Positioning Central Bank Digital Currency in the Payments Landscape

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Contents

BOXES

FIGURES

TABLES

Acronyms

ATM..... Automated Teller Machine

BIS ..... Bank for International Settlements

CBDC ..... Central Bank Digital Currency

CPMI ..... Committee for Payments and Market Infrastructure

CPSS……..Committee on Payment and Settlement Systems

DNS..... Deferred Net Settlement

e-money.... Electronic Money

FedNow…..Federal Reserve Now

FPS(s) ..... (retail) Fast Payment System(s)

IMF ..... International Monetary Fund

INR ..... Indian Rupee

KSH..... Kenyan Shilling

NBFI(s) ..... Nonbank Financial Institution(s)

PFMIs ..... Principles for Financial Market Infrastructures

PAFI.....Payment Aspects of Financial Inclusion

PSP..... Payment Service Provider

PIP ..... Payment Infrastructure Provider

PoS ..... Point of Sale

RMB ..... Renminbi

RTGS ..... Real-Time Gross Settlement

TIPS ..... Target Instant Payment Settlement (payment infrastructure in Euro Area)

UPI ..... Unified Payments Interface

1. Introduction

The IMF is often approached with the question of how a retail central bank digital currency (CBDC) compares to fast payment systems (FPSs) and even e-money, and which to prioritize in the context of constrained resources. There is no "one answer" to this question; working through this analysis requires authorities to carefully consider their jurisdictions' payments landscape, their objectives and core needs, and the practical constraints which they face.

Innovations in payments have proliferated over the past half century at varying speeds across the world. This has been a result of continual innovation from the supply side and the demand from users for better ways to move money and make transfers faster and at lower cost. E-money solutions and FPSs have been critical in delivering these efficiency gains across several regions. The next wave of innovation, catalyzed by both the changing private digital landscape and specter of privately issued crypto assets and stablecoins, has led to increased focus on the role of a public solution such as a retail CBDC.

A holistic exploration of retail CBDC requires a comprehensive assessment of legal, macro-financial, and operational considerations. The growing body of work across central banks and other organizations evidences the sustained focus on CBDC's potential implications for monetary and financial stability. This paper focuses instead on the comparison of retail CBDC—that is, the presence of digital central bank money available to the general public—with FPSs and e-money systems from a payments perspective, and how CBDC may support a jurisdiction's vision on payments in the digital age. It does not directly compare CBDC with stablecoins, as the latter is not yet widely used in payments.

This paper does not seek to advocate for CBDC over FPSs or e-money. The balance of arguments for any one system may change over time, and the choice may not be mutually exclusive in many jurisdictions. This paper aims to provide a foundational understanding of systems, comparing how they differ in meeting central banks' policy objectives, and outlines considerations of potential trade-offs to guide central banks in making their own assessment.

FPSs, e-money networks, and CBDC systems may all provide similar efficiency gains for economies. Each system could provide instantaneous and efficient payments, potentially lowering the cost of payments available to a broader set of the population and supporting further digitalization of the economy. Depending on design and supporting policies, they could also support financial inclusion.

CBDC's distinguishing value lies in its property as public money in an increasingly digitalized economy. The fundamental difference between CBDC, FPS, and e-money is that CBDCs are first and foremost a form of central bank money that could sustain the presence and choice to use a publicly issued money, as well as a public payment solution, in a retail payments landscape which may otherwise be moving toward 100 percent private money. In contrast, FPSs are payment arrangements to smooth and accelerate the transfer of private liabilities, and e-money are private liabilities which act as an alternative to bank deposits with a lower access threshold in many markets. In this way, a CBDC system is more likely to be a complement to other systems, bolstering trust in money and payments by preserving choice and fostering interoperability between public and private money and payment systems.

In considering various payment innovations, central banks should address existing pain points while preserving capacity to adapt to changes in the future landscape. Digitalization is pointing toward a multi-instrument, multi-infrastructure landscape. Users' behavior is altering the use and

role of cash, and central banks will need to consider whether it is necessary and how to maintain the access of central bank money to the general public. Central banks will need to understand both the existing and future needs of their payment landscape and create a strategy that allows them at minimum to monitor trends and core benefits of multiple solutions as developments occur.

In the future, it is possible to envisage the coexistence of FPS, e-money, and CBDC in many payment landscapes across the world. Many central banks are pursuing CBDC explorations alongside improvements to the existing landscape. Central banks who choose to prioritize a "flagship" project may also retain a monitoring role in other initiatives to avoid falling behind on global progress. While this paper focuses on three specific innovations, a strategy for exploring CBDC or any payments development should take a holistic approach and consider the payment landscape as a whole, including (but not limited to) the existing role of card schemes and automated clearing houses, where payments activity primarily occurs in many advanced economies.

However, the transition path toward a multi-rail future could be different across jurisdictions, and the relative importance of each rail could differ between countries. Private sector developments should factor into the central bank's strategy too—today's landscape is strongly characterized by the strength of private innovation. Emerging innovations such as tokenized deposits and stablecoins, although not the focus of this paper, may need to be considered within a landscape assessment.

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

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

Key constraints beyond capacity and resources are the legal, regulatory, supervisory, and governance considerations of each system. Both CBDC systems and publicly owned FPSs require high levels of public sector involvement and may have similar types of development costs. However, a jurisdiction's mandate and ability to apply their powers around payments may ultimately determine how well a system can fulfill its objectives.

The remainder of the paper is divided into four sections. Section II considers the similarities and differences between CBDC, FPSs and e-money. Section III places the discussion of each system into the context of the evolving payment landscape and central banks objectives. Section IV explores the strategies currently pursued by central banks and considers the practical constraints that factor into a strategy. Section V summarizes the takeaways of the paper to offer an illustrative strategy that central banks could undertake to support the development of the payments landscape.

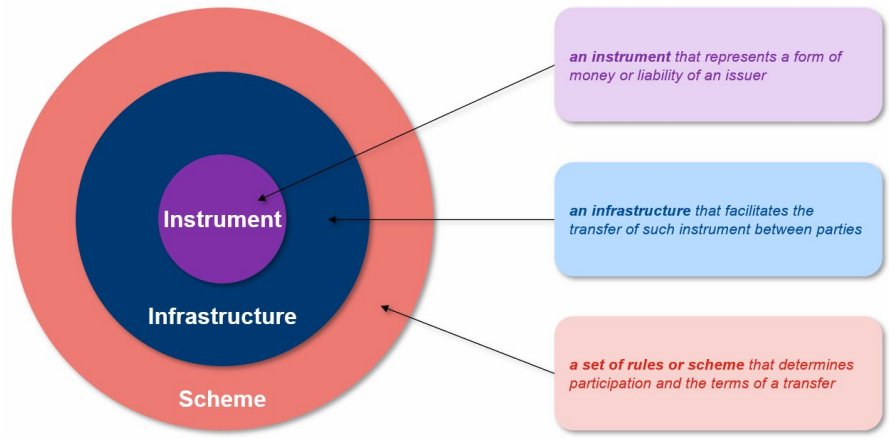
2. Understanding Retail Payment Systems

Before comparing different payment systems, a common understanding of their functionalities and features is needed. Payment systems around the world vary significantly, influenced by the specific conditions in each jurisdiction, including the rate at which different technologies were adopted. Importantly, there is no singular way to examine a payment "system"; definitions can encompass several different roles, arrangements, technical infrastructures, and regulatory connotations.[1] This section describes typical features of prevalent e-money systems, FPSs, and CBDC systems according to their functions. Tables 1.1–1.3 in Annex I lists systems and projects across the world that have been studied to inform the analysis.

Stylized Models of Retail Payment Systems

At the core of all payment systems is a relationship between three components: instrument, infrastructure, and scheme (Figure 1).[2] The *instrument* here refers to the liability (money) of a specific issuer. For example, a payment from a traditional bank account uses bank deposits—a liability issued by the bank to its customers. Instruments require some *infrastructure* (technology) to facilitate their transfer between users. The infrastructure encompasses both hardware and software technologies. In addition to the instrument and infrastructure, a *scheme* (rulebook) is needed. A scheme is a set of rules, practices, and standards agreed between participants to execute payment transactions. The coverage of the scheme can vary across different settings; for example, different schemes can cover different participants.

Figure 1. Core Components of Retail Payment Systems



Source: Authors' illustration.

[1] CPSS-IOSCO (2012) considers that "A payment system is a set of instruments, procedures, and rules for the transfer of funds between or among participants; the system includes the participants and the entity operating the arrangement." An updated definition considered in BIS (2020) also considers a distinction between "front-end" infrastructure that interacts with end users and "back-end" arrangements that process, clear, and settle payments.

[2] BIS-World Bank (forthcoming) considers similar components but adds "services" and "use cases and transactional channels" as additional layers on top of instrument, infrastructure, and scheme.

Using these three components, the three systems can be understood as

- **E-money** systems facilitate the transfer of e-money (instrument) which is defined as a form of electronically-stored money typically issued by nonbank financial institutions (an e-money institution) and is often backed by bank deposits.[3] Historically, most e-money systems are characterized by their "closed-loop nature" where they facilitate the transfer between users in a single network (see Box 1 for a discussion of closed loops). The infrastructure involves a combination of secure digital wallets and communication networks that connect users, merchants, and the issuer. The scheme in a closed-loop system is typically focused on the customer relationship between the issuer and its customers. Interoperable e-money systems, however, typically have a more developed scheme covering practices, standards, and protocols agreed between participating issuers. Rules such as compliance and supervision have also been applied to e-money systems as they have grown. The focus of this paper is predominantly on software-based, closed-loop e-money.[4]
- **Fast Payment Systems** (FPSs) focus more on the infrastructure and scheme rather than the instrument, as they are designed to bridge transfers (at speed) between different private issuers. Hence, an FPS can be used to bridge payments between banks or e-money issuers so that the liability transferred between the retail end users would be bank deposits or e-money (instruments). The infrastructure typically consists of a communication network that connects users, merchants, and issuers in real time, and a settlement service. The infrastructure can be owned and operated by central banks, private entities, or both. Settlement between issuers typically happens in a secondary system: either a private settlement system or often at the central bank making use of participants' central bank funds. The scope of the scheme varies, where some only cover the roles and responsibilities around the settlement service while others are comprehensive and cover the end-to-end transaction between end users. These schemes could be created by the private or public sector, or a combination of both.[5]
- **Central Bank Digital Currency** (CBDC) systems are being designed with all three components in mind: CBDCs are first and foremost a form of central bank money (instrument). A CBDC is a liability on the central bank balance sheet, denominated in the official unit of account, and it offers a direct relationship between the balance sheets of the issuer (the central bank) and the owner of the instrument. The liability is then transferred between users over an infrastructure that will be (in part or fully) publicly owned and operated. In contrast to FPSs, the role of a public liability at the core of the system motivates the need for end user encompassing scheme rules with the involvement of the central bank. Like e-money systems and FPSs, there could be variances in design, and given that very few CBDC systems operate today, there is no clear prevailing model.

[3] Some financial institutions also issue e-money in addition to deposits to provide specific payment services.

[4] E-money networks employ both hardware-based products and software-based products, with some combining both (Ehrentraud and others 2021). Hardware-based e-money stores value on physical devices, using hardware security features. For example, card-based solutions often use chips for transferring value "offline" via device readers, without the need for real-time connectivity to a server. These networks usually operate in "closed loops," where the issuer controls the processing and settlement timing, potentially delaying fund availability for offline transactions. Conversely, software-based e-money relies on specialized software on devices like mobiles and computers, requiring an online connection for real-time transaction verification.

