

Central Bank Digital Currency Global Interoperability Principles

WHITE PAPER
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Contents

Preface	3
Executive summary	4
Introduction	5
1 Scope	6
1.1 Definitions	6
2 CBDC priorities across regions	7
2.1 Areas of alignment	7
2.2 Latin America and the Caribbean	9
2.3 Sub-Saharan Africa	11
2.4 Middle East and North Africa	13
2.5 Asia-Pacific	14
2.6 Europe	19
2.7 North America	20
2.8 Global CBDC lessons learned	21
3 Global considerations	23
3.1 Monetary sovereignty	23
3.2 Financial stability	23
3.3 Geopolitical risk	24
3.4 De-dollarization	24
3.5 Infrastructure cost considerations	25
4 Key motivations for interoperability principles	26
5 Principles for CBDC interoperability	28
5.1 Governance	28
5.2 Legal and regulatory	29
5.3 Identification and authentication	29
5.4 Payments	30
5.5 Technical	31
6 Recommendations	32
6.1 For central banks	32
6.2 For policy-makers	32
6.3 For the private sector	32
6.4 Financial market infrastructure	33
Conclusion	34
Contributors	35
Endnotes	38

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Preface



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In 2023, the exploration of central bank digital currency (CBDC) has gained significant momentum, with over 100 countries, representing more than 95% of global gross domestic product (GDP), actively engaging in research, development, pilots or fully-launched CBDC initiatives. This exponential increase in exploration highlights the growing recognition of CBDCs as a transformative tool in the future of digital payments.

To ensure the successful implementation of CBDCs and promote interoperability in both domestic and cross-border payment systems, global coordination becomes paramount. It is essential to prioritize having open and regular dialogues between central banks and the private sector about their CBDC journey and experiences. Building upon previous work of the Digital Currency Governance Consortium (DCGC), the World Economic Forum held the CBDC Regional Roundtable series to allow for multistakeholder dialogues on the current state of CBDCs and the areas that require further inquiry. Roundtables were held starting in Spring 2022 in Latin America and the Caribbean, Sub-Saharan Africa, the Middle East and North Africa, Asia-Pacific, Europe and North America. The discussions brought together representatives from the public and private sectors to understand CBDCs from their respective perspectives and lessons that can

be learned from CBDC experiments and pilots in different regions. These dialogues promoted knowledge sharing across regions with the aim of encouraging globally interoperable CBDC systems.

In the CBDC space, further work is required to determine the principles and standards to which sovereign CBDC designs would need to adhere to support efficient payments. In an effort to push forward the conversation on principles, this publication gathered insights from each of the regional discussions in order to identify unique aspects from each jurisdiction that are affecting the design process. In addition to identifying the distinct aspects per region, the discussions surfaced areas of alignment between jurisdictions. With this input, along with other research, this paper sets out a series of interoperability principles that can form a basis for interoperable CBDCs.

By emphasizing global coordination, promoting knowledge sharing and establishing guiding principles, the CBDC ecosystem can advance in a harmonized manner, enabling efficient and interconnected digital payment systems. As countries continue their exploration of CBDCs, collaboration and the pursuit of interoperability will be instrumental in realizing the full potential of this transformative technology.

Executive summary

Central banks have different motivations for exploring or developing central bank digital currency (CBDC), and the demand for improved domestic and cross-border payment rails differs across jurisdictions. To help central banks in the planning and development of their CBDCs and to make sure that interoperable functionalities are considered in time, the central bank community should take steps at the beginning of the design process to include these considerations. Although this paper does not take a stance on the choice to issue a CBDC, it considers interoperability in a global future state where a CBDC may exist.

Based on the input of the Forum's Digital Currency Governance Consortium (DCGC) CBDC Regional Roundtable series and multistakeholder input, this paper analyses CBDC from a regional perspective to draw unique elements that would impact CBDC design in each jurisdiction. Based on these regional perspectives, there were several elements that were aligned among countries and regions, including:

- Trust in the payment instrument
- Promoting innovation
- Financial inclusion
- Monetary and economic stability
- Payment efficiency and security
- Regulatory compliance and financial integrity
- Privacy and data protection
- Cybersecurity and resilience
- User experience and accessibility
- Offline capabilities
- Cross-regional cooperation
- Public-private cooperation
- Interoperability and standards.

In addition, since the commencement of CBDC pilots and experimentation, there were lessons learned that are relevant globally. These included having a clear reason to pursue CBDC, having strong reasoning for the underlying technology choice, alignment with regulatory frameworks, ensuring integration with other payment solutions, prioritizing user experience and accessibility, building public confidence and trust in the CBDC, building the CBDC with public-private cooperation and prioritizing interoperability.

When considering CBDC interoperability, there are a few key areas that require additional attention. This includes monetary sovereignty, financial stability, geopolitical risk, de-dollarization and infrastructure cost considerations.

Based on all prior input, there arise a set of principles for CBDC interoperability. There are generally applicable principles such as the need for standardization, openness and inclusivity, scalability, resilience and redundancy, and cross-border integration. Additional principles are grouped by governance, legal and regulatory, identification and authentication, payments, and technical.

Thus, the recommendations for central banks are to foster public-private cooperation, engage in thought leadership and advocacy, and education and awareness on CBDCs. For policy-makers, there is a recommendation to aim for regulatory consistency, participate in international forums and foster innovation and research in CBDC. For the private sector, there should be greater participation in regulatory sandboxes and innovation hubs, interoperability testing and pilots, and participation in standards development. For financial market infrastructure players, there should be a focus on interoperable clearing and settlement systems, standardization of messaging formats, and sharing insights from interoperability work.

These principles can provide a foundation for interoperability with CBDCs. There is a call to action to continue this conversation and form a set of standards that can be applied readily and overseen and enforced by an agreed-upon entity.

Introduction

Central bank digital currencies (CBDC) have the potential to mitigate the long-standing challenges in payments, including high costs, low speed, limited access and insufficient transparency. As the future of payments could be transformed, there is an opportunity to ensure that there is global coordination in the creation of CBDCs. By understanding various jurisdictional priorities and identifying areas of alignment, a set of principles can be identified that serve as a foundation for the creation of interoperable CBDC design.

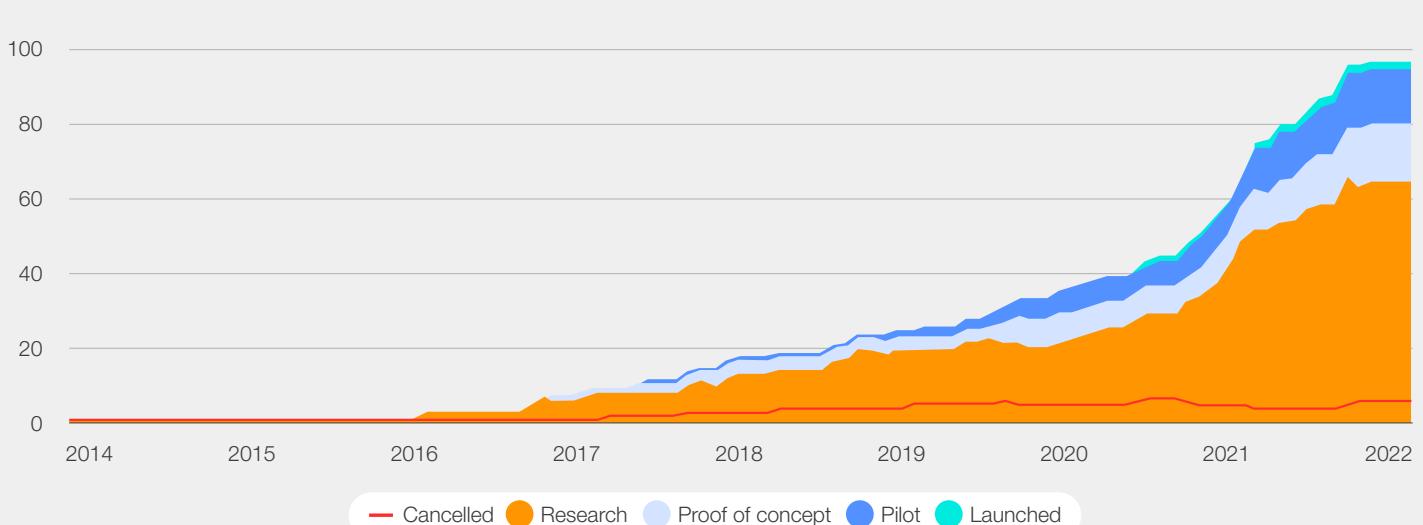
This piece builds off the World Economic Forum's Central Bank Digital Currency Policy-Maker Toolkit, the Digital Currency Governance Consortium (DCGC) white paper series and research from existing and new efforts in this space by international and inter-governmental organizations, many of which involve DCGC member organizations. This paper is informed by the CBDC Regional Roundtable series, workshops, interviews and panels, including World Economic Forum meetings at The Davos Agenda 2022 and 2023 and the Global Technology Governance Retreat. Above all, the paper attempts to provide a neutral, objective and analytical perspective on CBDC interoperability.

This white paper will address the following:

- Define the concept of interoperability and CBDC.
- Identify the areas of alignment for CBDC priorities across regions.

- Analyse the priorities for CBDC across regions including Latin America and the Caribbean, Sub-Saharan Africa, Middle East and North Africa, Asia Pacific, Europe and North America.
- Summarize lessons learned from CBDC exploration across the world thus far.
- Acknowledge considerations for CBDC in any jurisdiction, including monetary sovereignty, financial stability, geopolitical risk, de-dollarization and infrastructure cost considerations that need to be reflected on prior to any future CBDC issuance.
- Set out principles for interoperable CBDC that take into account the previously outlined jurisdictional priorities and areas of alignment.
 - These principles are organized in the categories of governance, legal and regulatory, identification and authentication, different forms of payment and technical considerations.
- Offer recommendations to central bankers, policy-makers, the private sector and financial market infrastructure players.
- Conclude with a look towards supporting a set of standards based on these principles.

FIGURE 1 **Exponential growth in CBDC exploration**



Notes: 1. The chart shows the status of CBDCs worldwide by month. 2. Proof of concept = advanced research stage. 3. Central bank digital currencies are being explored in more than 100 countries.

