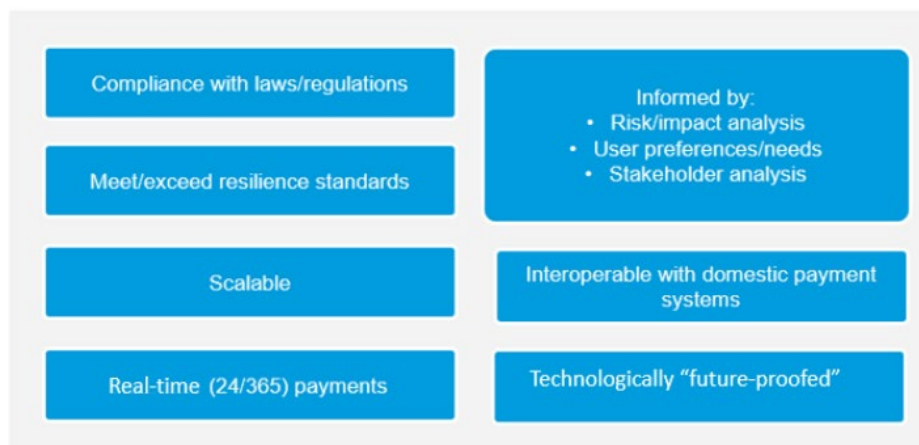
Also, design features must be compatible with existing laws and regulations and be accompanied by necessary legal and regulatory changes when appropriate to do so. For example, CBDC should be developed, taking into consideration existing data protection laws and regulations. At the same time, jurisdictions will also need to ensure that they can comply with the Financial Action Task Force standards and mitigate the money laundering and terrorist financing risks of their CBDC effectively.

At a minimum, all components in the CBDC system should meet or exceed the established resiliency and security standards of financial market infrastructures. To provide a competitive solution it should provide instant transaction settlement around the clock all year long and be able to recover quickly from operational disruption. A CBDC should be devised with scalability in mind and able to handle increased volumes of transactions without running into operational difficulties.

The design must be capable of incorporating risk-mitigating features. For example, reducing risk of bank disintermediation could entail specific design choices, such as holding and transaction size caps.

The CBDC must be designed and implemented in a manner that facilitates upgradability to accommodate evolving requirements and advancements in technology. In other words, the CBDC should from the outset be technologically *future-proofed*, and the central bank should adopt a mindset that continual updates to the system will be necessary after a potential launch.

**Figure 4. CBDC Design Principles**



Source: Authors

### **CBDC Operating Model and the Distribution of Functions between Different Actors**

The operating model is the highest-level CBDC design choice. By definition, a CBDC is issued by the central bank. However, many functions need to be carried out, from offering payment interfaces such as cards or digital wallets to providing customer support. CBDC operating models are broadly placed in two major categories: one- or two-tier models. In the one-tier model, the central bank carries out all the functions in the CBDC system, whereas in the two-tier model, the central bank issues the CBDC but delegates part of the operational work (see below) to a network of private sector intermediaries. However, the central bank remains responsible for ensuring that such intermediaries abide by the relevant standards (for example, security requirements). The two-tier model thus involves both public and private

sector actors, and jurisdictions have different circumstances that will affect the exact distribution of functions between the two types of actors.

To limit the operational burdens on the central bank, central banks primarily focus on the two-tier system.<sup>6</sup> But the central bank still needs to consider which functions should be carried out by private sector actors. In general private sector intermediaries engage with the end user, performing such tasks as providing customer support and conducting customer due diligence as well as other anti-money laundering and combating the financing of terrorism (AML/CFT) controls. A range of functions, for instance, storing user data or processing payment transactions, can be either private or public (Soderberg and others 2022). Crucially, the two-tier model relies on incentives of private sector actors to carry out their functions. Future IMF publications will consider different business models for CBDC intermediaries in more detail.

### **Design Features Aimed at Specific Purposes**

Regardless of high-level design choices, a central bank needs to make decisions that will affect the practical experience and use of CBDC. These are usually aimed to further a particular policy objective or reduce a particular risk.

### **Account and Transaction Limits**

To reduce risks of bank disintermediation, holdings of CBDC could be capped. For greater flexibility there could be CBDC wallets with different caps that could also be combined with greater or lesser requirements for identification. If holding limits are reached, the excess can automatically be transferred into the receiving user's bank account (Bindseil 2020).

Finally, jurisdictions can consider whether there are reasons to limit CBDC holdings by foreigners, who can own and pay with CBDC when visiting the jurisdiction after registering for an account with a low limit on both holding and transaction sizes.

### **Low Connectivity and Offline Use**

CBDC could be designed with the capacity for transactions via short message service (SMS),<sup>7</sup> for completely offline access (when no internet or telecom connectivity is available), or both (BIS 2023a). SMS-based digital payment platforms, such as M-PESA, are popular in sub-Saharan Africa and other regions. Nigeria's eNaira CBDC uses SMS and other technologies, such as unstructured supplementary service data, to provide access to Nigerians who have only basic mobile phones or cannot access the internet (Clickatell 2022). Ghana has piloted a smart card-based E-Cedi CBDC that supports consecutive offline payments, for example, from person A to person B to person C (Consultative Group to Assist the Poor 2023).