[5] Pix in Brazil is an example of an FPS infrastructure and scheme owned and operated by the central bank where the scheme is encompassing end-users. Conversely, the SEPA Instant Credit Transfer scheme is privately owned by the European Payments Council, while TIPS, an interbank settlement infrastructure service, is owned and operated by the European Central Bank.

Similarities and Differences

The above descriptions suggest that CBDC, FPSs, and e-money systems share many similarities. However, they also identify what properties may be specific to the instrument and what are relevant to the wider system (infrastructure and scheme). Table 1 summarizes key similarities and differences.

Table 1. Payment System Features

		CBDC SYSTEMS	Fast Payment Systems	E-Money Systems
Instrument	**Liabilities being transferred for end users (issuer)**	CBDC (central bank)	Commercial bank money or e-money (from private issuers)—the most common form is a "credit transfer"	E-money (of a specific private issuer)
Infrastructure and scheme	**Availability of funds to payee**	Instant	Instant (or near immediate)	Instant
	Settlement	Real-time gross settlement	Real-time gross settlement or deferred net settlement	Real-time "on us settlement"
	Risks in system	Operational and legal risks present. No credit risk. Liquidity risks may arise during funding and defunding	Operational, legal, credit, and liquidity risks present	Operational, legal, and credit risks present. Liquidity risks may arise during funding and defunding
	Ownership	Infrastructure and scheme likely owned by the central bank	Infrastructure and scheme could be public, private, or jointly owned	Infrastructure and scheme privately owned

Note: See Annex I for a list of systems studied. For e-money systems, a software-based, closed-loop model is assumed.

The core difference is the nature of the instrument. While a CBDC system transfers central bank liabilities for end users, e-money systems transfer privately issued e-money, and an FPS is designed to transfer liabilities users hold from different private issuers, such as commercial banks or e-money issuers. A defining and common feature of all systems is that the funds transferred are available to the payee instantly, in a matter of seconds, to use for other purposes.[6] That said, some FPS implementations would be classified as "near immediate" as there can be a slight delay, up to minutes, and even a couple of hours. CBDC systems and e-money networks settle transactions on a "real-time gross settlement" (RTGS) basis—transaction by transaction. Many FPSs operate on a similar basis, but many also use "deferred net settlement" (DNS)—periodic batches on a multilateral net basis (World Bank 2021).[7]

All three systems face operational and legal risks, but the presence of credit and liquidity risks differ between systems. The basic risks in payment systems include credit, liquidity, operational, and legal risks (The Federal Reserve 2023).[8] All three systems face and must manage operational and legal risks. While FPSs and e-money networks face credit risk, CBDC systems do not. Credit risk is present in FPSs and e-money networks because of the private nature of the liabilities transferred; the

[6] Hardware based e-money networks would not always have instant functionality, and thus are not the focus of this note.

[7] For interoperable e-money payments the settlement model can be either real-time gross settlement or deferred net settlement.

[8] Credit risk is the risk that a counterparty will be unable to meet fully its financial obligations when due or at any time in the future, for example, in the case of default of the issuer. Liquidity risk is the risk that a counterparty, whether a participant or other entity, will be unable to meet fully its financial obligations when due, although it may be able to do so in the future. Operational risk is the risk that deficiencies in information systems or internal processes, human errors, management failures, or disruptions from external events will result in the reduction, deterioration, or breakdown. System outages, data loss, and cyberattacks are examples of operational risks, where cyber is gaining increasing attention (Maurer and Nelson 2021). Legal risk is the risk of loss from the unexpected or uncertain application of a law or regulation. Additional risks and challenges do exist, such as general business risk and challenges related to illicit finance, but these are left out of scope for the assessment in this paper.

credit risk in an FPS normally does not arise between the payer and payee but may exist between their PSPs.[9] Since a CBDC system transfers central bank liabilities, it is considered free from credit risk. While liquidity risks are not present for payments within CBDC and e-money systems, it can arise during points of interoperability including funding or defunding. For example, a sudden demand for redemption of e-money might be problematic if insufficient bank deposits are held (Dobler and others 2021). Liquidity risks are prevalent in FPSs because PSPs require liquidity for settlement (World Bank 2021).

For CBDC systems, the central bank is likely the owner of both the infrastructure and scheme. The split of public and private sector ownership or responsibilities will correspond to the design choices and use cases ultimately pursued. For example, central banks are using third-party platforms for wholesale CBDC experiments—the Swiss National Bank is issuing CBDC on the SIX Digital Exchange in the Helvetia III pilot (Jordan 2024).[10] There are no such examples for retail CBDC; however, this may change in the future. FPSs may have public, private, or joint ownership (with variations across infrastructure and scheme), while for e-money networks, the infrastructure and scheme are privately owned by the issuer. In all three systems, the public sector likely remains the supervisor and regulator.

Box 1. Closed Loops versus Interoperable Payment Systems

"Closed loops" refer to systems where the (money) issuer facilitates transactions within a self-contained network. The issuer allows the instrument to be used only within its proprietary network. Both the merchant and the consumer need to be registered with the issuer and are bound by the terms and infrastructure of the issuer. Such systems act as a "single accounting ledger" and allow for the minimization of credit and settlement risk as the claim is always with the same issuer. Processing these transfers can happen at minimum to no cost to the issuer.

Conversely, interoperable systems facilitate transactions across networks and issuers.[11] Money issued by one entity is accepted by various merchants, irrespective of their affiliations with the issuer. This enables flexibility for consumers and fosters an interconnected and competitive financial ecosystem.

Closed-loop systems often lead to environments that can favor monopolistic tendencies, whereas interoperable payment systems seek to promote universal acceptance of their instruments. Closed-loop systems often scale from a specific unique use case, where they have grown a comparative advantage. Interoperable systems, on the other hand, focus on the benefits and utility of connecting different systems and money. However, interoperable systems require more sophisticated regulatory and operational frameworks to ensure seamless and secure transactions across different networks (and issuers).

Some payments in interoperable systems are treated as closed-loop payments. For instance, bank deposits of different issuers are interoperable, but payments between customers of the same bank are intrabank and processed as closed-loop or "on us" payments. Similarly, domestic CBDC-to-CBDC transactions would be closed-loop. However, like bank deposits, CBDC can be designed to be interoperable with other forms of money.

[9] If settlement takes place in real time before the PSP of the payee credits the funds in the account of its customer, credit risk does not arise between the PSPs. If settlement is deferred, the PSP of the payee may advance the funds to its customer before receiving them from the PSP of the payer, and credit risk arises between the PSP of the payee and the PSP of the payer (World Bank 2021). The payer and payee credit risk arise due to the private nature of the instrument exposed to credit risk of their PSPs.

[10] This paper does not cover an analysis of wholesale CBDC—a form of central bank money being considered and designed toward improving transactions between banks and other financial institutions—and leaves a study of indirect retail payment applications based on wholesale CBDC to future papers.

[11] Card schemes are an example of such systems.

3. CBDC's Role in an Evolving Payments Landscape

Undertaking a comparison of different payments systems requires an understanding of the current payment landscape, emerging developments and trends, and core motivations for change. Some jurisdictions experience clear pain points in their payment landscape today and require changes. Pain points include financial exclusion, high operational costs associated with cash, and inefficiencies such as slow and expensive payments. Central banks also need to consider their approach to long-term structural changes in the payment landscape where the case for CBDC may become more important. This section first sheds light on some of the main trends and emerging developments in the payments landscape, and then assesses how different systems can support central banks' objectives, with a focus on financial inclusion; payment efficiency, competition, and resilience; and public access to central bank money as those are some of the most directly linked to payments.

Emerging Developments and Trends in the Payments Landscape

Technological progress continues to enable innovation. Rapid proliferation of mobile devices and digital platforms, including the rise of BigTech and other nonbank PSPs, is changing the landscape. In addition, private digital money and payments innovation—including crypto assets, stablecoins, and a foreign CBDC—are potential disruptive external developments. Small open economies may be particularly vulnerable to such developments outside their own territory. These trends could endanger the current landscape through increased fragmentation, increased exertion of market power by private money issuers, and increased risk of adopting an alternative unit of account.[12]

Digitalization raises a fundamental question on the role of central banks in money and payments. Many jurisdictions have seen cash usage decline, and in some advanced economies, the two-sided market dynamics of payments have resulted in a self-reinforcing spiral. With a shift toward digital payments, cash use drops, diminishing businesses' willingness to accept it. This leads to a cycle where cash payers are forced to go digital, and with less cash use, banks reduce the supply of cash services, further diminishing willingness to accept and use cash (see Box 2 for an example of cash developments in Sweden[13]). Declining cash use is also causing concerns around the role and provision of public money and the need for a nominal anchor to ensure uniformity, or singleness, of money (see, for example, Armelius, Claussen, and Hendry 2020; Bank of England and HM Treasury 2023).

The rise of large private digital payment networks could also pose risks to the efficiency and resilience of payment systems. BigTech firms, with their vast resources, extensive customer bases, and technological prowess, can quickly dominate the market, sidelining traditional financial institutions and smaller competitors. This market dominance can lead to a lack of diversity in the payments industry, making it vulnerable to systemic failures if these large entities face operational or financial issues.

[12] See also Rivadeneyra, Hendry, and García (2024) who outlines similar trends that pose risks to the monetary system.

[13] Sweden stands out in an international context as one of the jurisdictions with the most dramatic fall in cash use the last two decades (Armelius, Claussen, and Reslow 2022) and might serve as an example of what to come for other jurisdictions.

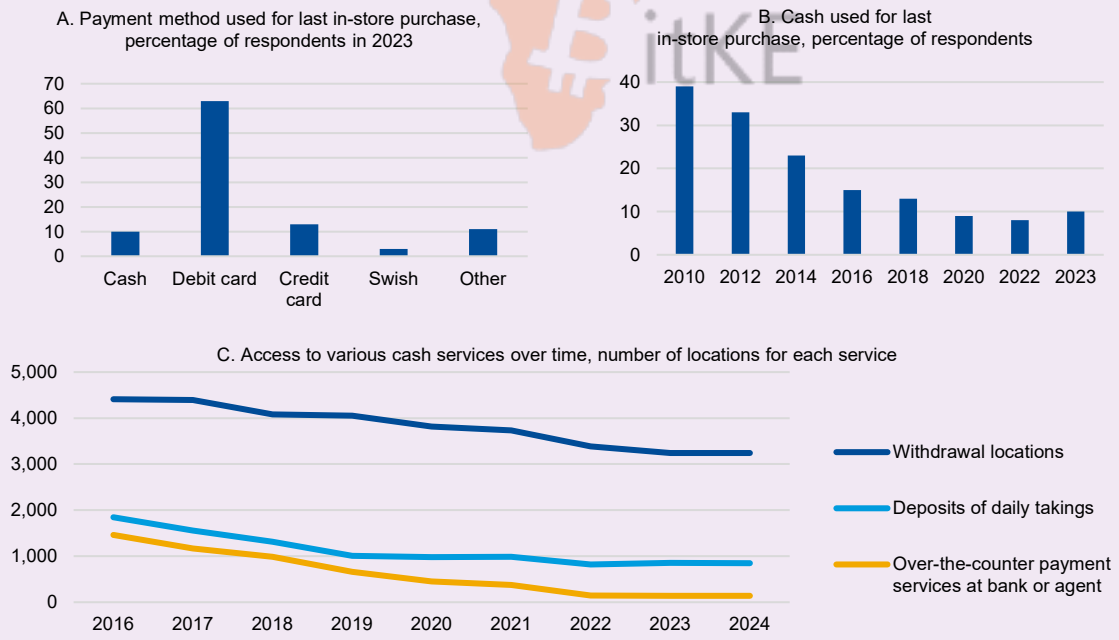
Moreover, the aggregation of financial services within "super apps" creates a tendency toward increased concentration of services, and can exacerbate these risks, as consumers may become overly reliant on a single platform for multiple financial transactions, from payments to savings and investments.[14]

Box 2. Cash Developments in Sweden and the Case for CBDC

The Central Bank of Sweden is taking measures to address the implications of declining use of cash. In Sweden, card payments dominate in-store payments, with cash usage and availability of cash services declining (Figure 2). Despite this, there is growing awareness of cash's importance, particularly in a crisis situation when current digital payments might become unavailable. While banks must adapt their services to varying digital proficiencies, the Riksbank believes that state intervention is necessary to maintain payment access for all, and crisis resilience. To prevent cash from becoming unusable in the near term, the Riksbank has urged immediate legislative action on its acceptance. And while acknowledging the importance of the role of cash for the foreseeable future, the Riksbank is also considering complementary measures. For example, the Riksbank has been researching and exploring a CBDC—e-krona—since 2017 as part of a long-term strategy to ensure access to useful and attractive forms of central bank money though no decision has been taken on its issuance yet. As the economy continues to digitalize, the Riksbank notes that new forms of money will be needed to support universal payment capabilities, and to enhance resilience in the payments landscape (Sveriges Riksbank 2024).