Source: CBDC Tracker, Today's Central Bank Digital Currencies Status [Interactive map], cbdctracker.org.

Scope

Interoperability of CBDCs is important, regardless of whether they are implemented in all regions.

CBDC issuance and design are sovereign decisions to be made by each jurisdiction. The scope of this deliverable assumes that some countries may adopt CBDCs in the future but is agnostic as to whether a CBDC is implemented. This piece of work does not advocate for or take a position on the need for a CBDC. It discusses the considerations that

need to be undertaken in the event that a CBDC is issued (either wholesale, retail or both). The focus includes ensuring that any CBDC is interoperable with domestic payment options. As for cross-border payments, it is also important to ensure interoperability with other countries that choose to issue a CBDC.¹

1.1 Definitions

Interoperability

There are existing definitions of interoperability framed by the Bank for International Settlements (BIS),² the World Economic Forum³ and various other institutions.⁴ The definitions used in this paper are consistent with these organizations.

Interoperability for central bank digital currency means interoperability, from both a domestic and cross-border viewpoint, with various types of payment systems, technical standards, regulatory standards and legacy payment architecture and infrastructure.⁵ Interoperability allows participants in different systems to conduct, clear and settle payments or financial transactions across systems without participating in multiple systems.⁶

CBDC

CBDC is a direct central bank liability and “a digital form of central bank money that is different from balances in traditional reserve or settlement accounts”⁷



Retail CBDC: A form of central bank digital currency that is accessible to the public and could be used domestically or cross-border. Retail CBDCs are sometimes also referred to as general purpose or universally available CBDCs.



Wholesale CBDC: A form of central bank digital currency that would be used among banks and other licensed financial institutions for interbank payments and securities transactions. Wholesale CBDC could be used both domestically and cross-border.



CBDC priorities across regions

Regions identify unique priorities for CBDC design, but certain objectives are universally significant.

There are areas of priority that have been identified that will impact the design of CBDC in each respective region. Although jurisdictions will have distinguishing motivations for CBDC, globally

important areas of alignment have been identified as well. The sections below elaborate on the important objectives for all CBDCs irrespective of region as well as regional priorities.

2.1 Areas of alignment



The following features are priorities that tend to align between regions when it comes to CBDC development.



Greater interoperability and automated transfers could ultimately benefit consumers through more convenient and cheaper products that are better tailored to their needs, thereby enhancing financial inclusion, innovation and the future of the monetary system.

Agustín Carstens, General Manager, BIS

TABLE 1 Areas of alignment

CBDC objective	Description
Trust in the payment instrument	CBDCs are intended to be an additional payment solution in the current array of payment choices. Central bank money is the safest and most liquid settlement asset, so central banks would like to ensure that any CBDC preserves consumer trust in the payment instrument.
Promoting innovation	Digitization of payment systems is an important innovation and jurisdictions are exploring CBDC in an effort to keep pace with global technological advancements.
Financial inclusion	Enhancing financial inclusion is a common priority across regions. CBDCs have the potential to enhance financial inclusion by providing access to basic financial services for unbanked and underbanked populations, empowering individuals with access to affordable digital payment options. ⁸
Monetary policy and economic stability	CBDCs have the potential to enable more effective implementation of monetary policy and enhance economic stability. Central banks seek to design CBDC frameworks that align with their monetary policy objectives and support economic development.
Payment efficiency and security	Improving payment systems' efficiency and security is a shared goal. CBDCs intend to offer faster and more secure transactions, reducing the reliance on traditional intermediaries and minimizing settlement times.
Regulatory compliance	Ensuring regulatory compliance and maintaining financial integrity are common concerns globally. CBDCs can be designed to facilitate compliance with regulatory frameworks, including anti-money laundering (AML) and combating the financing of terrorism (CFT) measures.

TABLE 1 Areas of alignment continued

CBDC objective	Description
Privacy and data protection	Safeguarding user privacy and data protection is a significant consideration. Many regions emphasize the need for strong privacy measures in CBDC design, such as ensuring anonymity or pseudonymity while balancing the requirements for transparency and regulatory oversight.
Cybersecurity and resilience	Building resilient CBDC systems and protecting them against cyberthreats is a universal priority. Robust security measures, including encryption and authentication protocols, are essential to ensure the integrity of CBDC platforms and maintain public trust.
User experience and accessibility	Focusing on user experience and ensuring that CBDCs are intuitive and accessible to all users is a shared concern. This includes designing user-friendly interfaces and addressing potential barriers to adoption, such as digital financial literacy.
Offline capabilities	Fiat currency today has features that are favoured when compared to digital solutions. It is recognized that CBDCs must provide offline capabilities in order to become more widely adopted.
Cross-regional cooperation	Although each jurisdiction has specific motivations for CBDCs, there is an understanding that broader success of CBDC on a global scale is necessary, and this must be achieved with collaboration across jurisdictions.
Public-private cooperation	The public sector and central banks are the final decision-makers for CBDC implementation; however, private sector players are deeply entrenched in the current financial system and payments system and add significantly to the creation and design of a CBDC.
Interoperability and standards	Achieving interoperability between CBDC systems and establishing global standards are important priorities. Collaboration among different regions to develop common protocols and frameworks can facilitate seamless integration between CBDCs.

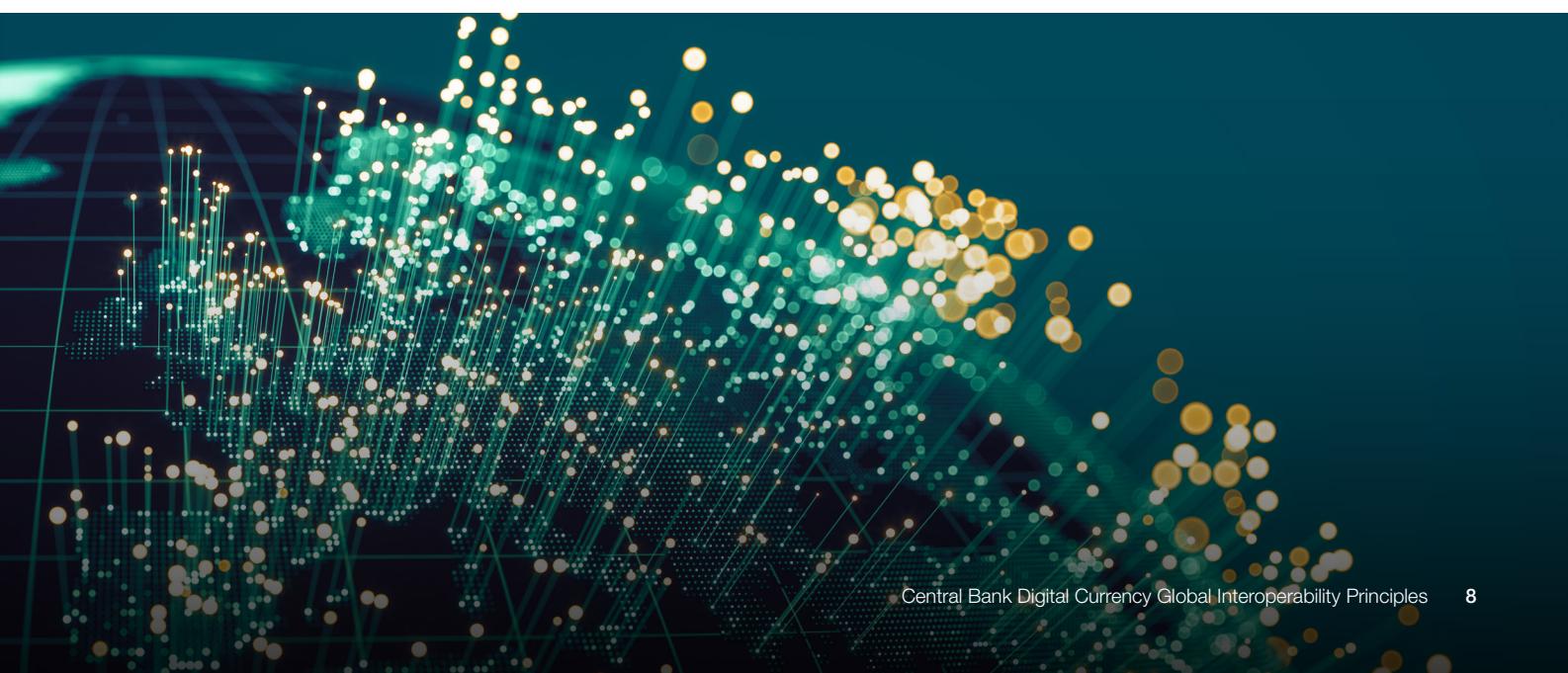
It is important to note that while these priorities align globally, the specific approaches, implementation strategies and emphasis on each priority may vary depending on the economic, cultural and regulatory contexts of different regions. In each of the regions discussed, there are selected examples of CBDC

projects that cover both retail and wholesale use cases (domestic and cross-border) and are at varying levels of maturity. These are meant to be demonstrative of the exploration globally and not comprehensive.



There is no universal case for CBDCs because each economy is different. In some cases, a CBDC may be an important path to financial inclusion—for instance, where geography is an obstacle to physical banking. In others, a CBDC could provide an essential backup in the event that other payment instruments fail. One such case was when the Eastern Caribbean Central Bank extended its CBDC pilot to areas struck by a volcanic eruption last year. So, central banks should tailor plans to their specific circumstances and needs.

Kristalina Georgieva, “The Future of Money: Gearing up for Central Bank Digital Currency”, *International Monetary Fund (IMF)*, 9 February 2022.



2.2 Latin America and the Caribbean

The Latin America and the Caribbean (LAC) region has engaged in research and development, piloting and launching central bank digital currency. There are several examples of countries in the region that have explored the benefits and challenges associated with CBDC implementation.