### **Cross-Border Functionality**

International organizations and central banks are collaborating to consider options to use CBDC to lower costs and increase speeds of cross-border payments (BIS 2021a and 2022b).

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<sup>6</sup> A limited one-tier system can still be considered as a backup to ensure basic payment services in extreme scenarios.

<sup>7</sup> SMS is the protocol used by cellular phones to send and receive text messages over a 2G, 3G, 4G, or 5G network. According to the Global System for Mobile Communications, 40 percent of the global population covered by a mobile broadband network is not using the internet. This does not even account for the population that has access to SMS but not to the internet. See <https://www.mobileconnectivityindex.com/>

If improved cross-border functionality is an important policy objective for the CBDC project, central banks should reach out to their foreign counterparts, in particular within the same region or to countries with which they share significant trade and financial linkages, to jointly discuss issues of CBDC interoperability and design. Central banks should also seek communication with international organizations, such as the BIS and IMF, which can serve as joint platforms for sharing information and discussing how to create suitable frameworks to facilitate the creation of CBDC arrangements for cross-border payments.

### Remuneration

Although none of the CBDCs launched or piloted to date have been remunerated, there are reasons to consider interest-bearing CBDC, such as supporting monetary policy (see Monetary Sovereignty and Monetary and Financial Stability subsection).<sup>8</sup> Remuneration could also be used to modulate CBDC demand by increasing (decreasing) rates to ramp up (dampen) demand. To mitigate disintermediation risk, “tiered remuneration” (high interest rates for small holdings and low rates for high balances) can be used to discourage demand for CBDC as a store of value. However, legal issues might arise from interest-bearing CBDC that should be carefully assessed. For instance, it must be assessed whether the CBDC can legally be remunerated. Even if the decision is made not to remunerate, the capacity to do so could be incorporated to keep future options open (Kiff and others 2020).

### Privacy and Anonymity

In developing a CBDC, central banks will need to consider various aspects and norms relating to privacy. One of the primary facets of privacy relates to rights and responsibilities surrounding the collection and use of personal information. There are three plausible forms and degrees of data privacy in ascending order of privacy (ECB 2022):

- Fully transparent to central bank, in which all data related to transactions and customer due diligence are visible to the central bank
- Transparent to intermediary, in which all transaction and customer due diligence data are visible to the intermediary
- Privacy threshold, in which there is a high degree of privacy for low-value transactions, whereas large-value transactions are subject to standard customer due diligence checks

Complete anonymity would conflict with AML/CFT procedures, and most central banks are opting for the privacy threshold model as the best compromise between guaranteeing privacy of payments, while accounting for regulatory requirements. Box 4 provides an example. Also, central banks typically have access only to pseudonymous data, but in some cases they can de-anonymize it if they can show probable cause, such as with a court order. Technology solutions have been developed that could potentially offer ways to increase privacy for select types of transactions.<sup>9</sup>

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<sup>8</sup> Sharia principles that govern financial affairs in Islamic jurisdictions prohibit interest payments, so in those cases remunerated CBDCs may not be an option (Lukonga 2023).

<sup>9</sup> Gross, Sedlmeir, and Seiter (2022) have proposed a CBDC system that enables cash-like private CBDC transactions up to specific monetary limits. Chaum and Moser (2022) have proposed a CBDC system based on blind signatures that allows central banks to issue tokens through PSPs without knowing who owns specific tokens. The BIS Innovation Hub's Swiss Centre has launched Project Tourbillon, which will build and test this eCash 2.0 platform.



#### **Box 4. A Possible Digital Euro and Privacy**

The European Commission's regulatory proposal establishing the legal framework for a possible digital euro aims to ensure privacy and data protection by design and by default (European Commission 2023). This is consistent with the European Data Protection Board digital euro privacy "wish list," which cautioned against the use of systematic validation and tracing of all transactions in digital euros (European Data Protection Board 2022). In this respect, the European Data Protection Board recommended that the digital euro be made available both online and offline, along a threshold below which no tracing is possible, to allow full anonymity of daily transactions.

According to the proposed legislation, user personal data would be accessed and processed mainly by the PSP with whom the user holds a digital euro account, for account management purposes, fraud prevention, and to abide by financial integrity regulatory requirements. The Eurosystem central banks would not be able to identify individual digital euro users or what they do with their money. The banks would have access only to encrypted data and only to the extent that this access is necessary to settle digital euro transactions and support payment services providers in performing their tasks.

Also, the digital euro must be usable to make low-value payments while offline as long as there is physical proximity between payer and the payee devices. And just like cash, the details of offline digital euro payments should not be visible to anyone—neither the user's PSP nor the Eurosystem central banks. It must be also possible to hold digital euro locally stored on electronic devices up to a certain threshold.