Figure 2. Cash Access and Usage in Sweden

Percentage of respondents and number of locations, respectively



Source: Sveriges Riksbank (2024).
Note: The term "deposits of daily takings" refers to cash acquired during the business day which is deposited at a location such as banks, service boxes, and automated teller machines. Over-the-counter payment services are locations where customers can make cash deposits or payments, other than at point of sale during an in-store purchase.

[14] See also Bains, Sugimoto, and Wilson (2022) on BigTech's role in financial services.

Digital money innovations such as stablecoins hold the potential to disrupt the financial landscape if they gain significant adoption. Privately issued crypto assets have attracted growing interest in the past decade; today, they mainly behave as tools for speculation and have not gained widespread acceptance as payment instruments. Stablecoins aspire to offer a consistent value against other instruments, potentially making them more viable for everyday payments, although this has not yet materialized.[15] However, with technological advancements and price stabilization, there could be increased acceptance, which could encourage their use in payments. Stablecoins have also been viewed as potentially attractive for cross-border payments, even though prospects of a global stablecoin arrangement have been subdued for now.[16] For example, although stablecoins have not gained much use outside of crypto-asset ecosystems in advanced economies, preliminary data suggest that in emerging and developing market economies, they are being used in a limited capacity for cross-border transactions and remittances (FSB 2024). The same analysis also suggested that there was a perceived preference for US dollar-denominated stablecoins as a store of value in countries with high inflation, currency devaluation, or the presence of capital flow measures. More generally, stablecoins potentially present a future which could involve a more diverse process for creating money, potentially implying that the monetary system is at a higher risk of becoming fragmented. Thousands of new digital "currencies" have been introduced, and though most have failed, the right formula may eventually be discovered (Rivadeneyra, Hendry, and García 2024). If crypto assets or stablecoins gain significant adoption, they could serve as alternative units of account in a jurisdiction, undermining the ability of central banks to conduct monetary policy.[17]

Easy access to foreign CBDCs could significantly influence a country's evaluation of its payment ecosystem. The majority of central banks globally are exploring CBDCs in some way. The potential implications of widespread adoption of a foreign CBDC would be similar to those from crypto assets or stablecoins. Compared to stablecoins, however, the nature of a CBDC as a central bank instrument (and the higher regulatory certainty associated with it) raises the possibility that individuals would find them attractive to hold and for use in everyday payments. The presence of multiple currencies within a single jurisdiction introduces complexities such as currency substitution and volatile capital flows. A keen interest in or adoption of a foreign CBDC with advantageous features might strengthen the argument for exploring innovative and alternative payment systems domestically. Small open economies, in particular, must assess the opportunities and risks from larger neighboring jurisdiction issuing a CBDC.[18]

[15] Many purported "stablecoins" face issues with maintaining parity against their backing asset (see for example Kosse and others 2023). E-money has faced similar challenges in safeguarding client funds.

[16] A global stablecoin is defined as "a stablecoin with an existing or potential reach and use across multiple jurisdictions and which could become systemically important in and across one or many jurisdictions, including as a means of making payments and/or store of value." See FSB (2023) for a further discussion on global stablecoins.

[17] Some of these risks might potentially be mitigated through regulation which requires stablecoins that will be used for payments to be denominated in the domestic unit of account to preserve the uniformity of money. Regulation and regulatory certainty could be an important factor that increases or decreases the attractiveness of stablecoins.

[18] See, for example, Börestam and Mölgaard Pedersen (2024) for an analysis of the possible impact of the digital euro on Sweden.

How Different Systems Meet Central Banks' Objectives

The comparison of CBDC with other digital payment solutions should be considered from the perspective of their ability to support central banks' policy objectives. As mentioned earlier, some central banks have clear current pain point to address, while others see potential threats on the horizon. This subsection considers how different systems could meet objectives of central banks including: financial inclusion; payment efficiency, competition, and resilience; and public access to central bank money as those most directly linked to payments.[19] These objectives are often related. For example, ensuring competition can be crucial for efficiency and resilience, and access to central bank money may be needed to ensure competition. Understanding how different solutions help fulfill central banks' objectives is essential to determining how CBDC substitutes or complements other payment solutions. There are other objectives, such as improving cross-border payments and monetary policy transmission, for CBDC exploration, and each central bank must assess the objectives most relevant for them.[20]

Financial Inclusion

While all three systems can play a role in improving financial inclusion, the channels might be different. Aurazo and Franco (2024) provide empirical results suggesting that FPSs positively correlate with financial inclusion. By giving instant availability of funds and thus mimicking cash more closely, underbanked individuals could gain additional incentives to become banked. Similarly, Huang and others (2024) show some evidence that e-money promotes financial inclusion. E-money provides the benefit that users may not require a bank account and could offer a more accessible entry point to the broader financial system. CBDC can have similar benefits to e-money as an entry point for the wider financial system (Lannquist and Tan 2023). CBDC, as a public good (and without a profit objective), could also be specifically designed to cater to the underserved or underbanked population. Box 3 considers some potential design considerations for CBDC, though there are significant barriers for any system to overcome which cannot be underestimated. Technology is a barrier for those who may lack the familiarity, confidence, or digital literacy to engage with digital financial services, and distrust of the financial system is a barrier in some jurisdictions (Demirgüç-Kunt and others 2022).

Efficiency

All three systems can enhance payments efficiency through speed. Two common efficiency measures are (1) the time from payment initiation to the availability of funds to the payee and (2) service availability. Instant payments allow users to send and receive funds in real time with funds immediately available to the receiver. This provides benefits to users such as improved cash flow, lower settlement risk, and the ability to make just-in-time payments. All three systems can provide instant payments and

[19] For instance, financial inclusion and efficiency in domestic payments are the most dominant motivations for CBDC exploration and adoption in sub-Saharan Africa (Ricci and others 2024), whereas access to central bank money is a core motivation in many advanced economies (for example, Canada, the Euro Area, United Kingdom, and Sweden).

[20] See Soderberg and others (2023) and Di Iorio, Kosse, and Mattei (2024) for commonly cited CBDC objectives; Table 4 in Annex I outlines the primary objective/rationale for exploration given by central banks taken as case studies in this paper. See also Reslow, Soderberg, and Tsuda (2024) on CBDC and cross-border payments, and Das and others (2023) on CBDC and monetary policy transmission.

settlement, thus increasing efficiency. All three systems can also increase efficiency by providing 24/7 service availability.

Efficiency should also be viewed from a cost perspective, and the pricing strategy of payment systems depends on many factors including ownership of such systems. It is difficult to verify if FPSs or e-money systems structurally lower transaction fees in the long term, since in many cases, it can be observed that lower fees are because of public sector intervention. For example, in many jurisdictions, transaction fees to end users have been capped (for example, by the overseer) to promote FPS adoption (World Bank 2021). Similarly, when regulating CBDC fees, central banks have two main options: they can either set them directly or impose caps. Koonprasert and others (2024) surveyed a sample of central banks and find that most believe that CBDC should be offered without fees to individuals, although some envision the possibility of charging fees for value-added financial services. Furthermore, while consumers might not be charged, merchants might incur fees from their PSPs. The pricing strategy also depends on ownership, where private ownership generally seeks profits, while public might settle for cost recovery.[21] Owners of payment systems can price the services based on considerations such as generating profits, recovering investments, covering operational expenses, and preparing for future investment needs (World Bank 2021).[22]

Cash management is expensive, and central banks consider that increased digitalization can reduce such costs and thus increase efficiency. While FPSs and e-money systems can promote digital payments and reduce operational costs associated with cash, to the extent that CBDC is designed as "digital cash" and replicates more features of cash, it could be more effective in reducing the cost of cash management. Indeed, some countries see CBDC as a potentially effective solution for reducing cash use and to promote digitalization (for example, Bahamas, India, Jamaica, and Nigeria).

Competition

The existence of multiple payment solutions is beneficial for competition and innovation. Given the strong network effects inherent in payments (see, for example, McAndrews 1997), there is a susceptibility to monopolistic tendencies (see, for example, Katz and Shapiro 1994; Bolt and Humphrey 2005). Central banks and other authorities can stimulate competition in several ways. First, they can promote a level playing field through appropriate regulation. Second, they can supply public infrastructure, scheme, and instrument, and third, they can serve as a vehicle through which private payment instruments become interoperable. Increased competition among PSPs is crucial since it results in lower prices, higher quality services, greater variety, resilience, and more innovation (see, for example, Barrdear and Kumhof 2016; Lagarde and Panetta 2022).

A CBDC system can increase competition by serving as a platform that lowers the barriers to entry for nonbank PSPs. By providing a public (market-neutral) infrastructure and scheme, market entry can become easier by lowering investment costs and ensure a level playing field for market participants. In addition, PSPs can be integrated into the ecosystem using the public instrument to offer payment services without having to issue their own money. Currently, such non-money-issuing PSPs must

[21] In some cases, cost of payments may have been raised because regulators levied taxes on transactions, such as the mobile money tax in Tanzania, Zambia, and Cote d'Ivoire.

[22] Social cost could be another way to analyze cost saving. See Annex II for more on costs in payments systems.

collaborate with banks or e-money providers to gain access to an instrument to provide payment services. CBDC, as a public instrument, can also support competition by assuming the "credible threat" role as an alternative and a vehicle for interoperability that cash has historically played against other payment instruments. However, central banks face a long-standing challenge of providing a carefully designed public intervention (in this case, CBDC) that does not crowd out private innovation in both payments and financial intermediation. If not carefully designed, a CBDC could excessively disrupt the private sector's role in payments (Panetta 2022).

Private FPSs can in some cases limit competition as they might restrict market participation. Concerns of this type have underpinned recent decisions by the central banks in the euro area, Sweden, and the United States to have an active role in the operation of their FPS (CPMI 2021). While some larger markets can support multiple FPSs, it might not be feasible for medium or small-size economies. For example, in the United States, FedNow, a public FPS service, has been introduced to sit alongside RTP, a privately owned FPS, while in Sweden, publicly provided RIX-INST is replacing BiR.[23] Participation arrangements for FPSs are not always the same as for domestic RTGS systems—some FPSs are more restrictive, while others are less restrictive than RTGS systems. Technical and operational capabilities and readiness outside normal business hours can be part of the eligibility criteria for a FPS, which may limit participation to a subset of banking entities and PSPs. Furthermore, privately operated FPSs, especially those that use deferred net settlement, may restrict direct participation to entities with "acceptable" risk profiles to minimize the credit and operational risks the FPS takes on (CPMI 2021). Based on the FPSs studied by CPMI (2021), around 30 percent are more restrictive compared to the domestic RTGS system.