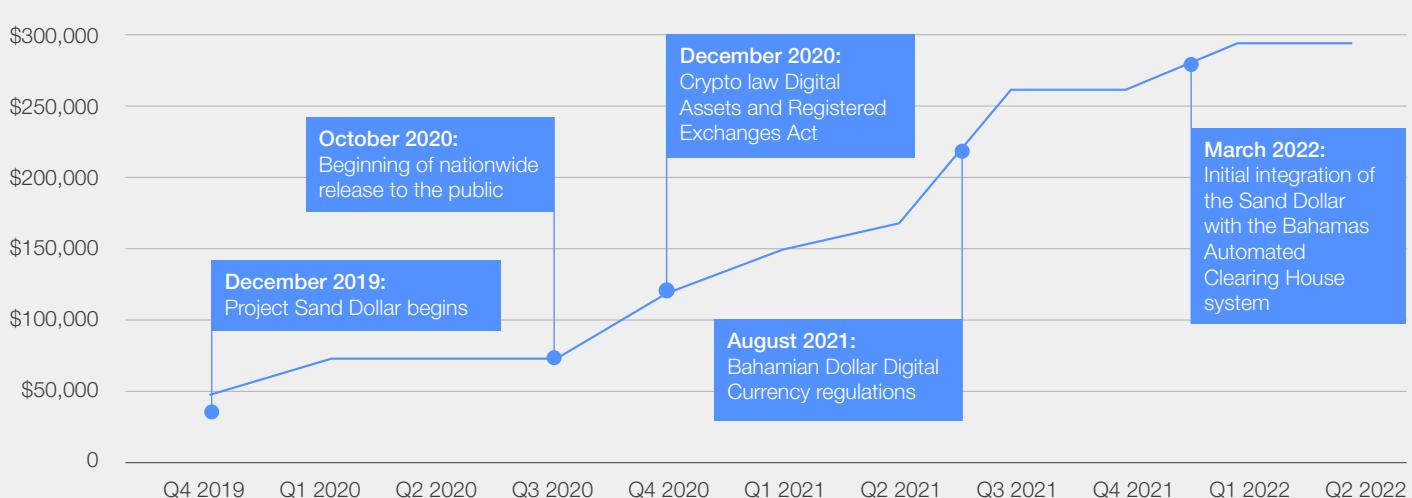
The Central Bank of Brazil has been studying the potential benefits and risks of a digital real. Research in Brazil has emphasized the importance of promoting financial inclusion by leveraging CBDC technology to reach unbanked populations and reduce the costs associated with traditional payment systems.⁹

In the Caribbean, the Central Bank of the Bahamas has launched the “Sand Dollar”, a digital version of the Bahamian dollar, which aims to improve

financial access, reduce cash use and enhance the resilience of the country’s payment system.¹⁰ In 2019, the Bahamas was the first country to issue a retail CBDC. Pegged to the US dollar, the Bahamian Sand Dollar is based on digital ledger technology (DLT) with a hybrid wireless network to connect mobile devices. The Bahamas prioritized this advancement since 18% of its population is unbanked, and frequent bouts of severe weather hinder cash distribution. However, interest levelled off after an initial surge, and by mid-2022, only about 30,000 Sand Dollar wallets were in use in the Bahamas (an adoption rate of nearly 8%). The slowdown is surprising in a country with 90% penetration for mobile devices, but when surveyed, around 77% of Bahamian firms said that checking accounts were still their most used payment method.¹¹

FIGURE 2

Sand Dollars in circulation (\$)



Source: Deutsche Bank; Central Bank of the Bahamas.

The Eastern Caribbean Central Bank (ECCB) has also been at the forefront of CBDC research. In 2021, the ECCB launched DCash, the first digital currency used in a monetary union, with eight out of nine member states participating. The CBDC has no transaction fees and was intended to facilitate digital money transfers made to consumers and merchants. However, on 14 January 2022, the DCash program crashed due to an “expiring certificate” on the technology that hosts the CBDC and was offline for two months.¹² The ECCB intends to introduce an e-commerce function that will enable businesses to accept DCash via websites and engage a local marketing agency to promote DCash and encourage education about the technology. The research conducted by the ECCB focused on testing the technical feasibility, security and scalability of a CBDC in a small island economy.¹³

Furthermore, in 2022, Jamaica launched its own CBDC, the Jam-Dex, through a digital wallet known as the Lynk app. To open a wallet, users are required to upload one government-issued photo ID and a copy of their taxpayer registration number.¹⁴ As part of the launch, the Bank of Jamaica offered a \$16 incentive for the first 100,000 users who activated wallets.¹⁵ The Central Bank of Jamaica also implemented an in-person public education programme across the island under the banner of “No Cash, No Problem”.¹⁶ As of August 2022, there were more than 120,000 users and over 2,300 merchants on the Lynk platform. More recently, there have been additional rollouts to new wallet providers, with JN Bank onboarded in December 2022.¹⁷

The below features are specific to the LAC region that impact CBDC development. These distinguishing features reflect considerations of the region.

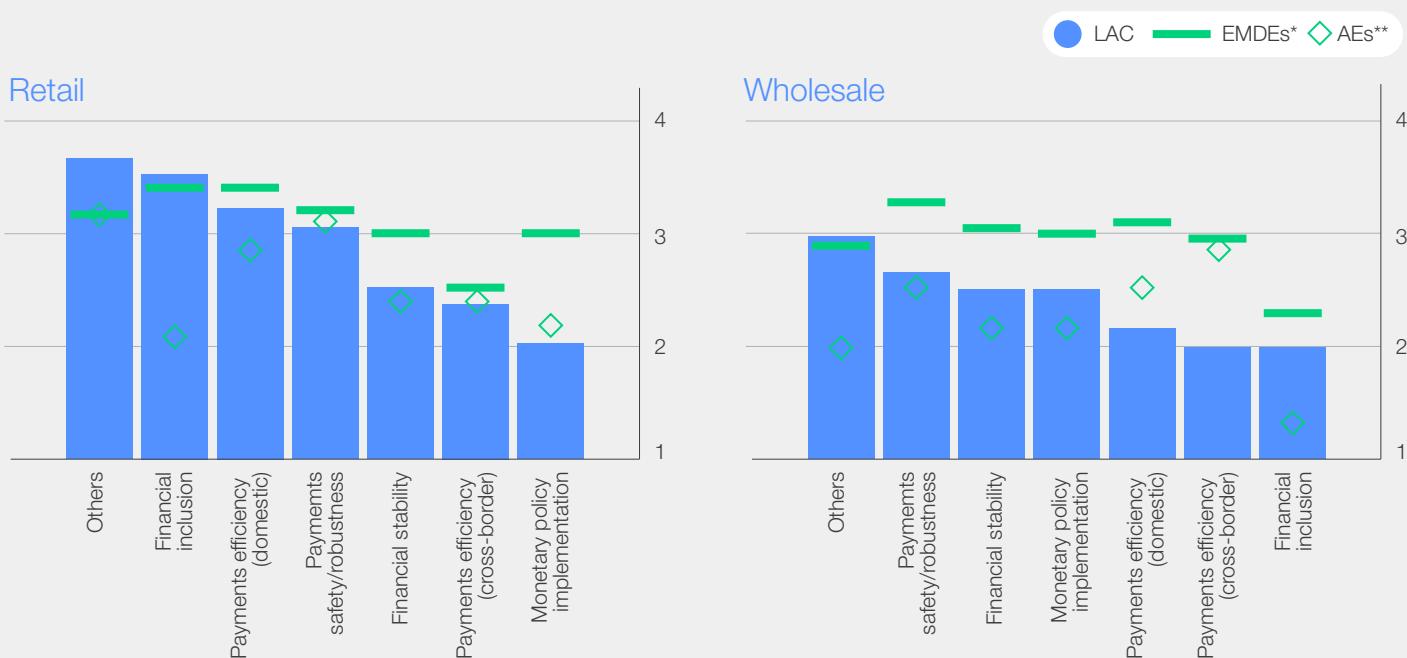
TABLE 2 | LAC CBDC considerations

Consideration	Description
High cash use	The LAC region as compared to other regions has a pronounced difference in cash use trends. Compared to central banks in other jurisdictions, LAC central banks report less decline in cash use. ¹⁸ Thus, CBDC would need to offer similar features to cash such as offline payments and self-custody.
Informal economies	The LAC region has a series of significant informal economies, where a substantial portion of economic activity occurs outside the formal banking sector. This phenomenon makes up between 20-80% depending on the jurisdiction. ¹⁹ CBDC development in LAC needs to consider the unique characteristics and challenges associated with integrating the informal economy into the digital financial system.
Remittances	The LAC region is a major recipient of remittances, with many countries relying on these inflows for their economies. During 2021, LAC received \$127.6 billion in remittances, which constitutes an annual growth of 26.0%, the highest registered in the past 20 years. ²⁰ CBDCs in LAC may prioritize enhancing the efficiency and reducing the costs of cross-border remittances, aiming to provide affordable and secure remittance solutions for migrants and their families.
Financial inclusion challenges	While financial inclusion is a priority globally, the LAC region faces specific challenges in this regard. CBDC experimentation in LAC focuses on addressing barriers to financial access for marginalized communities, including Indigenous populations, and rural areas, aiming to bridge the digital divide and promote inclusive growth.
Dollarization	Some countries in the LAC region, such as Ecuador and El Salvador, have adopted the US dollar as their official currency. CBDC experimentation in these countries may explore the potential for hybrid models, where CBDCs can coexist or interact with existing dollarized systems, addressing unique monetary policy and financial stability considerations.
Small island nations	The Caribbean region consists of many small island nations with unique economic and geographic characteristics. CBDC experimentation in these countries needs to prioritize solutions tailored to their specific needs, such as resilience to natural disasters, cross-border transactions and tourism-related challenges.
Regional integration	The LAC region has ongoing efforts for regional economic integration, such as the Caribbean Community (CARICOM) and the Pacific Alliance. CBDC experimentation in LAC considers the potential for harmonization and interoperability of digital currencies across countries, aiming to facilitate trade, investment and financial integration within the region.

LAC CBDC priorities:

Most central banks in the region are prioritizing retail CBDC research and development, and have a few key motivations for a possible future issuance of a CBDC.

FIGURE 3 | Motivations for issuing a CBDC in LAC



*Emerging market and developing economies

**Advanced economies

Note: 1 = "Not so important", 2 = "Somewhat important", 3 = "Important", 4 = "Very important".