#### **Programmability**

CBDC could potentially be programmed for conditional payments by utilizing technologies such as smart contracts (Monetary Authority of Singapore 2023). Potential functions of programmability include making automatic point-of-sale tax payments (Bank of England 2020). Also, and controversially, smart contracts could restrict where or when it could be spent, for example, if funds are provided as part of a government household relief subsidy. However, there is concern that programmable CBDC could impinge on the universality of currency and blur the boundaries between currency and vouchers. Reflecting such concerns, several central banks have stated that they will not issue CBDC that are programmable by central banks or governments (HM Treasury Bank of England, 2023; ECB 2023). There is, however, a difference between smart money and smart payments. Thus, payment conditionality can be introduced within the payment infrastructure without altering the nature of the digital currency itself (Gross 2020). Such programmability of payments is not unique for CBDC and could be applied to other types of digital payments as well.

#### **Choice of Technology Platform**

The choice of CBDC technology platform should be guided by several factors, starting with the policy objectives. The use cases, regulatory context, stakeholders' readiness, risk assessment, and other

considerations outlined in this document should also be taken into consideration when choosing the right technology and technology partners.

A key CBDC design decision is whether to use a traditional centralized ledger or a distributed ledger technology (DLT) platform that decentralizes selected functions to multiple agents, such as the verification and settlement of transactions. DLT can either be open, which means that anyone can take part in validating transactions, or permissioned, which means that a few trusted counterparties take part in validation. All DLT-based approaches to CBDC are currently permissioned, and it is difficult to see how systems that are not permissioned could be compatible with financial integrity. Permissioned systems are to some extent similar to traditional payment systems but can provide new functionalities and new features such as encryption and tokenization.

There is no definite answer on the right option for a particular central bank. It is important to distinguish payment system design from technological options. In principle, payment systems design could be achieved with a variety of technologies.

Table 2 shows some of the considerations that may make one technology more attractive than another. Potential benefits of permissioned DLT-based platforms include, if designed properly, enhanced resilience, the ability to implement alternative governance structures, and compatibility with potential DLT-based financial asset platforms. However, central banks should weigh the benefits against the risks of decentralizing authority to adjust claims on their balance sheets. Most central banks already have mature security postures to manage centralized databases. Also, centralized platforms are in general more scalable than DLT-based platforms (in terms of transaction throughput). However, centralized models will likely also impose a stronger burden on the central bank as the administering authority. If a DLT-based platform is chosen, the central bank must decide who will have access to the ledger and what their respective roles will be.

**Table 2. Potential Advantages of Centralized Databases versus Permissioned DLT**

Advantages of Centralized Databases	Advantages of DLT (if implemented properly)
<ul style="list-style-type: none"> <li>▪ Competencies more readily available for technology, security, and vendor relationship</li> <li>▪ Better control of privacy</li> <li>▪ Easier to scale</li> <li>▪ Easier to upgrade</li> <li>▪ Large available product base built on top</li> </ul>	<ul style="list-style-type: none"> <li>▪ More resilient by design if no single point of failure is introduced</li> <li>▪ Offers new governance options</li> <li>▪ Central bank does not have to hold any private data</li> <li>▪ Could increase compatibility with DLT-based tokenized financial assets</li> <li>▪ Innovative domain, with new solutions emerging from decentralized finance</li> </ul>

Source: Authors. Note: DLT = distributed ledger technology.

An additional consideration is the compatibility with the technological infrastructure of the domestic banking system and legacy payment systems. At this time, commercial banks largely rely on centralized databases that do not feature the technological benefits of newer technologies. How to support technological transition of the domestic banking system and payment systems are additional key considerations.

## F. Legal Framework, Regulation, and Oversight

CBDC issuance and distribution require a sound legal basis and robust regulatory foundations. Lawyers with expertise in central banking and monetary law, payment systems law, and financial law need to be involved in the design of CBDC, as the legal framework is critical to provide legal certainty, contribute to financial stability, and ensure appropriate accountability and transparency over the central bank's role. Also, a CBDC arrangement may have implications for financial integrity, depending on the various design choices. To address possible risks to financial integrity resulting from CBDC issuance, the AML/CFT regime may need to be updated. CBDC issuance also requires a strong rule of law environment with well-functioning institutions to ensure effective protection of rights and mitigate risks of corruption and fraud related to CBDC issuance and conversion.

Central banks should ensure they have a legal basis to issue CBDC under the design they ultimately chose. Furthermore, such a legal basis is a precondition for the authorities' mandate in setting up a supervisory and regulatory framework to support CBDC safety.

Legal amendments are likely needed to give CBDC private transactions legal certainty, as well as to strengthen the supervisory and regulatory framework surrounding CBDC operations (for example, allowing CBDC service providers to be appropriately supervised and regulated). Central banks should design CBDC systems to facilitate compliance with existing national capital flows management measures including for the holding and using of CBDCs by nonresidents and to respect monetary sovereignty of foreign jurisdictions. Moreover, central banks should take into account when designing CBDC the laws and regulations related to technology-based data security, privacy protection, and confidentiality.