E-money can serve as a competitor and alternative to commercial bank deposits, but when operated only as closed loops, they can become monopolistic. In many jurisdictions, the e-money market is very concentrated (Boku 2021), often resulting in limited competition. While e-money has and can lead to new innovative products in the payments market, innovation in the long term rests on the ability for the market to stay sufficient competitive. The monopolistic nature of closed-loop e-money systems has prompted jurisdictions to facilitate, or even mandate, them to be interoperable (Ricci and others 2024).

Resilience

While each system itself should have resilience measures, the resilience of the wider payment landscape can be improved from having alternatives.[24] The presence of several payment alternatives may enhance resilience through redundancy.[25] The introduction of e-money systems, FPSs, or CBDC systems can all provide redundancy, provided that introducing these alternatives does not fully crowd out the existing alternatives. To the degree that different systems also use different rails, resilience can be

[23] FedNow is infrastructure developed by the Federal Reserve that allows depository institutions to provide instant payment services, whereas the RTP network is privately provided infrastructure developed by The Clearing House. RIX-INST is the Riksbank's settlement system for instant payments (using the TIPS technical platform developed by the Eurosystem), whereas the BiR settlement service was developed by Bankgirot, which is owned by a consortium of commercial banks.

[24] Supervision and oversight of payments focuses heavily on ensuring resilience of a system through risk mitigation. See Principles for Financial Market Infrastructure (PFMIs) (CPSS-IOSCO 2012). Any potential CBDC system would need to ensure a high level of resilience like other systems to avoid any adverse impact to wider payments landscape resilience.

[25] *Resilience through redundancy* refers to a backup/alternative for payments in the event of failure or disruption of the first choice.

strengthened; as it could operate outside of existing rails, CBDCs are viewed as providing additional resilience (see, for example, Bank of England and HM Treasury 2023; Mu 2023a). As a public offering, a well-designed CBDC also provides an opportunity to strengthen and possibly enhance operational and cyber resilience of a country's payments infrastructure (Bharath, Paduraru, and Gaidosch 2024). It could safeguard against market disruption such as underinvestment in operational resilience by the private sector, or private actors exiting the market.[26] This is especially true in smaller markets, served by a few private solutions where a private actor may decide to leave because of low profitability or de-risking.

Public Access to Central Bank Money

FPSs and e-money networks cannot meet objectives around public access to central bank money. Access to central bank money provides individuals and businesses with an alternative to privately issued money. A relevant form of retail public money is important as it provides an ever-present check on the private sector by allowing people to move their money in and out as desired (Rivadeneyra, Hendry, and García 2024). As such, the provision of central bank money serves as a mechanism for market discipline and supports the uniformity or singleness of money (see, for example, Armelius, Claussen, and Hendry 2020; Bank of England and HM Treasury 2023). This is crucial for maintaining monetary and financial stability for multiple reasons. Firstly, individuals and businesses need to trust that all money in the economy holds the same value at all times. Secondly, there needs to be an unambiguous unit of account that forms the basis of all economic transactions in society. Thus, while some jurisdictions (especially emerging market economies) are actively trying to reduce cash use, the declining use of cash has prompted jurisdictions in advanced economies to explore CBDC (for example, Canada, United Kingdom, and Sweden) as it would ensure access to central bank money for the public and a nominal anchor as economies digitalize.[27] FPSs and e-money solutions cannot ensure access to central bank money alone as they transfer privately issued money between users; in this regard, FPSs and e-money cannot substitute for CBDC.[28]

Access to central bank money is closely linked to preserving monetary sovereignty—a nation's ability to independently control its own currency and monetary policy. Central banks' ability to control monetary policy and provide services as lender of last resort can be challenged if alternative digital money—issued by private sector entities or foreign governments—were to become widely used as an alternative to domestic currency as a means of payment, store of value, and unit of account without a public alternative to provide the nominal anchor.

[26] Khiaonarong, Leinonen, and Rizaldy (2021) note that FMIs and PSPs often underinvest in resilience, warranting clear public oversight.

[27] Although CBDC can ensure public access to central bank money, people suffering from digital exclusion are negatively affected when cash becomes too marginalized. Central banks therefore generally consider CBDC as a complement to cash for now, and would continue to supply cash, as long as there is demand, leaving the choice between the two to the consumers (Bowman 2023). Some jurisdictions are also strengthening the role of cash (see, for example, Sveriges Riksbank 2024).

[28] This is true in any FPS or e-money model, even if central bank money is used as a settlement asset, or to back private money.

Box 3. Design Choices for CBDC That Could Support Financial Inclusion

Payments are crucial in promoting financial inclusion by serving as a gateway to wider services. They enable funds transfer between transaction accounts and support financial services such as savings, loans, and credit lines. To support financial inclusion, the payment instrument provided should always be available and the infrastructure and services should be accessible and usable, at an affordable cost.

CBDC systems may offer incremental benefit for financial inclusion in the following four areas:

- **Immediate settlement and increased trust**—as a form of public money like cash, CBDC may be attractive to hold by the willingly excluded (who may distrust existing private financial institutions).[29] Equally the ability to receive funds immediately can support those who rely on immediate cashflow.
- **Universal access**—central banks could seek to specifically distribute CBDC through providers who can reach underserved or unbanked markets. Barriers can be geography, lack of inclusive design, and lack of identity documentation. To tackle geography, nonbanks such as telecoms and post offices with wide networks could distribute CBDC without needing to qualify to undertake financial intermediation.[30] To ensure inclusive design for different abilities, the central bank could procure specialist providers to deliver user interfaces tailored to specific needs.[31] For identity challenges, a wallet with lower identity requirement for very small value payments could be offered if they are deemed low risk.[32] Such wallets could potentially allow users to incrementally provide documentation to enhance wallet functionality.
- **Offline capability**—although e-money systems can support some offline functionality, FPSs today generally require at least one party to be online to effect the funds transfer on an immediate basis or otherwise need to deploy heightened risk management measures. Offline solutions for CBDC do exist, but none are yet technically mature enough to be deployed at scale. In the long term, such functionality may provide a key advantage.[33]
- **Programmability**—CBDC may speed up/automate the disbursement of conditional government transfers, improving the cashflow of underbanked citizens; user-implemented programmability could also support financial confidence by allowing users to set their own spending limits.

A user's payments data may also provide useful information about their creditworthiness, which can be used to enhance access to credit. Payment data of one user could be used to create a data profile of how a person spends their money, providing an accurate picture of their habits and potential behaviors which could be used to evidence their creditworthiness. If users were given the choice on how to share their data, this may support better access to credit services. Such use of data may be subject to prevailing standards on data use and privacy. See Murphy and others (2024) for considerations on CBDC and data use.

FPSs and e-money systems could support some of the functionality discussed; however, no current FPS or e-money wraps all elements into one single service. CBDC systems, if designed this way, could deliver marginal gains across all elements to provide an aggregate advantage. See Lannquist and Tan (2023) on CBDC and financial inclusion and Annex III on payments systems and financial inclusion.

[29] About a quarter of the unbanked population cited distrust in the banking sector as a reason for not having a bank account in a sample analyzed by Demirgüç-Kunt and others (2022). Where CBDCs are distributed by the banking sector it may face similar challenges. In some jurisdictions, CBDC may conversely face challenges in gaining trust due to privacy concerns.

[30] CBDC providers will likely need to be licensed or authorized to instill trust. However, as they take no financial intermediation of a payment their oversight is focused on onboarding and operational elements.

[31] Sutton-Lalani and others (2023) further discusses the importance of accessibility for a wide range of needs include cognitive challenges and highlight the need for a CBDC to be designed with consideration to cognitive load.

[32] Both the e-CNY (China) and Sand Dollar (Bahamas) can, for example, be used with only a mobile number for the lowest tier.

[33] Most offline digital solutions in place today require a user/payment actor going "online" at some point so records are updated.

4. Implementing a Strategy

In considering various payments innovations, central banks should address existing pain points while preserving capacity to adapt to changes in the future landscape. Central banks will need to understand both the existing and future needs of their payments landscape and balance horizon scanning and policy analysis with practical considerations of where to invest time and resources. They will likely confront a trade-off between what is most desirable from a policy perspective and what is practically feasible to implement.

A strategy for supporting the payments landscape must consider practical constraints of each jurisdiction. Once countries have a strong assessment of their core policy priorities and ideal vision, an examination of the existing market, institutional capacity (both public and private), and timing considerations may determine the most appropriate path forward. This section considers how central banks currently tackle the question of which systems or solutions to explore and discusses constraints that could be important in crafting a suitable strategy: resources, legal powers, and timing considerations.

Observations from Central Banks' Explorations

Jurisdictions have different starting points. The systems in place condition the potential strategies a central bank could pursue, and how fast. For countries with highly digitalized landscapes with multiple well-functioning systems, the incremental value of CBDC over and above existing systems may be the focus of any exploration strategy; for other jurisdictions where digital solutions do not already exist or function poorly, CBDC could be the most direct opportunity to improve the current landscape.

However, even countries with similar payments landscapes may draw different conclusions. Box 4 provides examples of some contrasting approaches of central banks with different landscape dynamics. From these examples, some observations can be drawn about what may influence central banks:

- **Countries see value in CBDC for tackling particular use cases and pain points even where well-functioning systems with public-private partnerships exist**—this supports the importance of an analysis of both current and future objectives (see Section III).
- **Effective regulation and oversight of existing privately provided systems remains important but may prove challenging**—countries should continue to assess the effectiveness of their regulatory frameworks alongside exploration of publicly provided solutions, but also understand the limitations within their jurisdiction.
- **Private sector willingness can be an important factor in determining the future strategy**—their incentives to participate in a domestic market at present or in the future may factor into a country's design and provision of payment systems (as further discussed by World Bank 2024a and Koonprasert and others 2024).

Box 4. CBDC Exploration in the Context of Different Environments

Countries face different retail payment dynamics. These reflect their historical developments, financial and digital inclusion, cultural norms, market and regulatory structure, and size and diversity of the financial sector. This can lead countries with similar payment arrangements to take different approaches to future development and innovation. This box highlights some contrasting approaches.

Jurisdictions with Widely Adopted FPSs

Brazil's Pix and India's UPI represent two prominent FPS success stories of recent years. Both systems are widely used across their jurisdiction and have proven to encourage digitalization of the domestic payments landscape and improve efficiency. However, these jurisdictions have taken differing approaches to CBDC: Brazil has chosen not to pursue a retail CBDC at this time but instead focus efforts on developing the Pix ecosystem further. In addition, a wholesale CBDC platform (Drex) is being tested with the intention of underpinning private retail systems. In contrast, India has pursued piloting of both retail and wholesale CBDC, noting potential complementary and additional use cases for a retail CBDC (Digital Rupee)—particularly around privacy, programmability, offline, and cross-border use cases. Concurrently, the Reserve Bank of India, as regulator of UPI, is working to further develop UPI, including encouraging interoperability between CBDC and FPS.