Source: BIS central bank survey on CBDC.

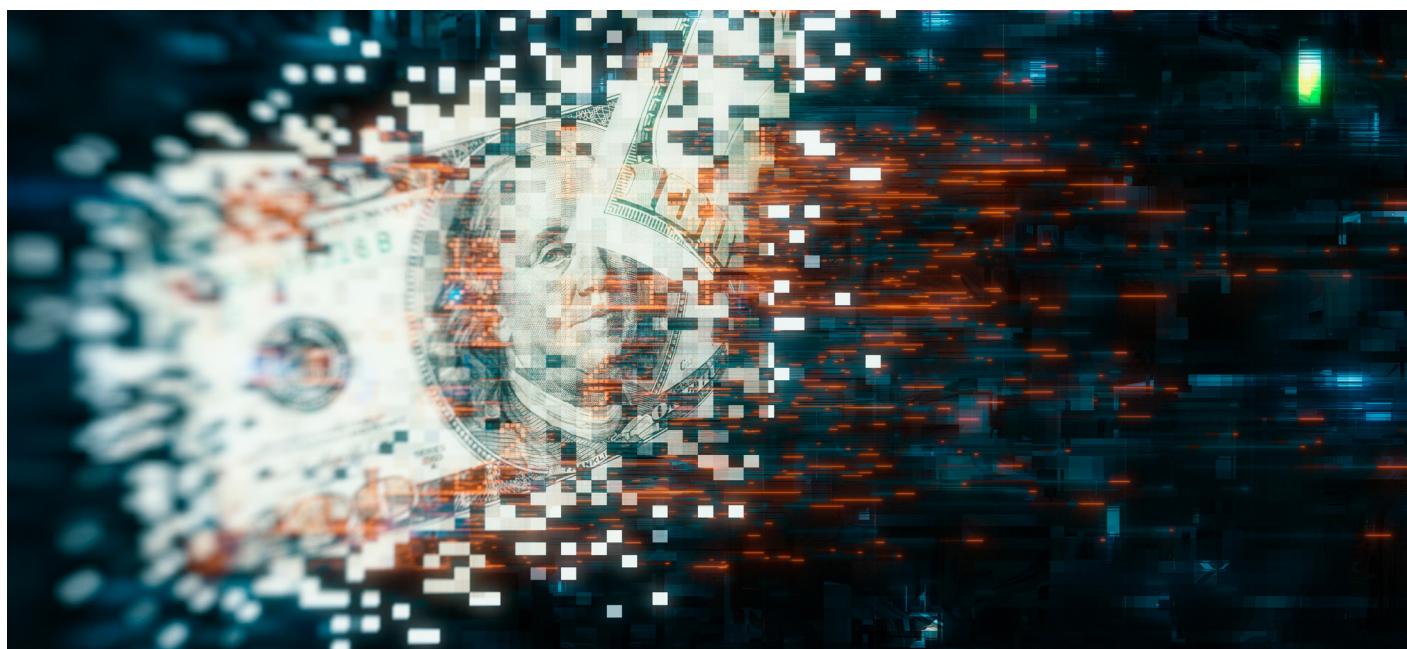
CBDCs have the potential to facilitate low-cost and efficient cross-border remittances to support the large number of migrants sending money back to their home countries.

Financial inclusion and poverty reduction: Prioritizing CBDC implementation is aimed at providing financial services to the unbanked and underserved populations. As a part of this, considering the large informal sector in some countries of the region, CBDCs could also potentially provide financial services to workers in the informal economy, helping them access banking services and participate in the formal economy.

Increasing efficiencies for payments: Domestically and internationally the cost of payments is high in the LAC region.²¹ Thus, CBDC could promote advancements in payment systems that could lower these costs. When it comes to cross-border payments including remittances,

CBDCs have the potential to facilitate low-cost and efficient cross-border remittances to support the large number of migrants sending money back to their home countries.

Addressing financial stability and crises (inflation and currency volatility concerns): Developing CBDCs could serve as a potential tool to address financial stability concerns, including offering emergency liquidity assistance during times of financial crises or natural disasters. CBDC could be explored in how it may address the region's history of inflation and currency volatility to provide a stable and reliable digital currency option that can be used as a store of value and medium of exchange.



2.3 Sub-Saharan Africa

Several countries in Sub-Saharan Africa have made notable progress in CBDC research. Various jurisdictions in the region have initiated studies and pilot projects to assess the feasibility and implications of CBDC adoption.

For instance, the South African Reserve Bank has launched a project called Khokha to explore the feasibility, desirability and appropriateness of using a CBDC in the country's financial system.²² The project aims to assess various aspects, including scalability, resilience and regulatory compliance.

In October 2021, the Central Bank of Nigeria was the first in Africa to issue a CBDC: the eNaira. The CBDC was intended to meet its population's strong demand for digital payments and to reduce remittance transfer costs.²³ Initially, only individuals with a bank verification number were able to open a wallet (approximately 26% of the population).²⁴

Although the central bank was targeting 8 million users by August 2022, fewer than 1 million Nigerians (equivalent to less than 0.5% of the population) were using the digital currency.²⁵ At the end of 2022, Nigeria suffered a cash shortage that led to a surge in demand for alternative payments, including the eNaira. The value of eNaira transactions surged 63% to 22 billion naira year to date in 2023.²⁶ In 2022, the Central Bank of Nigeria reported that 13 million more wallets have been opened, 12 times that of October 2021. Governor Emeefiele stated that increased adoption may have been driven by the payment of social welfare through the CBDC programme.²⁷

Below are features and considerations for CBDC in Sub-Saharan Africa that reflect the specific socioeconomic and technological context of the region.

TABLE 3 Sub-Saharan Africa CBDC considerations

Consideration	Description
Connectivity	Connectivity issues, limited digital infrastructure and cybersecurity concerns pose significant hurdles to the widespread adoption of CBDCs in the region. Approximately 45% of Africa's population is further than 10km from fibre network infrastructure, which is a higher percentage than on any other continent. ²⁸
Mobile money adoption	Sub-Saharan Africa has experienced significant growth in mobile money services, such as M-Pesa in Kenya. ²⁹ CBDCs can build on this existing mobile money infrastructure, integrating with mobile wallets and leveraging the familiarity and widespread use of these services to facilitate CBDC adoption.
Informal economy integration	Informal economies are prevalent in Sub-Saharan Africa, nearly 85% of employment in Sub-Saharan Africa is informal, with a substantial portion of economic activity occurring outside formal systems. ³⁰ CBDCs can aim to bridge the gap between the formal and informal sectors by providing digital payment solutions that cater to the needs of informal businesses and individuals, enhancing financial inclusion and fostering economic growth.
Addressing currency volatility	Some countries in Sub-Saharan Africa experience significant currency volatility, which can have adverse effects on economic stability and international trade. ³¹ CBDCs could incorporate features to mitigate currency volatility.
Financial inclusion	Sub-Saharan Africa has a high proportion of unbanked populations. Therefore, one of the primary priorities for CBDC in the region is to promote financial inclusion by providing access to digital financial services for individuals who are currently excluded from the formal banking system and would like to engage in the banking system. CBDCs can use existing mobile payment infrastructure to reach remote areas and underserved populations.
Remittances	The region has a substantial volume of cross-border trade and remittance flows. ³² CBDCs could reduce the number of intermediaries, the costs associated with those intermediaries and improve transparency around remittance status, thus reliance on traditional remittance channels.

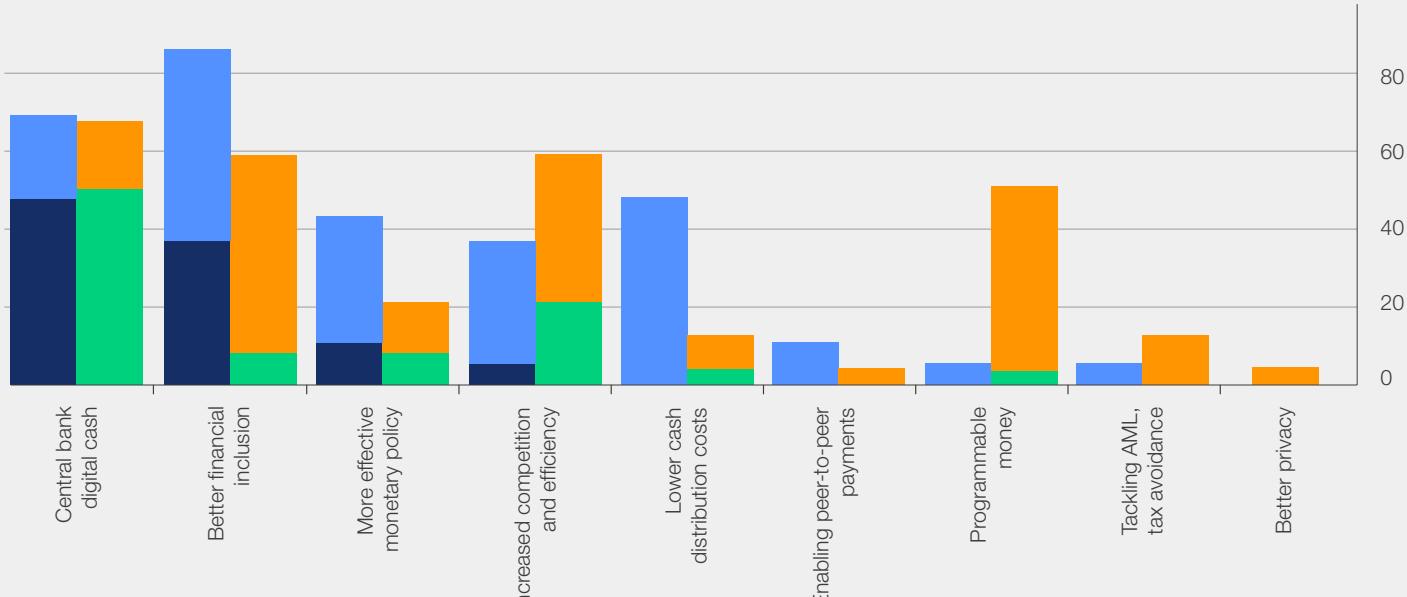
Sub-Saharan Africa CBDC priorities:

FIGURE 4 Motivations for issuing a CBDC in Africa

Fostering financial inclusion is one of the main motivations for CBDCs in Africa¹

Percentage of participating central banks²

Benefits of CBDC



Ranked 1st:



Ranked 2nd or 3rd:

- African survey
- EMEs survey

Notes: 1. Each bar indicates the percentage of central banks that choose a given motivation as one of their top three benefits of CBDC. 2. Unless otherwise stated, the percentage is computed over all the central banks that participated in the surveys (19 and 24 central banks in the African and emerging market economies (EMEs) survey, respectively), including those that did not answer the specific question.