This section presents preliminary considerations that will be further developed in detail in upcoming publications.

### Legal Basis for CBDC Issuance

CBDC requires a legal underpinning in both public and private law (Bossu and others 2020).<sup>10</sup> Therefore, the authorities should, before the issuance of CBDC, assess the existing legal framework to evaluate whether (1) there is a legal basis for issuance or (2) adjustments are needed.

Necessary legal reforms would eventually depend on the design and use cases. Central banks should carefully review the existing public and private laws in their jurisdiction. For example, one design feature that would have major legal implications is the legal relationship between the central bank and the holder of CBDC—especially whether there are contractual relationships between the central bank and CBDC holder. For legal purposes, if the CBDC is based on a current account contractual relationship, it can be classified as account-based, that is, a digital balance linked to specific users on the books of the central bank.<sup>11</sup> Account-based CBDC would deploy conventional banking techniques (based on a contractual relationship between the central bank and the CBDC holder) in which transfers are done through debits and credits of accounts. If it is classified as token-based, it implies that a *sui generis* claim on the central bank is incorporated in an immaterial token, and the transfer of the token equals the

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<sup>10</sup> Public law rules the “vertical” relationship between the state and its subjects, which in the context of CBDC focuses on the legal foundations of CBDC under central bank law and its treatment under monetary law. Private law is the area of law that affects the “horizontal” relationships between individuals and groups, which defines the legal relationship for the holding structure of CBDC and how it will be transferred.

<sup>11</sup> The terminology used here deviates slightly from that introduced by [Khan and Roberds \(2009\)](#) of account- versus token-based payment systems. This is to distinguish this level of classification more clearly from the technology used, as the word *token* often denominates a blockchain-based payment instrument ([Garratt and others 2020](#)).

transfer of the claim, which raises the novel legal issues discussed in the next section. Cross-border use of CBDC would entail additional legal challenges that need to be carefully addressed.

Central bank law may need to be reformed to allow issuance of CBDC. The principle that a central bank's activities should be explicitly (or at least implicitly) authorized means that the issuance of CBDC may require the inclusion of the following:

- An explicit *function* in the central bank law “to issue currency” generally, without limiting the issuance of currency to physical currency such as banknotes and coins
- Associated *powers* to issue token-based CBDC, such as the power to produce, acquire, distribute, withdraw, and destroy token-based CBDC (in addition to similar powers in this area related to banknotes and coins)
- An explicit *power* to open accounts for all intended users of an account-based CBDC

Central banks need to assess when the central bank law should be amended. Considering the possibility that the fundamental design features could be altered during the pilot phase, maintaining flexibility (not amending the law) at this stage could be a useful option, in particular, when CBDC is not yet issued as an actual liability of the central bank.

Monetary law regulates two issues, namely, a jurisdiction's official monetary unit and its official means of payment (that is, the currency). These two concepts are linked as the official means of payment is expressed in the official monetary unit. The legal concept of an official monetary unit equates with the “unit of account” role of money used by economists. The sanctioning of an official means of payment could legally be achieved through the following important legal mechanisms that apply to physical currency. The authorities should assess whether those mechanisms would, legally as well as operationally and technically, also be established to sanction CBDC as an official means of payment.

- ***Monopoly of issuance for the state.*** In most jurisdictions this takes the form of a legal provision stating that the central bank has the exclusive right to issue currency/banknotes and coins. The question is whether this clause would grant the central bank the monopoly of issuance of all forms of currency, including digital currency.
- ***Cours forcé.*** This concept was developed initially for banknotes, mandating that they be accepted in payment at face value, without convertibility into gold.
- ***Legal tender status.*** Legal tender refers to the power granted by law to a currency to extinguish monetary obligations validly and definitively. Jurisdictions achieve this in different ways. In some it is legally clear that a creditor's claim deriving from that obligation is extinguished by the offer of full payment with legal tender currency. In other jurisdictions, this may merely grant certain privileges to the debtor. Some even impose administrative or criminal sanctions on creditors when they refuse to accept legal tender currency in payment.
- ***Privileges under private law.*** States have officially sanctioned payment instruments by granting them privileges under private law with a view to favor the circulation of “currency” relative to other possible means of payment. However, currency is not the only means of payment that benefits from private law privileges: the check and bill of exchange, the original payment instruments, also enjoy certain privileges as “negotiable instruments.”
- ***Protection under criminal law.*** States have protected officially sanctioned means of payment by imposing criminal law sanctions on those who counterfeit, damage, or destroy those instruments. So

far, both national and public international law focus on the suppression of counterfeit or altered banknotes and coins.

To create the necessary trust for CBDC, the authorities must assess their private laws to make sure that CBDC benefits from legal certainty. For that purpose, the authorities should carefully go over every stage of the “legal life” of a CBDC to make sure that it is consistent with the existing legal mechanisms. In particular, the authorities should reflect on the legal nature of the CBDC under existing frameworks and in particular the conditions to consider a CBDC transfer as legally valid. This certainty should also exist on the relationship between the CBDC holders and the private intermediaries in the ecosystem. Having this private law, certainty on the domestic level, will contribute to increasing the confidence a CBDC will need to be used in cross-border transactions and will inform regulatory and supervisory considerations. Jurisdictions will need to consider whether there is a need for legal reform and whether to anchor such reform in a broader framework that would govern digital money in general or in a targeted one specifically created for CBDC.