Jurisdictions with Large E-Money Networks

The success of AliPay and WeChat Pay in China and M-Pesa in Kenya showcases how primarily closed-loop systems can establish a substantial market share through network effects. Authorities in China and Kenya have taken successive steps to improve oversight and mandate more interoperability of these systems, with the People's Bank of China also requesting AliPay and WeChat Pay to store customer funds at the central bank to assure their backing in 2018. But China and Kenya have taken different approaches to CBDC exploration. China was an early mover, being one of the first to implement a pilot of CBDC (in 2019, following nearly five years of research). Core motivations included supporting inclusion in digital payments and providing a level playing field for the payment market given market developments. Kenya, in contrast, concluded in response to their 2022 CBDC consultation that there was no case at present for a CBDC because of the role of existing systems, and instead chose to focus on bolstering existing systems and CBDC research was deprioritized to periodic monitoring. A key focus for the central bank today is increasing its oversight of M-Pesa following concerns around its resilience.[34]

Jurisdictions with Low Digitalization

The Bahamas launched the Sand Dollar in 2020 to address issues in the existing payment landscape. These included geographic challenges and lack of private innovation and services in digital payments. Many citizens relied on cash because of lack of access, onboarding frictions, and the high cost of services, particularly in the outer islands. At the same time, the domestic financial sector has experienced material de-risking. Such factors prompted the Central Bank of Bahamas to explore a publicly provided alternative to provide efficient and universal and non-discriminatory access to payment services (Branch, Ward, and Wright 2023).

[34] M-Pesa is owned by Safaricom meaning the Central Bank of Kenya share oversight with the Communications Authority of Kenya who regulate the telecoms business. Additionally, with the Kenyan government currently taking a 40 percent stake in Safaricom, there is a need for more prudent oversight to avoid potential conflicts of interest and ensure fair and impartial regulation.

Peru is another example of a country heavily reliant on cash with high levels of financial exclusion. Between 2021 and 2023, they explored CBDC in the context of tackling many pain points in their current landscape (IMF 2023). Although they have not taken a decision on CBDC issuance yet, they are preparing a one-year pilot program to further assess the viability of a CBDC system. In parallel, they are exploring improvements to their FPS, recently announcing a partnership with the National Payments Corporation of India to explore implementing a UPI-like solution in Peru.

Common Implementation Constraints

Building a new system requires a clear evaluation of institutional capacity and the possible speed at which such systems could and need to be implemented. This paper proposes three common factors that central banks should aim to map to understand the potential complexity of new systems: (1) central bank resource constraints—both direct financial costs in research, building and operating systems, and also the human capital required; (2) legal, regulatory, supervisory, and oversight considerations; and (3) timing and sequencing—the practical lead time to develop and build solutions, in addition to the more strategic consideration of how to sequence and prioritize within any strategy.

The private sector should be considered in the plans of any new initiative. Across all three systems, the private sector may play varying roles (as established in Section II), with a stronger influence as more responsibilities are delegated to them. E-money systems, for example, explicitly rely on a private sector presence and commitment to offer payment services. Private sector incentives to invest and actively participate in different systems will also reflect the potential business models any system allows through design and scheme specification. Central banks should carefully balance private sector involvement, taking into account their objectives. While the private sector can contribute to and innovate on publicly owned or coordinated infrastructure, there may be conflicting incentives if this infrastructure—whether a CBDC or an FPS—is perceived as a competitive threat. In addition, ongoing initiatives may limit the private sector's capacity to engage with new projects. While Section III noted the importance of balancing crowding-out effects from CBDC, it is equally important to ensure that one private solution does not crowd out competition from other solutions.

Resource Constraints: Financial Investment and Sustainability

The central bank's resource capacity will influence what projects may be most viable to establish in the near term. Projects such as publicly provided FPSs and CBDCs require substantive financial investment at the outset of a project (research and development phases). The financial requirements vary significantly among these systems depending on design and intended scope.[35] It is challenging to benchmark costs for CBDC development at this early stage of maturity, and cost estimates differ widely.[36]

[35] Annex II expands further on cost considerations of retail payment systems. As discussed in Section III the central bank will need to additionally consider differences in social cost between systems to support a sustainable payment system.

[36] For example, the ECB has indicated that it was ready to allocate up to €1.2 billion for private vendors to develop and test multiple digital euro services and features including offline functionality. In contrast, central banks in Sub-Saharan Africa provided some highly preliminary quotes of between US$1 million to US$3 million for development of a CBDC and between US$0.8 million and US$3 million for central bank infrastructure (Ricci and others 2024). These figures reflect feedback from a few central banks and do

Where systems are being enacted through coordinating the private sector, the central bank may be able to minimize their upfront investment to the core settlement infrastructure requirements for interoperability.[37] For example, developing e-money systems explicitly relies on a private sector presence and commitment to offer payment services. As such, developing e-money systems may minimize costs to the public sector in the short term, but in the longer term, the central bank may need to make a financial investment to connect e-money with other systems to support interoperability—today this is most commonly done in the form of a national switch. The following considerations on financial costs focus on CBDC and FPSs.

Central banks should estimate a rough cost allocation between each phase of implementation to align with their capacity and identify where private sector investment is necessary. Upfront costs of research for CBDC systems and (public) FPSs will be primarily borne by the central bank. In comparison, the development phase will likely be some combination of public and private funding. For example, during development, FPSs typically follow two funding models: (i) the central bank funds the system development, and (ii) participants fund it through monetary contributions through operator ownership or banking associations.

Direct financial costs in the operation stage will vary considerably based on design and configuration of public and private sector roles. Where money is settled on central bank infrastructure, there are direct operational costs which will be a function both of fixed maintenance costs and variable costs of usage. As an example, CBDC-to-CBDC payments should be able to operate at lower cost because of the reduction or minimization of common risks in the instrument (credit, settlement, liquidity). However, this needs to be considered alongside the fixed costs of operating the respective infrastructure, which includes maintaining a high level of security, and operational and cyber resilience.[38] Service models can also influence how costs of operation are borne by different parties. For example, a central bank pursuing a “direct” approach or one-tier model for CBDC (serving households directly) will have to fund the end-to-end operation of a CBDC system. In a “two-tier” approach, some operational responsibilities and costs may be distributed to service providers.

Central banks may also need to support the operational phase with financial investment in education and awareness. The level of support that central banks provide to the private sector can vary, ranging from education and awareness programs to more intense measures. If a system is struggling to gain adoption, it may be helpful to ensure that potential users are aware of how to access and use it. Promoting even an existing system requires financial investment, and central banks like Banco Central do Brasil and the Reserve Bank of India have invested a lot of resources in promoting the Pix and UPI platforms. There is also a comparison to be drawn with the efforts of Open Banking in advanced economies to enhance access and transparency in traditional channels. CBDC projects will require a similar strategy to build awareness.[39]

not account for additional cost considerations such as bolstering national infrastructure (for example, internet and mobile connectivity) to support capacity.

[37] Data on central bank infrastructure costs vary greatly and could still be considered significant.

[38] All digital payment systems should maintain a high level of cyber resilience. The choice to incrementally increase the resilience of central bank-owned/operated systems (whether public FPS or CBDC) will be determined by the risk tolerance of each central bank.

[39] Koonprasert and others (2024) considers strategies for adoption in CBDC.

Central banks could target a cost recovery strategy, balancing short-term adoption goals with longer-term financial sustainability. For instance, operators in a privately owned FPSs often employ a fee-based approach, charging participants joining fees proportional to the financial institution size and variable fees tied to the transaction volumes—this approach could also be applied for CBDC systems. Depending on the central bank framework, seigniorage may help offset CBDC operation costs. To promote adoption, some FPS operators (or regulators) cap end user transaction fees and/or waive them for some transactions (for example, low-value transactions). In addition, some central banks/national authorities subsidize operating costs of an FPS to support the lowering of costs to end users (for example, UPI). In the long term, a more financially sustainable approach may be desirable. This may also head off potential risks of underinvestment in the long term. However, no single cost recovery or business model has yet been identified for CBDC systems.

Central banks can also explore the possibility of reusing or sharing infrastructure. It could be feasible to use some FPS infrastructure for a CBDC system. Experimentation within the digital euro project has shown the technical feasibility of scaling up existing infrastructure, such as that used by the Eurosystem for instant payments, TIPS, to process the roughly 300 billion retail transactions carried out in the euro area each year (Panetta 2021).[40] That said, the Eurosystem TARGET Services currently take a modular design separating use cases into T2 (for settling payments), T2S (for settling securities), TIPS (a service for instant payments), and ECMS (a service for collateral management). Adopting such a modular design makes it easier to tailor each system to particular needs. Separation also allows systems to maintain degrees of resilience. As such, the possibility of reusing current infrastructure for a CBDC depends largely on prioritization of design and functional requirements including the desirable use cases.

Resource Constraints: Human Capital

Beyond the financial investment, central banks will require significant internal capacity to research, develop, operate, and oversee CBDCs. Both policy and technical resources are required for the development of different systems, and where multiple initiatives may be underway, central banks should consider how to use finite resources and expertise. For publicly provided FPSs, central banks will need to provide similar institutional capacity, although, as a more mature technology, FPSs will likely require less R&D costs than CBDC. Where the central bank has had a smaller role in retail payments to date, time to build capacity and expertise may be important to account for the nuances of operating a high volume-low value system versus a traditional RTGS service of high value-low volume.

In operation, the role of the public sector may span across governance, supervisory, and oversight roles as well as broader monitoring of impacts on monetary policy and financial stability. During the introductory phase of operation or period of stress, the monitoring of macro-financial impacts may be important for a CBDC, but also for a systemically important FPS or e-money system. While the central bank's day-to-day involvement in any private e-money system may be minimal, the central bank and relevant regulators will instead need to focus on resourcing to meet forecasted regulatory and supervisory/oversight capacity requirements. Ensuring that staff have the right skills and

[40] Beyond upgrading and sharing existing infrastructure, CBDC and fast payment systems could *combine* infrastructure elements (see, for example, ECB 2021). World Bank (2024b) also considers links between wholesale CBDC and FPSs.

expertise for different systems, or that external resources can be leveraged appropriately, will be important to smoothing implementation and operational challenges.

Legal, Supervisory, and Oversight Constraints

Legal, regulatory, and governance frameworks determine how the instrument, infrastructure, and scheme of each system can be designed and used. First and foremost, legal mandate determines the right of the central bank to issue CBDC as currency.[41] Legal mandate and powers around payments, including but not confined to roles as operator and overseer, and powers to mandate provision and economically regulate, all factor into the preparation for all systems.

Central banks generally hold a duty to ensure the smooth functioning of payment systems; through this interim objective, central banks apply their powers to different degrees. For example, the success of Pix is in part attributed to the Banco Central do Brasil's decision to mandate participation in the Pix platform by the banking sector and designate low costs of the platform in some areas for end users. In contrast, the recently launched FedNow system in the United States has been set up without a strict scheme around end user fees or mandatory participation. Thus, the choice to participate has been left to the private sector, and the private sector will determine how fees are borne by end users. In the development phase of FPSs and CBDC systems, refining the scheme and governance of the infrastructure in conjunction with industry can be useful. For example, the digital euro scheme Rulebook Development Group brings together public and private sector representatives to propose scheme rules for a possible digital euro (European Central Bank 2023).

Regulatory and supervisory implications may vary for each system depending on the competency split between the central bank and regulators. Allocation of supervisory and oversight resources and capabilities for each system should align with the systemic importance of the system, including adhering to international standards like the PFMIs.[42] Prudential regulation considerations may be applicable in some circumstances, for example if an FPS is established with a new private settlement structure. For jurisdictions with systemic e-money systems, specific prudential regulation and licensing/supervision/oversight need to be established (Dobler and others 2021). Market conduct supervision/oversight is crucial across all systems, with clear roles for conduct regulators.

Digitalization in payment systems could increase the case for evaluating economic regulation and competition policy. Section III highlighted the challenges of ensuring market contestability, especially in digital payments. Competition effects are hard to determine ex-ante but difficult to alter once established. In some countries, new authorities have been set up to tackle broader digital market competition issues.[43] Clear frameworks and oversight may mitigate the risks for some economies but may not be deemed sufficient or viable in others; importantly, authorities should consider an agile approach to competition policies in the payments industry.