Source: BIS, Central bank digital currencies in Africa, 2022, www.bis.org/publ/bppdf/bispap128.pdf.

<p>Improving financial access and inclusion: Prioritizing CBDC implementation to provide accessible and affordable financial services to the unbanked and underserved populations in remote areas.</p> <p>Enhancing cross-border trade and remittances: Focusing on reducing transaction costs and increasing the efficiency of cross-border payments</p>	<p>to facilitate regional trade and support economic development.</p> <p>Strengthening financial stability: Promoting the use of CBDCs to address challenges such as currency volatility, inflation and the prevalence of informal economies.</p>
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2.4 Middle East and North Africa

The Middle East and North Africa (MENA) region has several countries actively investigating the potential benefits and challenges associated with CBDC implementation.

One of the notable CBDC explorations in the region was a joint effort between the United Arab Emirates and Saudi Arabia called Project Aber. Launched in 2019, Aber aims to facilitate faster cross-border transactions and strengthen both countries'

positions as global financial hubs. This joint project reflects the regional cooperation and shared vision for advancing digital currencies in the MENA region.³³ The United Arab Emirates is also a key member of the cross-border mBridge project.

The below features and priorities are distinctive to the MENA region. Considering these factors can help central banks tailor their CBDC designs to meet the specific needs and challenges of the MENA region.

TABLE 4

MENA CBDC considerations

Consideration	Description
Technological infrastructure	Developing and upgrading the necessary technological infrastructure is a key consideration. MENA countries aim to build robust digital payment systems that can handle large transaction volumes and operate reliably. Digital payments adoption is quite high, which may facilitate the adoption of CBDC.
Regulatory compliance	MENA countries have diverse regulatory frameworks, and compliance is a critical consideration for CBDC implementation. Developing CBDC systems that align with regulatory expectations and enhance transparency is a priority for the region.
Cybersecurity and data privacy	Given the increasing digitalization and potential cyber threats, ensuring robust cybersecurity measures and protecting user data privacy are paramount for CBDCs in the MENA region. Implementing state-of-the-art security protocols and encryption techniques is a priority to safeguard the digital currency ecosystem.
Cultural and religious considerations	The MENA region has diverse cultural and religious norms that may influence payment behaviours and preferences. Taking these factors into account during CBDC design can help ensure acceptance and adoption among the population.

MENA CBDC priorities:

Digital transformation and innovation: The MENA region prioritizes innovation and is investing in advancing the digital transformation of payment systems and any CBDC would need to enhance the current payment system offerings.

Driving economic growth: Countries in the MENA region are very diverse in terms of advancement. However, digitization is an important goal to

accelerate their economic growth and advancement by providing digital payment solutions that will lead to greater economic opportunities.

Fostering regional economic integration: The MENA region prioritizes facilitating cross-border trade and investment and strengthening economic cooperation in the region. CBDC would need to enable improvements in this regard.

2.5 Asia-Pacific

The APAC region has the largest number of countries that have CBDC pilots launched, including Japan, South Korea, China, Hong Kong, India, Singapore, Thailand, Malaysia and Australia.

Currently, the Asia-Pacific (APAC) region has the largest number of countries that have CBDC pilots launched, including Japan, South Korea, China, Hong Kong, India, Singapore, Thailand, Malaysia and Australia. The APAC region is also involved in several cross-border CBDC projects within the region and across regions, including Project mBridge, Project Dunbar and Project Mariana.

China has been at the forefront of CBDC research and development and began research and development in 2014. In 2019, the People's Bank of China (PBoC) launched a pilot CBDC in the regions of Shenzhen, Suzhou, Xiong'an and Chengdu and has expanded to several other regions since then.³⁴ The Winter Olympics, held in February 2022, saw the e-CNY marketed to foreigners for the first time. During the games, the digital currency was used in transactions worth CNY 2 million (Chinese yuan) (approximately \$315,000) a day.³⁵ China is a prime location for a CBDC experiment. First, relative to the West, China boasts a young, tech-savvy population.³⁶ Second, China is unique in that it skipped directly from physical cash to mobile payments in the mid-2000s.³⁷ Today, mobile payments are the preferred payment method in China, representing 66% of total transactions in 2021.³⁸ Third, the PBoC and government provided infrastructure and readily supported the use of e-CNY (electronic Chinese yuan). In February 2021, Alipay and Tencent began participating in trials with the aim of offering services through the e-CNY app.³⁹ The PBoC has also paid civil servants in e-CNY, most recently in the city of Changshu.⁴⁰ Yet, the Chinese CBDC project still has the ability to grow in the amount of user adoption. In June 2021, 71 million transactions using the digital wallet occurred, with a value of CNY 34.5 billion, equivalent to 0.04% of the total CNY in circulation.^{41,42} By August 2022, the number of transactions had increased to 360 million, with a total value of over CNY 100 billion.⁴³ By the end of December 2022, e-CNY transactions amounted to 0.13% of total currency in circulation.⁴⁴

Singapore has been another key player in CBDC research. The Monetary Authority of Singapore (MAS), through its Ubin+ initiative, researched CBDC through five phases and included cross-border experimentation with the Bank of Canada and the Bank of England.⁴⁵ Project Orchid explores domestic retail CBDC use cases in Singapore.⁴⁶ MAS has been collaborating extensively with other central banks and financial institutions to explore the potential for cross-border CBDC use during Project Dunbar and Mariana. They have conducted successful trials using CBDCs for international transactions, aiming to improve efficiency, reduce costs and enhance financial interoperability.

The Bank of Thailand (BOT) began exploring a domestic retail CBDC in 2020, and the pilot tests the deposit, transfer and withdrawal functionalities of the wallet. For cross-border projects, the Hong Kong Monetary Authority, the Bank of Thailand, the People's Bank of China and the Central Bank of the United Arab Emirates are working together to build a multi-CBDC platform known as mBridge.⁴⁷

In Australia, the Reserve Bank of Australia (RBA) has undertaken CBDC research starting with a wholesale CBDC proof of concept in 2021, followed by a larger general-purpose CBDC pilot collaborating with industry players to explore various potential use cases and economic benefits in 2023.⁴⁸ With an efficient domestic payments system and relatively high financial inclusion, research is aimed at understanding how an Australian CBDC might bring efficiency, reduced cost or risk to the Australian economy.

The features detailed in Table 5 reflect the unique characteristics and challenges of the APAC region, highlighting the need for tailored CBDC solutions that address specific regional needs while making use of the potential benefits of digital currencies.

TABLE 5

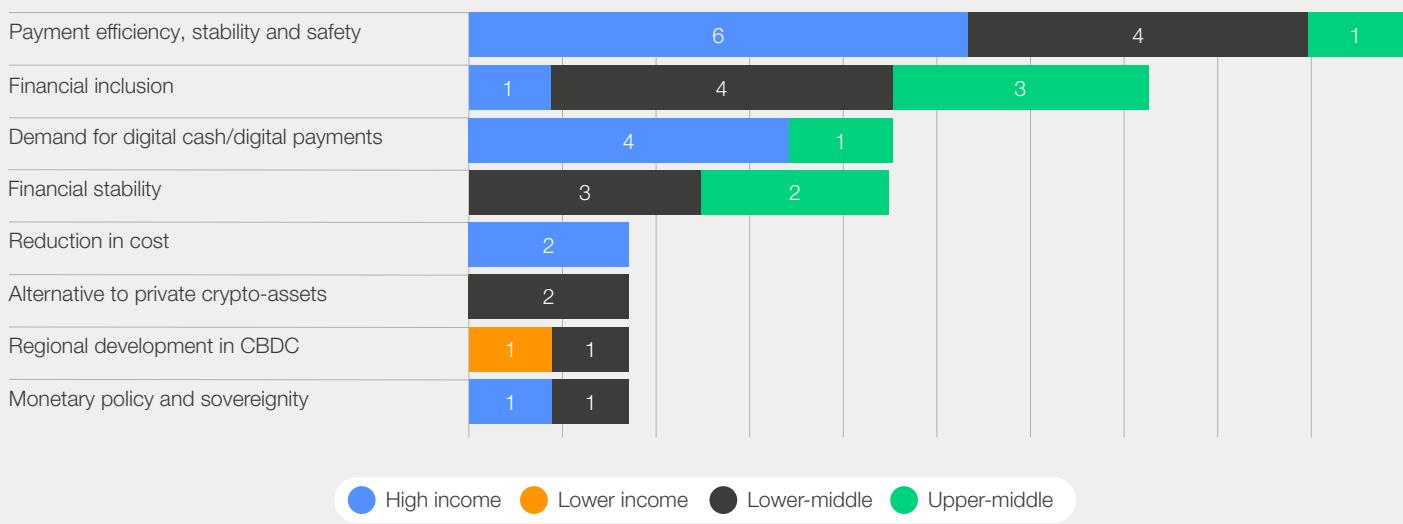
APAC CBDC considerations

Consideration	Description
E-commerce and digital economy	APAC has a thriving e-commerce market and a rapidly growing digital economy enhanced by mobile payments. ⁴⁹ CBDCs can provide seamless and secure digital payment infrastructure, promoting the growth of e-commerce and facilitating digital transactions in the region.
Financial inclusion	APAC countries have large unbanked or underbanked populations, particularly in rural areas. More than 1 billion people within the region still have no access to formal financial services. ⁵⁰ CBDCs can provide accessible digital payment solutions and financial services to those who currently lack access.
Global trade and cross-border payments	APAC economies have strong interconnectivity and trade relationships. Enhancing cross-border payment efficiency and reducing transaction costs through CBDCs is a specific focus.
Remittances	The APAC region has a significant number of migrant workers who rely on remittances to support their families. ⁵¹ CBDCs can offer faster, cheaper and more transparent remittance solutions, addressing the challenges associated with traditional remittance channels.