### **Payments and Financial Supervisory Law Considerations**

The Committee on Payments and Market Infrastructures and the International Organization of Securities Commissions have established Principles for Financial Market Infrastructures. Countries have adopted the Principles for Financial Market Infrastructures for the oversight of systemically important payment systems and to some extent also of payment instruments. As an official means of payment, and for its various related functions (issuance, transfer, and so on), CBDC systems will have to be designed in order to observe Principles for Financial Market Infrastructures principles.

Holders of CBDC should have a clear legal relationship with the issuing central bank and with the entities operating in the CBDC ecosystem to reduce risks. More specifically, in the case of a two-tier operating model, ultimately the holder should have a direct legal claim toward the issuing central bank, regardless of which intermediaries provide the wallet and account services.

CBDC systems would also need to manage the potential risks arising from critical third-party service providers, such as cloud services and specialized software vendors. Central bank procurement officers will have to assess carefully the agreements signed with those providers to make sure they are adequately protected, for example, to avoid any lock-in situation in case of termination of agreement (BIS 2012, 2014b; Financial Stability Board 2023).

### **Financial Integrity Implications**

Prior to embarking on a CBDC issuance, a jurisdiction should assess and understand the risks to financial integrity posed by a CBDC arrangement (taking into account the desired design features). As with any value transfer system, CBDCs could be used for illicit activities, and jurisdictions should implement measures to mitigate those risks. To be effective, an AML/CFT regime must be understood and implemented effectively by all relevant stakeholders, both public (that is, all authorities and agencies with AML/CFT responsibilities) and private (that is, the so-called reporting entities).<sup>12</sup>

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<sup>12</sup> Reporting entities refer to any individual or entity that is defined by the Financial Action Task Force as a financial institution, designated nonfinancial businesses and professions, and virtual asset service providers.

The assessment of the money laundering and terrorist financing risks should inform a jurisdiction's design decisions and mitigating measures. It should include a review of the existing legal framework prior to the launch of the CBDC to identify the legal and regulatory changes needed to ensure that no gaps exist in the AML/CFT framework. Existing vulnerabilities may persist or even be exacerbated in a CBDC context. Major shortcomings or weaknesses in a jurisdiction's AML/CFT regime should therefore be addressed prior to pursuing a novel product, such as a CBDC.

The design of and technological choices related to a CBDC arrangement may have implications for financial integrity. The specific risks posed by CBDC will depend on the specific features adopted. For example, the wider the user base and the more varied the use cases, the more risks will be posed. Similarly, the number and type of intermediaries involved in the issuance, distribution, and use cases of the CBDC will have regulatory and supervisory implications.

Mitigating these risks requires a sound AML/CFT preventive framework, including customer due diligence (identification of all parties involved in transactions, monitoring of transactions and business relationships), record-keeping, reporting of suspicious transactions, and implementation of targeted financial sanctions, implemented effectively by all reporting entities designated in the Financial Action Task Force standard. This may require amendments to the legal and regulatory framework because a CBDC arrangement may see the evolution of new service providers or new activities being taken on by existing service providers. User identification and transaction tracking may not be inherent in all CBDC models (for example, ones that are not primarily oriented toward an account-based system or in which "cash-like" features are built in). In such cases, appropriate due diligence would need to be well thought out; for instance, it could be built in as a precondition to obtaining a CBDC wallet. Regardless of the model chosen, clear and appropriate measures need to be set in law and regulation prior to a CBDC issuance to enable proper conduct of AML/CFT preventive measures.

A CBDC arrangement may also require adaptation of existing supervisory models. Supervisors need to have the adequate capacity and expertise to monitor compliance by both new and existing reporting entities conducting activities in CBDC (and sanction breaches). New supervisory expertise may need to be developed. Any conflicts of interest that arise from dual functions on the part of the supervisor (for example, if a central bank is an AML/CFT supervisor in a one-tiered model of distribution) will also need to be addressed. If cross-border usage is permitted, extra supervisory challenges with respect to foreign service providers and users located abroad will likely arise. Interagency coordination will be important, both domestically and with foreign counterparts.

Finally, law enforcement agencies need to have a solid legal basis and the requisite capacity and expertise to pursue criminal cases involving and/or generating illicit proceeds in CBDC. Amendments to the criminal law framework may be needed to allow for law enforcement agencies to conduct investigations involving CBDCs and freeze or seize criminal proceeds or instrumentalities in CBDC. Prosecutorial agencies and the judiciary will also need to have the requisite capacity and expertise to prosecute and judge complex cases involving CBDCs. Agencies will need to be able to cooperate with foreign counterparts in the context of cases and investigations involving CBDCs. Therefore, in this context, capacity and independence of law enforcement and judicial institutions to effectively detect, investigate, and prosecute illegal transactions would be critical.