[41] See Bossu and others (2020) for a further discussion of central bank and monetary law considerations. A recent IMF survey of sub-Saharan African central banks showed that legislative changes were delaying CBDC issuance plans (Ricci and others 2024).

[42] Other important international standards include Financial Action Task Force's (FATF) standards to tackle money laundering and combat the financing of terrorism (AML/CFT). This paper does not focus on financial integrity risks, which could exist in any system.

[43] For example, the Digital Markets Unit establishment in 2021 in the United Kingdom, with a mandate to (1) impose conduct requirements which manage the effects of market power of firms with Strategic Market Status (SMS) and ensure that markets are open to competition and innovation and (2) take pro-competition interventions to tackle the sources of SMS firms' market power.

The central bank will need a strong role in governance for a CBDC system or systemically important FPS to safeguard financial stability.[44] Governance arrangements broadly relate to system and scheme ownership. If the objective is for a system to be widely adopted, and effectively to become part of the national infrastructure, the system will need to put in place strong governance arrangements and practices in order to prevent systemic risks. In addition, environmental sustainability considerations should also inform system design.[45]

Timing and Sequencing

Developing a CBDC from scratch can take significant time. Without a prevailing model to follow, many central banks are taking time to consider the right approach and design choices. The latest survey of central banks on CBDC by the BIS suggests that while over 90 percent are doing work on CBDC, only 28 percent think a retail CBDC will be issued in their jurisdiction within the next six years (Di Iorio, Kosse, and Mattei 2024). This reflects the wide set of choices and the opportunities for the central bank to shape the design and impact of CBDC, but also the unmet challenges (for example, offline functionality) that central banks will still need to tackle. Soderberg and others (2023) and Tourpe, Lannquist, and Soderberg (2023) discuss many considerations of the stages of a CBDC project, including research, testing, and stakeholder engagement.

The practical implementation of a FPS could be relatively faster compared to a CBDC, if key preconditions such as established payment networks and strong central bank infrastructures are in place. For example, if a jurisdiction has a resilient and well-functioning RTGS and has high bank account or e-money ownership, then upgrading systems may be a fast and effective incremental solution to making efficiency (speed) gains in payments. Indonesia's FPS (BI-FAST) was deployed within a 12-month timeframe from procurement to rollout. However, if a jurisdiction has very low bank account ownership, or the central bank cannot directly provide access to e-money providers, then an FPS may take relatively longer to implement. Even for advanced economies with high bank account ownership, such as the United States and the United Kingdom, upgrading existing central bank infrastructure, or linking up to a well-established financial network, can require a prolonged timeline. As an example, FedNow (United States) has taken a decade to develop from inception to production, in part because of the technical upgrades required between private entities and the central bank infrastructure.[46]

Launching an e-money system can also be expedited, particularly if the central bank has developed a supportive regulatory environment. E-money systems rely on private sector provision because of the private nature of the instrument, infrastructure, and scheme. The central bank can provide more of a coordinating or supporting role here (such as the provision of a national switch to serve as an interoperability mechanism).[47] Partnering with existing providers or leveraging mobile money platforms

[44] As noted in PFMIs, though statutory definitions of systemic importance vary across jurisdictions, typically a payment system is systemically important if it has the potential to trigger or transmit systemic disruptions; this includes systems that are the sole payment system in a country, or the principal system in terms of aggregate value of payments (CPSS-IOSCO 2012).

[45] G7 Principles for Retail CBDC consider the use of environmentally sustainable technology and operation (G7 2021).

[46] The UK RTGS service has been undergoing a phased "next-generation" upgrade since 2016.

[47] For example, in sub-Saharan Africa, lack of domestic interoperability between different mobile money systems is a significant challenge. Many central banks in the region are exploring a national switch to enhance interoperability (Ricci and others 2024).

could accelerate the implementation process. However, this becomes hard if the private sector has no willingness to be involved because of potential low profitability.

Where pursuing multiple initiatives is desirable, the timing and sequencing of implementation can affect the extent to which different systems may substitute or complement each other. For example, where an FPS is already in place, central banks should analyze whether and how the introduction of CBDC will complement or cannibalize the FPS. Conversely, central banks should analyze if the introduction of an FPS might hinder the long-term implementation of a CBDC (by diverting resources and investment), or if it can help ease CBDC implementation (by strengthening private sector infrastructure for CBDC distribution, and user confidence and awareness in digital payments). An incumbent FPS could act as an interoperability mechanism between CBDC and other private instruments (World Bank 2024b). In addition, implementing several systems is resource-demanding, and might require sequencing, potentially pushing CBDC implementation further down the road.

Resource-rich central banks and jurisdictions have the ability to work on several solutions in parallel. Advancing CBDC work can be important for two reasons. First, since policy research and eventual implementation will take time, it is important to do the foundation work to be ready in the case a tipping point is reached; while the urgency for a CBDC might not be heightened at the moment, developments in the payments landscape can be such that the implementation of a CBDC becomes urgent. Starting from zero at such a tipping point would significantly delay the ability to address adverse developments. Second, being an early mover and adopter can have benefits including influencing standards and best practice.

Resource-constrained central banks can take a "wait and watch" approach to CBDC. By allowing others to advance the research about CBDC as well as allowing others to implement CBDCs first can increase the ease of implementation for those following, and it can allow them to learn about the dos and don'ts. An analogy can be drawn to FPS development where countries implementing FPSs now have benefited from a long development curve, and lessons from live implementation in other countries. Central banks may adopt this strategy not only because of being resource-constrained but also to reduce reputational risks associated with making mistakes. Central banks need to balance these risks against those of falling behind (which can also present reputation risks) or playing catch up or moving too late and being hit by adverse market developments. In addition, some countries may pay specific attention to what neighboring or economically similar countries are considering when employing these strategies.

Any strategy should be flexible to both changing landscapes and constraints. The knowledge gap on CBDC development should also narrow as central banks deepen their research and experimentation, reducing the costs of research and development. Technologies may mature allowing for currently immature solutions (for example, offline functionality) to flourish in the near future. Equally other risks (for example, post-quantum computing) could make existing systems more vulnerable. This uncertainty motivates the need for a periodic assessment of the landscape and objectives, alongside the feasibility of different systems. Not only can this affirm what efforts are working well, but it can also highlight emergent issues or signal potential tipping points for an assessment.

5. Concluding Thoughts

The decision on whether to prioritize CBDC exploration will be dependent on jurisdiction-specific circumstances. Each jurisdiction is unique, and there is no "one-size-fits-all" strategy. CBDC is still a novel innovation and requires further evidence and analysis before a general approach can be formed.

For certain objectives, there may be little difference between outcomes achieved by a CBDC system, FPS, or e-money. Speed is a core design feature of FPSs and e-money networks; these systems may be able to deliver strong enough improvements to payments efficiency to warrant prioritized action in the short term.

For other objectives, FPSs and e-money systems may fall short of what CBDC systems can be expected to achieve. There are unique objectives where a CBDC provides benefits, such as access to central bank money and monetary sovereignty because of its nature first and foremost as public money. In this way, CBDC systems also seek to complement private payment systems as they bolster trust and confidence more generally. CBDC research and exploration can also catalyze private sector action to innovate in existing systems.

When crafting a CBDC strategy, central banks should assess the current performance and future potential of existing non-CBDC systems. Existing systems may still be struggling to gain adoption, or their benefits (for example, lower costs) are not being realized and passed on to their target users. This raises two core considerations: i) is there potential to improve on the current landscape through better regulation or coordination of the private sector? and ii) is a new system or provision of service required from the central bank itself?

No single answer exists on whether central banks should encourage improvements to existing systems or pursue CBDC. Implementation capacity will play a strong role in such considerations, including capacity of the private and public sector powers. Central banks will be tied to their current powers unless there is an appetite to extend them. Subsequently, not all central banks will be able to implement the same solutions or improvements, even for similar systems.

Practical capacity may constrain the ability of central banks to implement change today, even if they have a clear long-term vision. Even systems with (now) well-trodden development paths can take a few years to develop and launch, as well as be adopted (Frost and others 2024). Benefits and costs may change over time with technological development and increasing practical experience; factors such as design configuration and usage will alter respective net costs for both public and private sectors, as well as social costs. Long-term sustainability of a solution remains important.

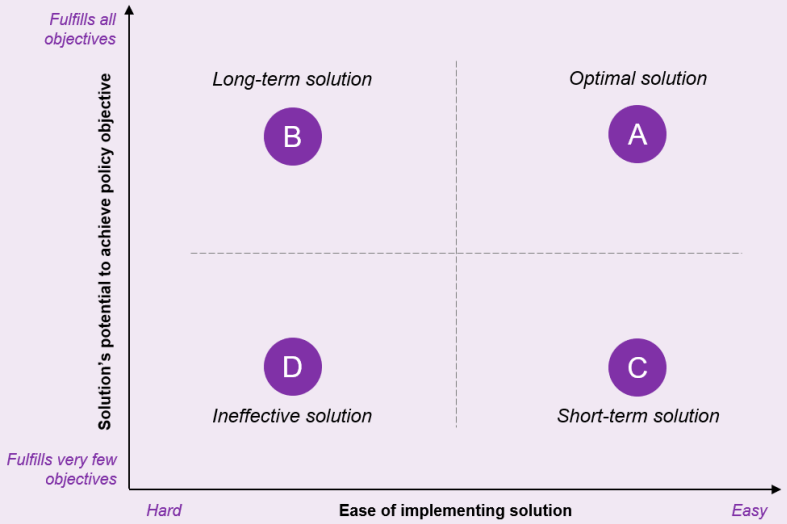
The changing payments landscape, toward a multi-instrument, multi-infrastructure world, requires central banks to be flexible and pragmatic in their approach to CBDC. While not all central banks can pursue multiple initiatives at once, investing time in monitoring and engaging internationally on payment system innovation remains a minimum essential for resource-constrained central banks given the pace of developments. An assessment should be iterative and always keep one eye toward the future. The illustrative strategy in Box 5 would support an evaluation, and any eventual development, of CBDC alongside other solutions in the short and long term. Resourcing an iterative approach will position the central bank itself to identify, plan, react, and drive developments for the domestic payments landscape.

Box 5. Illustrative Strategy for the Central Bank

Central banks may benefit from undertaking these steps regardless of which solutions are pursued:

1. **Identify policy priorities and vision for future landscape.** *What are the target objectives? What are the current pain points versus proactive vision?* Define short- and long-term goals.
2. **Stocktake the existing money and payments landscape.** *How do they meet desired objectives today? Could they be improved or upgraded? Could further supervision or oversight help? Is more direct action needed? What is the capacity of the private sector?*
3. **Understand central bank and regulator powers.** *What is the central bank mandate and what are the objectives of the central bank and regulator? How do they affect powers around supervision, oversight, and regulation of instrument, infrastructure, and scheme? How well do current frameworks perform?*
4. **Consider costs and resource factors for different solutions.** *What are the possible financial and non-financial costs between the research, development, and operation stage? What preconditions are important? Can costs between initiatives be combined?*
5. **Determine a choice set of solutions in the short and long term.** To manage the trade-off that the desired solution (to meet all policy objectives) is difficult to implement, central banks should understand the interim steps that could be taken (see Figure 3). Some central banks may find for their prioritized objectives, that there is a solution that can achieve these objectives and is simple to implement—an "optimal" solution (A). More likely, central banks will identify a "long-term" solution (B) to target which requires much more preparation and analysis. Central banks may therefore define "short-term" action(s) which complement(s) and build(s) toward this (C) such as improved regulation or coordination of existing systems. Central banks may wish to minimize resources on "ineffective" solutions (D) to a monitoring role.
6. **Monitor and evaluate the previous steps periodically.** External trends may shift the priorities of the central bank and create new tipping points for digital payments. Keeping the flexibility and resources to evaluate this strategy will position the central bank for a long-term vision.