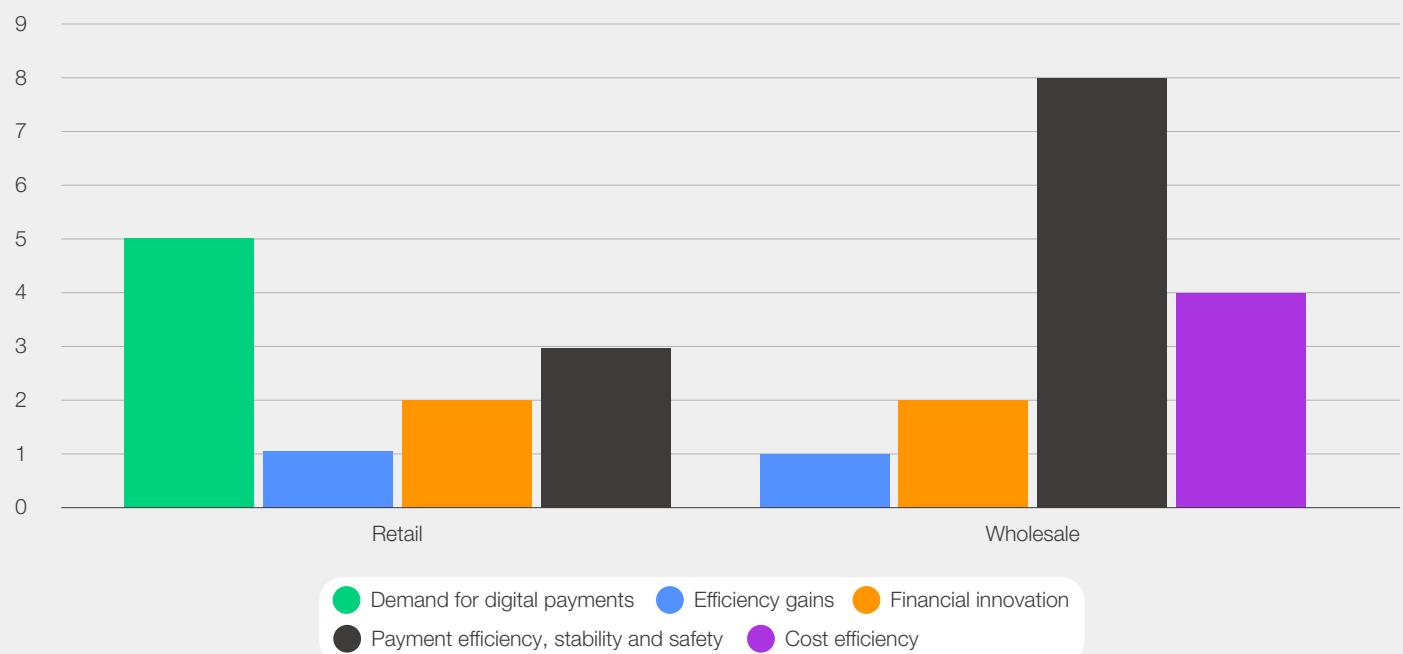
APAC CBDC priorities:

FIGURE 5 Motivations for issuing a CBDC in APAC

By income group (number of countries that responded to the survey)



By type of CBDC (number of countries that responded to the survey)



Note: Income groups are based on World Bank classification, which classifies economies into four income groups: low, lower-middle, upper-middle and high income using gross national income (GNI) per capita data in US dollars.

Source: IMF survey

Enabling payment efficiency: Supporting technological advancements, such as integrating CBDCs to foster efficiency and innovation in the financial sector.

Promoting cross-border transactions: Prioritizing low-cost and efficient cross-border payments and remittances to facilitate international trade and

support the large number of migrant workers in the region.

Advancing cashless societies: Focusing on reducing cash use, promoting digital payments and enhancing financial literacy to drive economic growth and increase efficiency, while balancing privacy concerns.

CASE STUDY 1

China: e-CNY

The e-CNY pilot is an ongoing initiative by the People's Bank of China (PBoC) to test and promote the use of digital currency in China.

Pilot launch: The e-CNY pilot was first launched in 2019 in several cities, including Shenzhen, Suzhou, Chengdu and Beijing. It involved the distribution of digital currency to selected individuals and businesses for trial use.

Dual offline payment system: One of the key features of the e-CNY pilot is the dual offline payment system, which allows transactions to be made without an internet connection. This feature ensures the reliability and availability of digital payments, even in areas with poor network coverage.

Integration with existing payment systems: The e-CNY is designed to work alongside existing payment systems, such as Alipay and WeChat Pay. It aims to enhance the efficiency and security of digital transactions while providing interoperability with popular mobile payment platforms.

Retail and wholesale use: The pilot has been conducted in both retail and wholesale scenarios. Retail use involves small-scale transactions, such as everyday purchases, while wholesale use focuses on larger transactions, such as business-to-business payments.

Merchant acceptance: During the pilot, various merchants, including restaurants, supermarkets and online platforms, have been encouraged to accept e-CNY payments. This helps to establish an extensive network of acceptance points and increases the convenience for users.

Privacy and security: The e-CNY pilot emphasizes the importance of privacy and security. Transaction data is encrypted and stored securely, ensuring the protection of user information. However, the central bank maintains the ability to monitor and trace transactions to prevent illegal activities.

User experience: The pilot aims to provide a smooth and user-friendly experience for e-CNY users. Mobile apps and digital wallets have been developed to facilitate transactions, allowing users to easily send, receive and manage their digital currency.

Cross-border use: The e-CNY pilot has explored the potential for cross-border use.



Lessons learned:

Technical infrastructure: Building a robust and scalable technical infrastructure is crucial for the successful implementation of digital currency. It requires coordination between financial institutions, technology providers and regulatory bodies to ensure smooth operations and user experience. The project employed a large team to build and deploy the digital currency and focused on public-private sector collaboration in order to deliver this result.

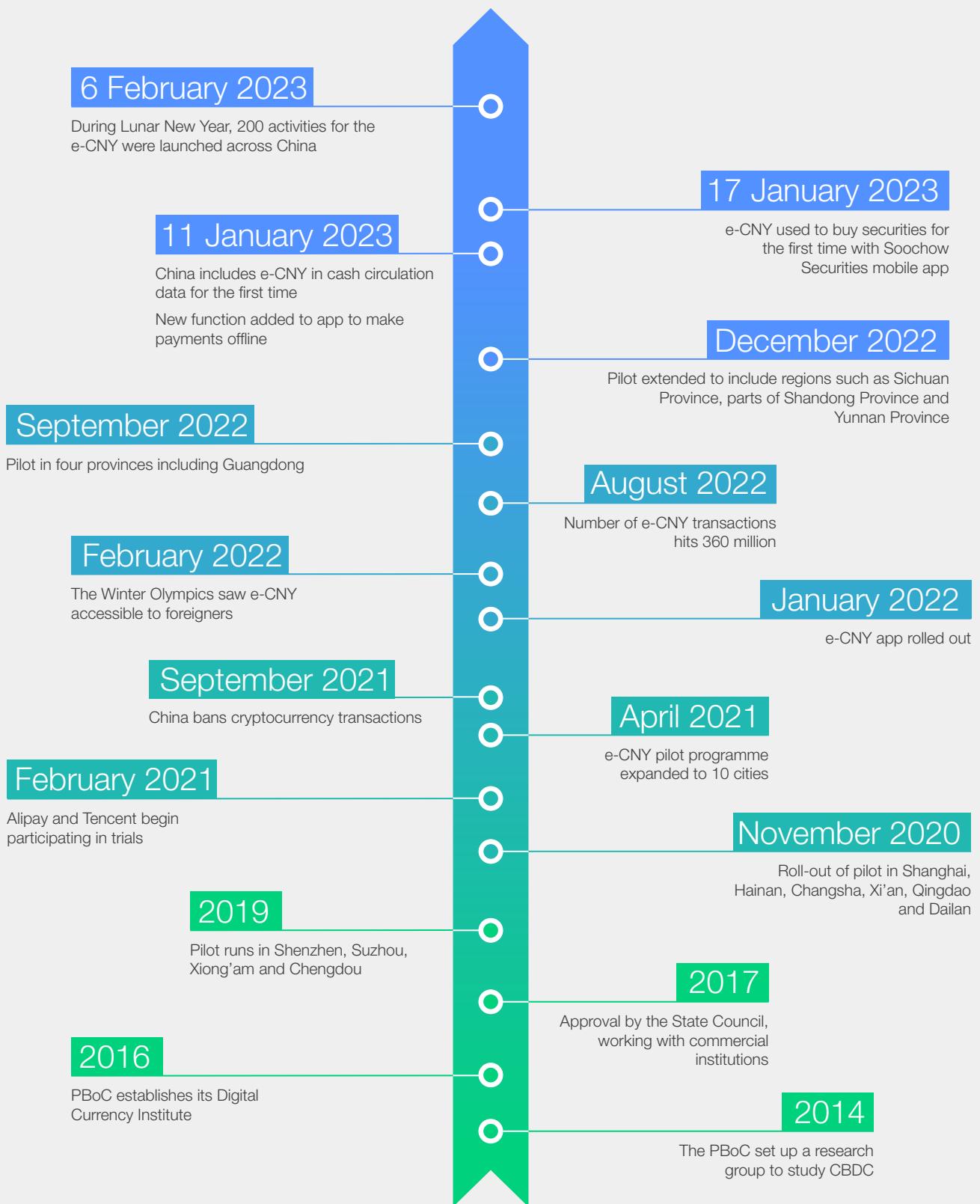
Public acceptance: Widespread adoption of digital currency relies on public acceptance and trust. Educational campaigns and outreach programmes can help promote awareness and understanding among the general population, fostering confidence in the new payment system.