New technology could also help make the implementation of AML/CFT measures more efficient (BIS, 2023c).

## 4. Experimentation and Development

If the central bank decides to proceed, preparations are followed by experimentation—both on technological and social/economic aspects—and development of an actual CBDC product. This takes place through proof of concepts, prototype, and pilot. Experimentation is crucial to guide decisions and evaluate the viability of different approaches, and the subsequent development of what could eventually be launched as a CBDC. The overarching theme of experimentation and development is to ensure that the CBDC system is designed and can be operated in such a way as to meet the specified policy objectives.

The preparation phase sets the requirements and guidelines for the experimentation and subsequent development but, importantly, results from the experimentation might lead to revisions of the initial conclusions. As depicted in the CBDC roadmap in Figure 1, the workstreams initiated and planned in the preparation phase continue during the experiment and development phases, with varying degrees of intensity.

### A. Specification of Key Success Measures

To evaluate different and eventually identify the most useful options, the team must have a clear definition of success and accompanying metrics. Conducting this analysis in each subsequent phase is essential, as these metrics can determine what data needs to be collected to inform CBDC evaluation. Table 3 outlines common CBDC key performance indicators (KPIs). Stakeholders can be useful partners in setting and giving feedback on proposed KPIs.

The metrics should be clearly specified and derived directly from the policy objectives, risk mitigation initiatives, or other considerations that are important for the functioning of the CBDC. For instance, if a policy objective is to digitalize payments, a quantitative measure of success could be defined as a certain percentage of the targeted population within a specific region using CBDC instead of cash at least once a day within the first year. Additionally, a qualitative measure could involve gathering feedback from a percentage of these individuals who report feeling safer carrying CBDC compared with cash.

**Table 3. Examples of Key Performance Indicators Relevant to Measuring CBDC Experimentation and Development Success**

*While most of these metrics are implemented during the prototype phase and tracked during the pilot phase, they must be identified by the policy management team and communicated to the development team.*

Metrics	Examples of Goals to Be Documented
<b>Goal:</b> Define and measure adoption over time ( <a href="#">BIS 2021b</a> )	
<b>Number of CBDC Accounts:</b> Total number of accounts opened for the CBDC by individuals or entities	By [date] the central bank aims to have [number] opened accounts.
<b>Number of Active CBDC Accounts:</b> Total number of accounts that are actively used to make day-to-day payments	By [date] the central bank aims to have [number] active accounts



<b>Transaction Volume:</b> Total number of transactions conducted using CBDC	On average, [number] transactions will be processed in the first [number] months. Thereafter, we expect the growth to be [percent] per month for the subsequent year.
<b>Average Transaction Value:</b> Average value of CBDC transactions	It is expected that [percentage] of transactions will be below [amount in currency]
<b>Adoption Rate among Target Population:</b> Intended user base or specific demographic groups that are utilizing the CBDC. This may include specific requirements for people with disabilities and those with literacy constraints	In [number] months, [percentage] of the targeted population will be using their CBDC wallet at least [number] times per week
<b>Geographic Reach:</b> Number of regions or locations where CBDC transactions occur	In average, [percentage] of small transactions that will occur in rural areas located in [name of a region]
<b>Merchants Accepting CBDC:</b> Number of businesses or merchants that accept CBDC payments	By [date 1], [percentage] of business-to-business transactions will use CBDC, leading to [percentage] of merchants to accept CBDC payment by [date 2]
<b>Goal:</b> Define and monitor satisfying response time	
<b>System Availability:</b> Percentage of uptime for the CBDC system	The system should be available [percentage] of the time in average, per year
<b>System Resilience:</b> Recovery time in the event of system failures or disruptions	In case of cyberattack, services should be fully restored in less than [number] hours
<b>Response Time:</b> Average response time for transactions	Under the worst conditions, users should not wait more than [number] seconds to know the status of their transaction

Source: Authors based on BIS (2021b). Note: CBDC = central bank digital currency

## B. Testing Multiple Aspects of CBDC: Proof of Concepts

By PoC we mean the process and end result of an empirical investigation aimed to answer a question about how a potential aspect of CBDC could work in a simulated environment. Frequently, these questions relate to the ability to promote the designated policy objectives or mitigate identified risks. The PoC phase thus resembles an empirical research process in which assumptions or hypotheses are subjected to testing to “find proof,” without committing yet to a specific approach that will later be used in a potential CBDC.

A PoC is characterized by its limited scope, cost, time, and setting. The small scale is crucial as it enables the exploration of various tests at low risk. PoC experiments can be likened to a funnel that starts broad and gradually narrows down as options are evaluated, leading to the go/no go decision for the prototype phase. However, PoCs can still be usefully conducted at each subsequent phase. At the prototype or pilot stage, specific aspects might need to be tested out in a smaller or more controlled environment through a PoC.