Figure 3. Illustrative Choice Set of Central Banks



Source: Authors' elaboration.

Annex I. Payment System Case Studies

These are selected case studies of different e-money, fast payment systems, and CBDC projects around the world to support the considerations in this paper. This sample is not intended to be exhaustive.

Table 2. E-Money Systems

System Name	Primary Jurisdiction	Year Launched	Subject to Interoperability Regulation?	Other Market Presence?
PayPal	Global (United States)	1998	No	Yes
AliPay	China	2004	Yes	Yes
MTN Mobile Money (MoMo)	Sub-Saharan Africa	2007	Yes	Yes
M-Pesa	Kenya	2008	Yes	Yes
Venmo	United States	2009	No	No
Paytm	India	2010	Yes	No
WeChat Pay	China	2011	Yes	Yes
GrabPay	Singapore	2016	Yes	Yes

Source: Based on publicly available data.

Table 3. Fast Payment Systems

System Name	Primary Jurisdiction	Year Launched	Scheme Ownership	Infrastructure Ownership	Settlement Mechanism	NBFI Participation ?
Zengin System	Japan	1973	Private	Both	DNS	Yes
Faster Payments UK	United Kingdom	2008	Private	Both	DNS	Yes
Unified Payments Interface (UPI)	India	2016	Private	Both	DNS	Yes
SEPA Instant Credit Transfer	Euro Area	2017	Private	Both	RTGS	Yes
PromptPay	Thailand	2017	Private	Both	DNS	Yes
RTP	United States	2017	Private	Both	RTGS	No
New Payments Platform (NPP)	Australia	2018	Private	Both	RTGS	Yes
CoDi	Mexico	2019	Public	Public	RTGS	No
Transferencias 3.0	Argentina	2020	Private	Both	RTGS	Yes
Pix	Brazil	2020	Public	Public	RTGS	Yes
Bakong	Cambodia	2020	Public	Public	RTGS	Yes
BI-FAST	Indonesia	2021	Public	Public	RTGS	Yes
Sarie Instant	Kingdom of Saudi Arabia	2021	Public	Public	RTGS	No
RAAST	Pakistan	2021	Public	Public	DNS	Yes
PayShap	South Africa	2023	Private	Both	RTGS	No
FedNow	United States	2023	Public	Public	RTGS	No

Source: Based on publicly available data.
Note: Infrastructure ownership covers both clearing and settlement. “Both” denotes an FPS that uses a combination of public and private infrastructures in clearing and settlement. As noted in the Section II, most FPSs use central bank infrastructure for the final settlement. DNS = deferred net settlement; FPS = fast payment system; NBFI = nonbank financial institution; RTGS = real-time gross settlement.

Table 4. Retail Central Bank Digital Currencies

System Name	Primary Jurisdiction/Region	Exploration (Production) Began	Primary Objectives/Reason for Exploration	Accounts Onboarded
			Production	
Sand Dollar	Bahamas	2017 (2020)	Increase payments efficiency; provide non-discriminatory access to payments; achieve greater financial inclusion; and strengthen national defenses against money laundering, counterfeiting, and other illicit ends by reducing the ill effects of cash usage (Branch, Ward, and Wright 2023)	>100,000
e-Naira	Nigeria	2017 (2021)	Improve financial inclusion and reduce the size of the informal economy and facilitate cheaper and more efficient diaspora remittances (Central Bank of Nigeria 2023)	>850,000
JAM-Dex	Jamaica	2019 (2022)	Improve financial inclusion and modernizing the payment system and reducing costs for cash distribution and storage (Haynes 2020)	>190,000
			Pilot	
e-CNY	China	2017	Improve the efficiency of the central bank payment system; provide a backup or redundancy for the retail payment system; improve financial inclusion (Mu 2023a)	>180 million
D-Cash	Eastern Caribbean Currency Union	2017	Improve financial inclusion, economic growth, resilience, and competitiveness (Eastern Caribbean Central Bank 2019)	N/A
Digital Rupee	India	2020	Reduction in operational costs involved in physical cash management, fostering financial inclusion, bringing resilience, efficiency, and innovation in payments system (Reserve Bank of India 2022)	>4 million
Digital Tenge	Kazakhstan	2021	Modernizing the financial system and improving innovation and competitiveness of the financial market (National Bank of Kazakhstan 2022)	N/A
			Exploration	
e-Krona	Sweden	2017	Decline of cash and need to preserve access to central bank money to preserve uniformity of money and support competition, innovation, and resilience (Sveriges Riksbank 2018)	N/A
Digital Canadian Dollar	Canada	2020	Decline of cash and need to preserve access to central bank money (Bank of Canada 2020)	N/A
Digital Euro	Euro Area	2020	Safeguard the role of public money and maintain trust in the currency to ensure strategic autonomy and monetary sovereignty, making the payments landscape more competitive and resilient and ensuring a secure means of payment universally accepted throughout the euro area (European Central Bank 2024)	N/A
Digital Pound	United Kingdom	2020	Ensure the availability of central bank money as an anchor for confidence and safety in money, and to promote innovation, choice, and efficiency in payments (Bank of England and HM Treasury 2023)	N/A
CBDC in Peru	Peru	2023	To improve the efficiency and interoperability of the payments system in Peru to support further digitalization and to support financial inclusion (Banco Central de Reserva del Peru 2023)	N/A

Source: Based on publicly available data and central bank publications.
Note: Exploration is recorded as the year of the first publicly available policy paper or press release of project for consistency. Some countries may have started their exploration much earlier (for example, China established the digital fiat currency research group in 2014).

Annex II. Social Cost of Payments

Costs can mean different things to different stakeholders. In retail payment systems, costs are a function of existing infrastructure, instrument usage, and distributed between central bank, PSPs, and consumers which is defined by system architecture. Three types of costs emerge when a central bank wishes to establish a system. First, user fees are borne by consumers and merchants. Second, central bank's budget to build and operate the system. Third, total costs for the economy (social costs) which are a sum of all resources spent by all stakeholders. In addition, the climate impact is a cost for society to consider.

The World Bank recommends that a comprehensive cost analysis of a retail payment system cover both resource and transfer costs. The resource cost of payments is the sum of all internal costs incurred by a stakeholder for a payment to occur while transfer costs are the fees paid by one stakeholder to another. This structure covers both demand and supply sides. As shown in Table 5 the demand side reflects costs incurred by payment services users, spanning individuals, businesses, and government, while the supply side portrays expenses borne by service providers, such as central banks, PSPs, and Payment Infrastructure Providers (PIPs). Within this framework, each cost category comprises both resource costs (RC) and transfer costs (TC), with the total expenses for each stakeholder calculated as the sum of RC and TC.

Table 5. Cost Structure in Retail Payments

Type of Costs		Resource Costs (RC)	Transfer Costs (TC)	Total Costs per Stakeholder
Demand side (users)	**Consumers**	RC^{P}	TC^{P}	$\Sigma(RC^{P}, TC^{P})$
	Businesses	RC^{B}	TC^{B}	$\Sigma(RC^{B}, TC^{B})$
	Government	RC^{G}	TC^{G}	$\Sigma(RC^{G}, TC^{G})$
Supply side (providers)	**Central Banks**	RC^{CB}	TC^{CB}	$\Sigma(RC^{CB}, TC^{CB})$
	PSPs	RC^{PSP}	TC^{PSP}	$\Sigma(RC^{PSP}, TC^{PSP})$
	PIPs	RC^{PIP}	TC^{PIP}	$\Sigma(RC^{PIP}, TC^{PIP})$
Total costs for the economy (social costs)		$\Sigma(RC^{P}, RC^{B}, RC^{G}, RC^{CB}, RC^{PSP}, RC^{PIP})$		

Source: Authors based on World Bank (2016).
Note: PIP = payment infrastructure provider; PSP = payment service provider; RC = resource costs; TC = transfer costs.

Using the cost structure in Table 5., the three types of costs consist of (i) **user fees**, which are the sum of either consumers' or business' RC and TC; (ii) **central banks budget**, which includes the central bank's RC and TC to establish and operate the systems; and (iii) **the social costs**, computed as the sum of all RCs exclusively, excluding TC to avoid double counting as TC in retail payments signifies

the expenses associated with transfers between PSPs or PIPs and their outsourcing partners (World Bank 2016).

Cost studies using frameworks such as presented earlier are undertaken by central banks, but there is no clear and easy way to compare costs between the systems evenly. Each payment system is distinct, and as previously mentioned, costs for each system are influenced by various factors including infrastructure, user base, and regulatory environment. Consequently, a standardized metric for cost evaluation across systems remains elusive. However, by employing a comprehensive cost structure perspective, policymakers can: (i) gain valuable insights into the intricacies of cost distribution among stakeholders, enabling a nuanced understanding of the economic implications associated with different costs in payment systems; (ii) make informed decisions to optimize the efficiency and affordability of retail payment systems; and (iii) work toward minimizing overall social costs while maximizing the societal benefits derived from these systems.

Recent studies from Sweden and Norway indicate that cash payments are expensive for the society as they consume more resources compared to digital alternatives.[48] Sweden and Norway are, however, jurisdictions with low levels of cash usage, and high fixed cost and low volumes are contributing factors to this result. Other studies find that cash has a relatively low unit cost in jurisdiction with more cash usage (see Junius and others 2022).

Thinking about the social cost of a new system, such as CBDC or FPS, can be challenging since numbers would be purely theoretical. However, by comparing a particular design toward existing systems with many similarities can give a good indication toward the cost. For example, a software-based CBDC would have a cost structure more similar to some software-based e-money alternatives or mobile-based FPSs, while a CBDC with physical card alternatives would have to account for cost structure elements present in card-based payments. Importantly, central banks would need likely to adjust for who is bearing the different costs, as it likely that the central banks would bear some costs that, for example, PSPs bear in a private FPS.

A possible consideration for digital payment systems is their climate impact. While studies on the climate impacts of cash and retail payments exist (see, for example, Thinkstep 2017; Arvidsson and others 2024), research on CBDC systems remains scarce.[49] Evidence today suggests that the carbon footprint of retail payments is primarily determined by the energy usage of infrastructure, particularly data centers, and the utilization of payment instruments. From Arvidsson and others (2024), it could be concluded: (i) cash exhibits the highest carbon footprint compared to non-cash payment instruments; (ii) FPSs has lower carbon footprint than e-money (both hardware- and software-based); (iii) both FPSs and e-money systems currently present lower carbon footprints than cash and card payments networks; and (iv) each country may yield different results when calculating the total carbon footprint for each system, depending on usage patterns. Discussions on a green CBDC are at an early stage and currently focus on the technology implementation.[50]

[48] See Sveriges Riksbank (2023) and Norges Bank (2022) for the most recent cost studies.

[49] In a broader context analysis of the connection between digital currencies and energy consumption. See, for instance, Agur and others (2023).