Interoperability: Integrating digital currency with existing payment platforms is essential for user convenience and acceptance. Ensuring interoperability between different payment systems and establishing a seamless user experience should be a priority.

Cross-border collaboration: Exploring opportunities for cross-border use and collaboration with other countries can enhance the global reach and potential impact of digital currencies. Cooperation between central banks and regulatory bodies is essential to address legal and regulatory challenges.



FIGURE 6 | Timeline of the development of China's CBDC



Source: Deutsche Bank; PBoC.

CASE STUDY 2

Thailand: digital baht

The Bank of Thailand's ongoing Retail CBDC pilot project (digital baht) focuses on conducting pilot tests through foundational and innovative tracks. For the foundational track, deep technical tests were conducted prior to the start of the pilot, whereas for the innovation track, a hackathon was organized to explore innovative use cases from the private sector.

The pilot: The Bank of Thailand initiated a canteen pilot for its retail CBDC during the start of 2023 with a restricted user base. The pilot achieved a significant milestone by successfully minting and distributing CBDC to three Financial Service Providers (FSPs)*. Currently, the project is advancing towards an expansion of users, which is limited to the officers of three FSPs, with up to 10,000 users. The CBDC technology is provided by German technology partner Giesecke+Devrient.

Integration with existing payment systems: The integration with existing payment systems focused on enabling connectivity process with interbank electronic fund transfer system (RTGS) operated by the Bank of Thailand and establishing interoperability between FSP's payment system and payment processors.

Use: The pilot programme is conducted in various retail scenarios, specifically aiming to facilitate everyday purchases such as those made in canteens and coffee shops for bank employees. The focus of the pilot is on small-scale transactions in a retail setting.

Privacy and security: Thorough penetration tests were conducted to assess technical readiness for production, with the aim of minimizing security risks to the business and ecosystem. The importance of security-by-design of a CBDC was a focus point of the project.

User experience: The pilot aims to provide a smooth and user-friendly experience for digital baht users. Mobile apps have been developed by financial service providers to facilitate transactions, allowing users to easily send, receive and manage their digital currency.

Priorities: Recognizing the already high adoption of digital payments in Thailand, the Bank of Thailand envisions the CBDC as a transformative solution. This pilot aims to establish an inclusive and accessible financial infrastructure, enabling innovative and secure financial services to cater to the diverse needs of customers across the country.

Implementation: Collaborative partnerships with stakeholders, gradual user onboarding, robust security measures, scalability and flexibility, and ongoing evaluation were essential components of the project's success. These factors ensured a smooth and effective implementation process, providing valuable insights for future initiatives.

Public-private collaboration: Collaborative partnerships brought expertise, innovation and resources, enhancing project success. Effective communication, trust-building and clear roles were crucial for productive collaboration. These lessons emphasize the importance of ongoing public-private cooperation in future initiatives to leverage diverse skills and resources for success.

Communication to stakeholders: Learning on both technical and business aspects from CBDC pilot testing is the main objectives of this project. The plan to launch CBDC in Thailand has not yet decided at this stage. This intention should be passed forward to all stakeholders including end-users. Clear communication is important to ensure a common understanding of a CBDC by all stakeholders, but management of expectations is an important aspect of this.

The BOT Retail CBDC pilot project's successful continuation showcases effective collaboration, technical implementation and regulatory clarity. Valuable lessons learned from challenges encountered provide insights for broader scalability and adoption, serving as a guiding example for future initiatives.

*FSPs are comprised of bank and non-bank in this pilot.



2.6 | Europe

The European region has several prominent CBDC research and experiments. The European Central Bank (ECB), launched an investigation phase to address key issues related to the design and distribution of the digital euro in October 2021. This phase will continue until October 2023, after which the Governing Council will decide on whether to launch the realization phase.⁵² The ECB is also researching wholesale CBDC.⁵³

The UK has not decided whether it will introduce a CBDC.⁵⁴ On 7 February 2023, the Bank of England (BoE) and the HM Treasury jointly launched a public consultation on a retail CBDC. The paper outlines design considerations, and it concluded that a digital pound will likely be needed in the future. However, the BoE sees that it is still too early for

a decision on issuance. No concrete timeline has been released, and the BoE continues to research the viability of launching a CBDC.

Other European central banks have also been actively exploring CBDCs. The Swedish Riksbank has conducted a project, known as the e-krona, to examine the potential technical and practical aspects of a digital currency. Banque de France is among the other central banks in the region that have initiated research and conducted experiments to understand the implications and design options for CBDCs.

These features and priorities reflect the unique characteristics, needs and regulatory environment of Europe.

TABLE 6

Europe CBDC considerations

Consideration	Description
Sovereign autonomy over currency	It is a priority to harmonize European payment solutions, reduce high costs of cross-border payments and reduce reliance on foreign payment solutions. A large percentage of payments are run by non-European payment companies, which can expose countries to risk. ⁵⁵
Accelerating digital payments	Cash use is falling rapidly across Europe, with COVID-19 accelerating innovation in digital payments. Sweden is one of the economies with the lowest cash use. Other economies in Europe have also declined in their use of cash during the past several years. ⁵⁶
Privacy and data protection	Europe has stringent data protection regulations, including the General Data Protection Regulation (GDPR). Any CBDC design in Europe would need to address privacy concerns and ensure compliance with these regulations.
Eurozone integration	Europe consists of multiple countries with their own existing payment systems and infrastructures. Any CBDC in Europe would need to be designed with interoperability in mind, allowing seamless integration with existing payment systems and enabling efficient transfers between different currencies and jurisdictions.

Europe CBDC priorities:

Encouraging European integration: Promoting interoperability and cross-border use of CBDCs within Europe, streamlining transactions and fostering economic integration.

Ensuring privacy and data protection: Emphasizing strong data protection measures and privacy controls to address concerns around surveillance

and unauthorized access to personal financial information.

Supporting monetary policy implementation: Designing CBDCs to assist in implementing effective monetary policies, such as negative interest rates or targeted lending programs, while ensuring financial stability.

2.7 | North America

Central bank digital currency research in North America has gained significant momentum. Both the United States and Canada have embarked on comprehensive studies to evaluate the feasibility and implications of CBDC adoption.

In the US, the Federal Reserve System is researching central bank digital currency, but has not provided strong indication of whether it will pursue a CBDC.⁵⁷ In March 2022, the Biden administration released an executive order on ensuring the responsible development of digital assets.⁵⁸ In 2020, the Boston Fed began collaborating with the Massachusetts Institute of Technology's (MIT) Digital Currency Initiative on Project Hamilton, which has now been completed.⁵⁹ The New York Fed also issued a report on Project Cedar, an experiment on wholesale CBDC.⁶⁰

In Canada, the Bank of Canada has also been engaged in CBDC research in North America. The central bank, through Project Jasper, has conducted extensive experiments and pilot projects to understand the technological aspects, security considerations and potential economic implications of a digital currency. The Bank of Canada collaborated with other central banks and international organizations to share knowledge and expertise. It has also sought public input through surveys and consultations to gather diverse perspectives on the design and features of a potential digital currency.⁶¹

The below features are priorities in the North American region in their CBDC efforts.

TABLE 7

North America CBDC considerations

Consideration	Description
Mitigating systemic risks	North America has experienced significant financial crises in the past. CBDC policies may prioritize mitigating systemic risks by implementing features that enhance financial stability, such as real-time monitoring of transactions, increased transparency and improved risk management frameworks. ⁶²
International collaboration	North American central banks actively participate in international collaboration and knowledge sharing initiatives regarding CBDCs. This priority for international cooperation allows North American central banks to benefit from global expertise while contributing to the collective understanding of CBDCs.
Public input and transparency	Central banks in North America prioritize public input and transparency throughout the CBDC research process through surveys, consultations and public forums. The aim is to ensure that the design and features of the CBDC align with the needs and preferences of society.
Promoting innovation and fintech ecosystem	North America is home to a vibrant fintech industry, including various innovative payment solutions and digital assets. CBDC policies may aim to foster an environment conducive to innovation, supporting collaborations between traditional financial institutions and fintech companies to explore new use cases and promote technological advancements in the financial sector.

North America CBDC priorities:

Promoting innovation: Financial innovation is key in enhancing the current financial system, and the jurisdictions in North America are focused on promoting this modernization.

Enhancing financial system efficiency: As a global financial hub, any CBDC launched requires robust

testing to ensure that any risks are mitigated and that benefits increase system efficiency.

Promoting cross-border transactions: Facilitating seamless and efficient cross-border payments and reducing transaction costs between North America and other regions.

2.8 | Global CBDC lessons learned

Transparent communication about the design, benefits and risks of CBDCs can help mitigate concerns and ensure acceptance among the public.

The discussions during the Forum's CBDC Regional Roundtable series, not only highlighted specific regional considerations, but also discussed lessons learned from the pilots and experimentation thus far. Overall, there was alignment amongst regions for the lessons learned during the pilots. The following lessons should be considered in any upcoming CBDC experimentation.

Clear objective: Different countries have pursued CBDC experimentation with varying objectives. These include financial inclusion, enhancing payment systems, reducing reliance on cash, promoting monetary policy effectiveness, and countering private cryptocurrencies. It is essential to define clear objectives before embarking on CBDC development.

Technological considerations: CBDC development requires careful consideration of the underlying technology. Choices between centralized or decentralized architectures, permissioned or permissionless networks, and the use of DLT or other alternatives need to align with the specific goals of the CBDC project.

Regulatory frameworks: CBDC experimentation has highlighted the need for robust regulatory frameworks. These considerations should be integrated into CBDC design from the early stages to ensure compliance and mitigate risks.

Payment system integration: Integrating CBDCs into existing payment systems is crucial for their successful implementation. Compatibility with existing financial infrastructure, such as banks and payment service providers, is essential to ensure smooth and efficient interoperability.

User experience and accessibility: The user experience of CBDCs should be intuitive and user-friendly to encourage adoption. Accessibility to a broad range of individuals, including those without access to traditional banking services, should be a priority to achieve financial inclusion goals.

Public confidence and trust: Building public confidence and trust in CBDCs is essential. Transparent communication about the design, benefits and risks of CBDCs can help mitigate concerns and ensure acceptance among the public.