The questions posed in a PoC should be drawn directly out of the policy objectives, identified risks, and design features specified in the preparations phase. There should now be a concrete list of desiderata, that is, wanted, or necessary features that the finished CBDC should have according to the analysis carried out in the preparations phase.

The primary focus of the PoC phase is on design features of the CBDC (Figure 1). Technological experiments should be conducted to explore ways to satisfy the requirements identified during the

preparation phase. The product development team must interpret the technical implications of fulfilling the desired outcomes. Further details on this process can be found in the companion paper.

PoCs should also be made on economic, sociological, and user-oriented aspects of CBDC. These include assessing how different CBDC features are perceived and determining which features are most important to potential end users. The team should leverage the stakeholder analysis conducted earlier and maintain continuous communication with key stakeholders to obtain input on the types of PoCs that should be conducted.

### **C. Narrowing Down the Options: The Prototype**

The prototype phase marks the initial stage of developing the CBDC solution intended for eventual launch, contingent upon the decision to do so. A CBDC prototype can be defined as the first functional model of the CBDC, incorporating a technology solution and design features that closely align with the specified desiderata from earlier phases. During the prototype phase, there is a preliminary selection of the technology platform and design features, with a focus on conducting continuous experiments within a more defined setting. If the PoC phase represents the broadest part of the funnel, the prototype phase represents the narrower end, where deliberate commitments to actual technologies and designs are made.

The prototype phase begins by translating the knowledge gained from previous phases into clear requirements for the technology while establishing the initial capacity in personnel, governance, and regulation. This phase progresses iteratively to a point where a functional “product” is ready for testing in low-risk settings. The working prototype should involve representative stakeholders, including a panel of users, and the results obtained will guide the decision to pause the project, continue research and development, or proceed to the pilot phase for advanced testing.

The decision to start a prototype does not mean that the jurisdiction is ready to issue a CBDC. The prototype phase should strengthen the central bank’s understanding of the impacts of a CBDC, including its alignment to the stated policy goals and ability to manage risks, using more concrete and tested elements. The results of the prototype phase will inform the go/no go decision for the pilot phase.

The following elements will gradually be in place after several iterations of the prototype:

- The final solution is acquired (or developed) and eventually tested with live data and with stakeholders, including financial institutions and PSPs (Table 1).
- All known interoperability issues are successfully tested. This includes interoperability with existing payment solutions and different wallet providers, depending on the central bank’s goals.
- The central bank and the CBDC ecosystem’s participants have committed personnel, adequate funding, and capacity, and third-party relationships are in place to operate the CBDC to support a pilot.
- KPIs and metrics are identified and implemented to allow proper monitoring of performance, adoption, and progress toward stated policy goals. KPIs could include social impact metrics, for example, reach among marginalized users or improved access to a broad range of financial services if financial inclusion is an explicit goal of a CBDC. KPIs should be fully tested and improved during the pilot phase.

- Procurement and legal questions are addressed, especially with relation to vendors. Roles, responsibilities, service level agreements, vendors' performance expectations, intellectual property, confidentiality questions, and exit strategies are clearly documented and ready to be tested during the pilot phase.
- All resilience scenarios are identified and accounted for, and a plan is in place to strengthen each case (the plan will be tested during the pilot phase; see next section).
- A decision committee is in place to analyze the results of the prototype, validate the alignment with the stated policy goals, and accept risks.
- Communication and marketing strategies are in place.

#### **D. Real Life Testing: The Pilot**

The pilot phase is the real-life testing of the CBDC prototype. It provides information on how well the prototype fulfills its requirements, how it can be improved, and ultimately whether the CBDC should move into the production phase through an official launch. In the pilot, real-value CBDC is issued and circulated on a limited scale in society for real economic transactions. Key factors to test include, operational factors such as scalability, maintenance, and general risk management. The pilot phase also aims to ensure that the proposed solution can promote the policy objectives and that an appropriate level of adoption among the population can plausibly be reached. Conducting different iterations within this phase can allow new uses cases, scenarios, or participants to be added and tested in a progressive manner.

The central bank needs to decide the scale and duration of the pilot. Keeping the scale small is important to ensure that risks are kept low, but if the scale is too small it is difficult to draw firm conclusions from the tests. One way to keep risks in check is to gradually increase the scope of the pilot, using previous insights from the pilot to continuously improve performance and robustness. The Eastern Caribbean Central Bank had taken advantage of the jurisdiction's partitioning into island nations and extended their CBDC pilot in one country at a time. This has allowed for a staggered introduction of the pilot, allowing time to incorporate results and ensure that risks are kept low in case of malfunctions.

If the central bank has sufficient resources, it can gradually expand the pilot trials. For instance, the e-CNY pilot trial was initially launched in four cities and around the 2022 Beijing Winter Olympics and has now expanded to more regions, currently covering 17 provinces in total. Expansion of the pilot will allow the incorporation of new PoCs to test new features that could be added in the future to the CBDC if results are encouraging.