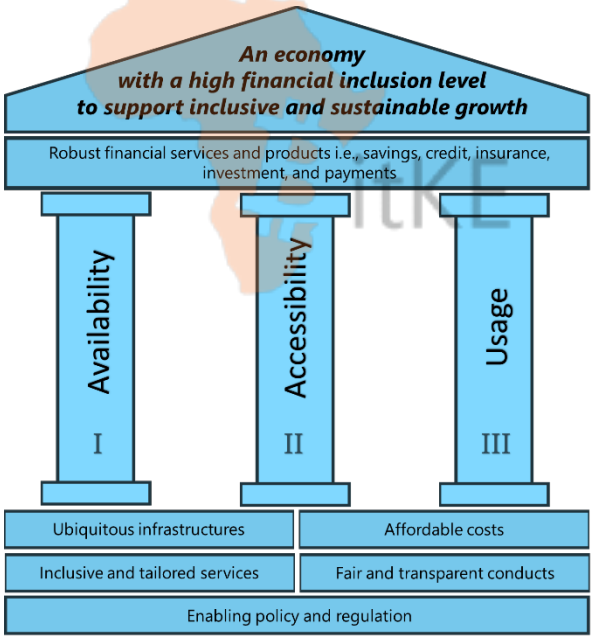
[50] See, for example, Principle 8 of the G7 Principles for CBDC promotes the use of sustainable technology and operations in any CBDC system (G7 2021).

Annex III. How FPS, E-Money, and CBDC Can Promote Financial Inclusion through Payments

This analysis builds on the foundational work of the IMF and other international organizations. Notably, the CPMI and the World Bank established a task force on Payment Aspects of Financial Inclusion (PAFI) in 2014. This task force developed a comprehensive PAFI framework designed to enhance financial inclusion, anchored by seven guiding principles. This framework is adapted to support our analysis (see Figure 4).

First, establishing a clear definition and scope of financial inclusion is fundamental for this analysis. Based on existing literature, financial inclusion is defined as the process of ensuring that all individuals and businesses, especially vulnerable and underserved groups, have access to suitable financial products and services at an affordable cost, delivered in a fair and transparent manner. This definition encompasses three key dimensions: availability, accessibility, and usage of financial services.

Figure 4. A Framework to Improve Financial Inclusion



Source: Elaboration by the Authors of PAFI framework.

Secondly, financial inclusion encompasses a broad spectrum of financial services beyond traditional banking. These services include savings, credit, insurance, investment, and payments. The specific needs for these services vary from person to person. For example, a farmer in Kenya may find that a mobile money person-to-person (P2P) transfer service provided by a mobile network operator meets his or her needs, while a medium-sized merchant in Brazil may require additional services, such as a savings and transaction account at a bank, to support his or her business. Regardless of individual needs, it is evident that people often require more financial services than they currently use. Therefore,

the goal is to ensure a diverse range of financial services that are always available, accessible, and ready for everyone.

Ultimately, financial inclusion starts with payments, and at the core of payments lies the transaction account. Therefore, the objective of payments in the context of financial inclusion is to leverage transaction accounts for payments, storing value, and serving as gateways to other financial services (CPMI and World Bank 2020). For this analysis, FPS, e-money, and CBDC will be considered as broad systems. Their potential to support financial inclusion will be evaluated using the framework outlined.

Availability

To effectively support financial inclusion, the infrastructure of payment systems must be ubiquitous. The ubiquity of the payment services shall cover both time (whenever needed) and place (wherever needed). In terms of time (whenever needed), FPS, e-money, and CBDC seem to have no difference as each has been enhanced to operate 365/24/7. However, in terms of place or access points to the services, there are some differences depending on their capability and design. Conceptually, access points to financial services can be classified based on payment initiation, consisting of in-person and remote payment access points (see Table 6).

Table 6. Different Access Points for Retail Payments

	In-Person Payments	Remote Payments
Payment access points	• Cash or check payment • PoS terminal • Bank branch • Agent banking • PSP agent • Post office • Collection office • ATM	• Mail • Internet/designated lines • Telephone/mobile phone network

Source: World Bank (2016).
Note: ATM = automated teller machine; PoS = point-of-sale; PSP = payment service provider.

In-person payment access points are crucial for reaching the unbanked, and underbanked. Financial inclusion efforts must address four consumer divides: class (rich-poor), geography (urban-rural), gender, and cultural-trust divides. Geographic divides are particularly relevant, with in-person payment access points playing a pivotal role in onboarding financially excluded individuals.

FPSs can offer extensive access point coverage when designed with financial inclusion in mind. FPS' design can leverage the use of the existing financial and payment landscape. For instance, Brazil's Pix system uses existing banks, credit cooperatives, and payment institutions to reach users, including the unbanked and underbanked. As of May 2024, Pix has 828 member institutions, and its services have been used by over 153 million people (nearly 90 percent of adults). However, the choice lies with the policymakers. China's Inter Bank Payments System (IBPS) restricts participants to banks, limiting its in-person payment reach compared to Pix. A more gradual approach can be adopted, by onboarding FPS participants in cohorts.

E-money systems typically have limited access points because of interoperability issues. Their networks often cover only point-of-sale (PoS) systems and mobile money agents within their ecosystem. Successful e-money schemes, such as Alipay and WeChat Pay in China or M-Pesa in Kenya, thrive on strong network externalities. However, similar success has been limited elsewhere because of these constraints.

Conceptually, CBDCs have the potential for widespread reach but require robust policies, design, and features. A common way to achieve this is by leveraging the existing financial and payment landscape, including banks, NBFIs, and other PSPs such as telecoms and post offices. However, this approach requires significant effort and commitment initiated by the central bank where the 'transaction accounts' for CBDC resides. For instance, the Reserve Bank of India mandated UPI merchants to accept digital Rupee payments during its pilot, leveraging 50 million UPI merchants for CBDC transactions. Similarly, the People's Bank of China initiated the pilot of e-CNY in 2020 within four cities (Shenzhen, Suzhou, Xiongan, and Chengdu) and the 2022 Beijing Winter Olympic Games. Currently, the pilot includes over 118 million e-CNY wallets across 17 provinces, with transactions totaling approximately RMB 1.8 trillion as of June 2023(Mu 2023b).

Accessibility

Payment services must be inclusive and tailored to transaction needs, particularly for those who are financially excluded. Depending on the transaction's purpose and whether the actors are individuals, businesses, or government agencies, the effects on financially excluded individuals can vary. Financial inclusion measures focus on individuals, so it is essential to review the types of financial inclusion-related retail payments (involving individuals) to understand user interactions and major transaction examples (see Table 7).

Table 7. Types and Examples of Financial Inclusion-Related Retail Payments

From/To	Person	Business	Government
Person	"P2P" *Money remittances/transfers, shared bill/payments*	"P2B" *Purchase of goods and services (PoS), e-commerce payments*	"P2G" *Tax (income, property), fines, duties, government fees (passport, driving license)*
Business	"B2P" *Payrolls and other compensation-related payments*		
Government	"G2P" *Social benefit transfers (cash, child support, student allowances), civil servant payrolls, pensions*		

Source: CPMI and World Bank (2016); and Authors.
Note: P2P should be read as "person-to-person," B2P as business-to-person, etc.; PoS = point-of-sale.

The design and features of payment services determine their ability to meet the needs of actual or potential users. Traditional bank clients may require sophisticated payment services, including

P2B and P2G, while individuals without transaction accounts may only need P2P functionality. The latter is because of their typically lower and more variable incomes (class divides) or residency in financially isolated communities (geo divides). Poorly designed payment services act as significant barriers to adoption.

CBDCs have a high potential to meet users' needs, following the success of some FPSs. Central banks have wide opportunity to tailor the design and features of CBDC to meet consumers' needs, but the implemented use cases are by far primarily focusing on P2P transfers/remittances and PoS payments (for example, e-Naira and Sand Dollar). Some offline transactions and programmable money are in a pilot phase, with e-Naira implements an offline transaction using USSD.[51] FPSs have also been designed to cater to a range of transaction types. For example, Brazil's Pix system allows customers to perform P2P, P2B, P2G, and vice versa transactions using predefined aliases or QR codes.

The ability of e-money systems to meet users' needs varies, depending on the initiatives of the private entities issuing the instruments. Common e-money features include P2P and PoS payments. However, mobile money is increasingly viable for G2P payments in safety net programs, such as Ethiopia's Telebirr mobile money service. Despite its promise, this initiative is currently in a pilot stage with limited application and faces challenges such as poor connectivity and limited access to electricity. Nevertheless, such services could improve efficiency and transparency of financial interactions with the government and connect unbanked users with the formal financial system.

Usage

A key driver for payment usage is an affordable cost.[52] Providing payment services at a low cost can encourage more usage, hence more effectively supporting financial inclusion.

In retail payments, costs are divided into fixed and indirect costs. Fixed costs, which include expenses for opening and maintaining transaction accounts, represent a significant portion of the total expenses for PSPs. These costs are largely independent of transaction volume or size, leading PSPs to charge fixed periodic fees, often monthly. For instance, many PSPs include basic services such as funds transfers within the same institution or a set number of ATM withdrawals in this fee, which may be waived if the account holder maintains a minimum balance. However, in markets with limited competition and high entry barriers, PSPs face higher average costs, resulting in higher fees that adversely affect low-income users. These higher costs hinder financial inclusion efforts by making it difficult for low-income individuals to maintain transaction accounts.

Indirect costs also significantly affect the accessibility of payment services. High fixed costs can limit the geographical coverage of the services, preventing them from opening branches or agents or operating in smaller towns without sufficient market potential. This limited coverage increases indirect costs for users, such as transportation expenses and time spent accessing the nearest access point. These indirect costs pose a significant barrier to both existing and potential users, deterring many from

[51] Unstructured Supplementary Service Data (USSD) is a communications protocol used by GSM cellular telephones to communicate with the mobile network operator's computers.

[52] Several aspects factor into usage including perceived safety, privacy, and convenience. CPMI and World Bank (2016) underscore that the high fees associated with maintaining and using transaction accounts are a significant barrier to financial inclusion, particularly for low-income users. This cost is a critical, endogenous factor that should be directly addressed to improve access and usage.

opening or maintaining transaction accounts. These type of fees can be reduced using electronic payments, standing orders, or direct debits.

In FPSs, central banks often have more involvement in imposing zero or low pricing policy to drive adoption. For instance, the Reserve Bank of India has banned any fees to be charged to UPI's customers or merchants, making UPI services zero cost (per transaction) to its users.[53] Banco Central do Brasil also prohibits charging Pix's customers directly with a cost but allows merchant fees. No cap is imposed on these fees; hence, it is left to the market to determine the fees. In the case where charging fees is prohibited, PSPs tend to do cross-selling and bundling the fees, for instance between FPS transaction costs and transaction account fees.

Zero transaction fees are also common for CBDCs. Since its inception in 2021, the Central Bank of Nigeria has imposed no transaction fees for e-Naira. During its pilot phase, e-CNY also did not incur transaction fees for users and merchants. This contrasts with card payments, which typically charge merchants in the United States around 1–3 percent (see, for example, Congressional Research Service 2021). However, a business model where costs are solely borne by PSPs may be unsustainable, necessitating the development of new cost-sharing models in order to ensure the long-term viability of CBDCs.

In e-money systems, fees are primarily determined by the issuer, with central banks or regulators playing a lesser role. Economies of scale and network externalities significantly influence the efficiency and cost of e-money systems. For instance, sending KSH 1,000 (US$13.06) through M-Pesa costs US$0.39, which is 27 percent cheaper than using local post office services. Conversely, e-money systems with low economies of scale and network effects can be costly for users. Efficient and widely accepted e-money systems can reduce fees and enhance financial inclusion, but those lacking scale may struggle to offer affordable services.

[53] To support this initiative and encourage digital payments, the Government of India has provided subsidies. For FY2021/2, the subsidy amounted to INR 200 crore, which was significantly increased to INR 1,500 crore for FY2023/4 to sustain and expand the UPI infrastructure. For more details on budget figures, see the Union Budget of India at https://www.indiabudget.gov.in/.

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Positioning Central Bank Digital Currency in the Payments Landscape

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