A communication and marketing strategy needs to be developed to ensure that the pilot involves all the actors that are intended to be part of the ecosystem envisioned in the design. Intermediaries, wallet providers, and end users such as merchants and individuals will need to be represented in the pilot. The central bank therefore needs to ensure that there is willingness and possibility for these to be onboarded. The stakeholder analysis conducted in earlier phases will provide important information on how to develop and execute these strategies. Further, continuous communication with stakeholders is necessary to evaluate the performance of the pilot and to build support for continuous experimentation.

If the pilot results continue to demonstrate the feasibility, readiness, and value of CBDC, the jurisdiction is on solid ground to discuss the potential to progress into the production phase.

## 5. Launching the CBDC: The Production Phase

The production phase starts with the formal launch of the CBDC and covers the ongoing management and improvement of it. To date only three jurisdictions in the world have entered the production phase (The Bahamas, Jamaica, and Nigeria). While there is thus less practical experience of this phase compared with earlier phases, central banks can draw on experiences from operating payment systems other than CBDC and knowledge generated during the previous phases.

The production phase is open ended and ongoing until there is a decision to cancel it. However, the production phase is the continuation of the previous process and will require continual evaluation, iteration, and improvement drawing on actual experience (see Box 5).

The decision to start production—or not—will ultimately depend on the circumstances of the individual jurisdiction. However, following a sound methodology, relying on careful testing throughout each phase, and proceeding deliberately through the decisions to enter new phases will minimize risk and give the best possible foundation for the decision.

Adequate adoption of the CBDC is key, but the adequate level will depend on the policy objectives, and reaching it might be a long-term goal. For instance, some policy objectives, such as ensuring convertibility into central bank money, do not rely on people extensively using the CBDC in their daily life—it is sufficient that the CBDC is present as a backstop. Thus, central banks need to consider what an adequate level of adoption is related to their policy objectives and incorporate the analysis in their KPIs. Reaching an adequate level of adoption relies on both analyses conducted in earlier phases as well as continual stakeholder communication to understand needs and preferences of potential users. Payments typically have network effects that present barriers of entry for new forms of payment, in particular when there are other forms of digital payments already. Central banks thus need to set realistic goals for adoption and realize that additional measures to increase adoption and establish network effects might be necessary.

Reaching adequate adoption requires understanding the needs of users and PSPs. As discussed earlier, a clear understanding of this should be established in the preparations phase and through frequent stakeholder engagement. Such engagements should be continued during the production phase. PSPs can also help build awareness and promote the CBDC if there are clear incentives for them to do so.

Production carries on the principles established during the previous phases. The CBDC is never “finished.” Continued innovation will be crucial to ensure that the CBDC evolves with the digital landscape and remains relevant. New PoCs may be needed and tweaks may be considered throughout. Experiences after the formal launch should continue to be evaluated, and changes may need to be made to the existing CBDC system. As depicted in Figure 1, several workstreams continue also in the production phase at lower or greater levels of intensity—most notably risk management to avoid harmful effects and stakeholder relations to gauge reception of CBDC and give input on the need for further tweaks.

The following areas are of special importance for ongoing evaluation.

- **Operational resilience.** Thorough testing of the CBDC should have revealed that it is scalable and resilient against cyberattacks and operational issues. Robust recovery plans must be in place according to the standards established for payment systems.
- **Appropriate design.** The design is intended to promote the policy objectives and to mitigate risks. If the design appears to be inadequate, improvements can be gradually introduced. New PoCs can be a useful tool to explore new potential tweaks to design.
- **Adequate reception.** Frequent communication and stakeholder analysis will be necessary to ensure a suitable level of adoption—both to inform stakeholders about the CBDC but also to learn from them why they are not interested in using it. Changes may need to be made to both design and communication on the basis of this ongoing engagement.

### **Box 5. The Production Phase as the Beginning of a Journey: The Bahamas Sand Dollar Experience**

Although the Bahamas Sand Dollar was officially launched in October 2020 after a 10-month pilot (Box 3), that was just the beginning of the journey. Uptake of the CBDC has been slow, but this was expected due to low e-money penetration in general ([Hall 2022](#)). Also, it takes time to build the network of merchants that accept Sand Dollars, educate potential users, and tighten interoperability with the traditional banking system. The CBOB's postlaunch efforts have included the following ([CBOB 2023](#)):

- Merchant training and working with PSPs to improve point-of-sale signage and more seamless use of QR code displays to process payments
- Promoting the Sand Dollar experience at civic and cultural events, particularly events organized by nonprofit organizations, and giving away Sand Dollars to early adopters
- Recruiting and training people to serve as “Sand Dollar Ambassadors” to provide support to wallet users and merchants and be at all public promotional events
- Integrating the Sand Dollar platform with the commercial banks' automated clearing House so that Sand Dollars can be transferred to and from any local commercial bank deposit account

Also, the CBOB publishes monthly updates to keep the public more informed on initiatives to promote digital currency adoption ([CBOB 2023](#)). And going forward, the public-facing Sand Dollar wallet and backend infrastructure will be upgraded to allow PSPs to customize the app's appearance to display their individual brand identities, including logos and branding color preferences.

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