Public-private collaboration: Both the public and private sectors can make key contributions to designing and implementing any future CBDC, and a stronger collaboration leads to more successful results.

Interoperability: Collaboration between countries and coordination will be necessary to address issues of interoperability.

FIGURE 7

Map of CBDC phase of exploration

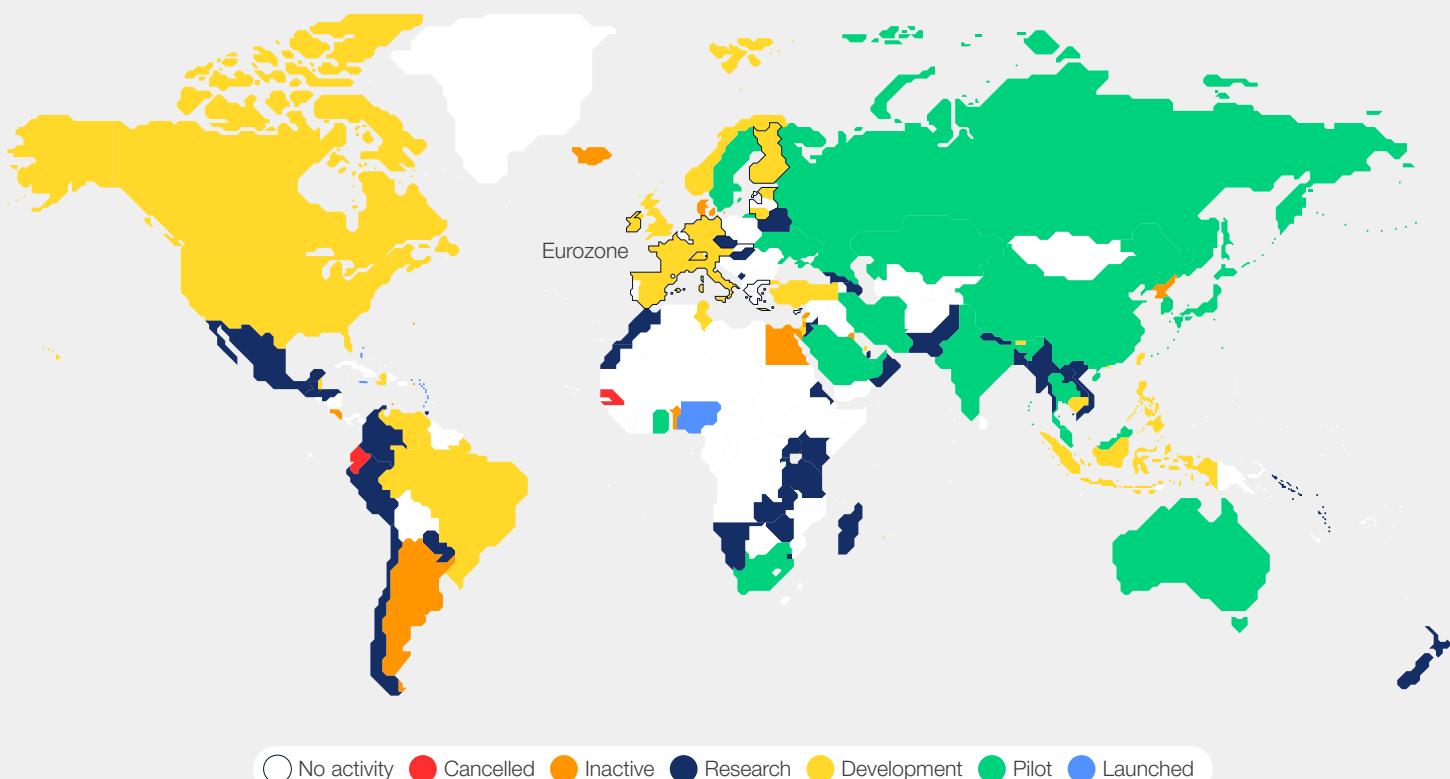


TABLE 8 | Overview of domestic and cross-border interoperability CBDC projects

Name	Countries	Cross-border/ domestic	Use case	Description
Multiple CBDC Bridge (mBridge)	Thailand, China, Hong Kong, United Arab Emirates	Cross-border	Wholesale	Aims to create a multiple CBDC arrangement for a faster, cheaper and more efficient mechanism for transfers and foreign exchange operations.
Project Dunbar	Australia, Singapore, Malaysia, South Africa	Cross-border	Wholesale	A platform for international settlements. As of March 2022, the project built two successful prototypes for settlements across multiple CBDCs.
Project Sela	Israel, Hong Kong	Cross-border	Retail	Explores the cybersecurity implications of two-tier, retail CBDC.
Project Icebreaker	Israel, Norway, Sweden	Cross-border	Retail	Interlinking and interoperability between different retail CBDCs.
Project Mariana	France, Switzerland, Singapore	Cross-border	Wholesale	Cross-border automated market maker project aimed at exploring using automated market makers to facilitate exchange between multiple currencies at a wholesale level.
Project Jura	France, Switzerland	Cross-border	Wholesale	Wholesale CBDC settlement across borders using DLT
Onyx/Multiple CBDC	France, Singapore	Cross-border	Wholesale	Cross-border payment experiment using JP Morgan's Onyx unit.
Project Rosalind	United Kingdom	Domestic	Retail	Prototype for retail CBDC effectively communicating with private sector vendors.
Project Aurum	Hong Kong	Domestic	Retail and Wholesale	Issuance of both wholesale and retail tokens.
Project Helvetia	Switzerland	Domestic	Wholesale	Explored the feasibility of issuing wholesale CBDC on SIX's DLT platform, the project integrated wCBDC to the core banking infrastructure.
Project Jasper	Canada, UK, Singapore	Cross-border	Wholesale	Cross-border testing
Project Aber	Saudi Arabia, United Arab Emirates	Cross-border	Wholesale	Bilateral CBDC project using DLT to facilitate cross-border transactions.

Source: "Central Bank Digital Currency Tracker", *Atlantic Council*, n.d., <https://www.atlanticcouncil.org/cbdctracker/>.

Global considerations

Regional preferences and global alignment in CBDC design and implementation should be balanced.

3.1 Monetary sovereignty

CBDCs can enhance monetary sovereignty by providing central banks with increased control over the monetary system and more effective tools for implementing monetary policy. With a digital currency, central banks can gain real-time insights into economic activities, enabling them to respond swiftly to changing market conditions. This increased visibility and control over the money supply can contribute to price stability and economic resilience.

However, there is a risk that private or foreign digital currencies could replace domestic currencies

through currency substitution. If a private digital currency or foreign CBDC becomes widely used in a country that accepts foreign currency as legal tender, it could threaten a central bank's ability to effectively conduct monetary policy and act as a lender of last resort. To address this risk, international monetary cooperation becomes crucial in setting parameters and conditions for the use of private or foreign digital currencies in a local context. By establishing clear guidelines and agreements, central banks can mitigate potential threats to their monetary sovereignty.

3.2 Financial stability

Having many institutions involved in the distribution of CBDC puts further emphasis on the need to ensure interoperability between different payment rails and different products.

Depending on the design of a CBDC, banks play a more or less active role in the distribution of CBDC to end users. In a one-tier model, the central bank would both issue and distribute CBDC, while in the far more common two-tier model, the central bank would issue CBDC, but distribution is organized via banks and other licensed service providers. In the two-tier model, it is possible to have different licensing requirements for different types of financial services providers. This diversity of institutions involved in the distribution of CBDC, on the one hand, improves the competitiveness and resilience of the financial system. On the other hand, however, having many institutions involved in the distribution of CBDC puts further emphasis on the need to ensure interoperability between different payment rails and different products.

Furthermore, the two-tier model has the potential to exacerbate threats to financial stability because funds can flow unimpeded between different types of licensed service providers, notably between banks and non-banks. In the short term, and depending on whether a CBDC would carry interest, it is unlikely that CBDC will lead to a disintermediation of banks, as users receive interest on their term deposits and benefit from the

information banks accumulate from processing payments. In the medium to long term, however, it is possible and likely that users will prefer holding larger amounts of CBDC, although it is not clear that users would prefer custody outside of banks. Whether this increase in CBDC is at the expense of deposits is less clear. If CBDC can be seamlessly exchanged for deposits, customers might prefer holding deposits and instead reduce their holdings of banknotes, which could even lead to an increase in bank balance sheet size.⁶³

CBDCs can improve the efficiency, speed and reliability of payment systems by employing new technologies, such as DLT or blockchain. By providing a secure and direct central bank-backed means of payment, CBDCs can reduce counterparty and settlement risks, enhancing the overall stability of the payment system. The risk of a seamless exchange of deposits and CBDC, though, is that during periods of distress, depositors might exchange large amounts of deposits for CBDC, exacerbating banks' funding needs. A possible remedy would be to introduce limits on CBDC transactions, as many countries are already discussing. CBDCs could affect liquidity conditions in the financial system. If CBDCs become widely

As a digital currency, a CBDC could be vulnerable to cyberattacks, fraud or operational glitches that may disrupt the functioning of the financial system.

adopted, the central bank would have more direct control over the money supply and the ability to influence interest rates. However, changes in the demand for CBDCs could also impact the availability of liquidity in commercial banks and the transmission of monetary policy, requiring careful management by the central bank to maintain financial stability.⁶⁴

While there hasn't been a major cybersecurity incident with far-reaching consequences for financial stability yet, cybersecurity risks naturally increase with an increased reliance on digital payments. The implementation of a CBDC introduces new cybersecurity and operational risks. As a digital currency, a CBDC could be vulnerable to cyberattacks, fraud or operational glitches that may disrupt the functioning of the financial system. Establishing robust security measures and resilience protocols is crucial to mitigate these risks and maintain financial stability.

Introducing a highly interoperable CBDC would, in the medium to long term, likely create additional competition for banks and potentially erode banks' profitability. This could lead to further financial stability risks. The introduction of a CBDC could lead to shifts in the allocation of funds from commercial bank deposits to CBDC holdings. If a significant portion of deposits were to move into CBDCs, commercial banks might face reduced funding, potentially affecting their ability to lend and perform traditional banking functions. This could have implications for financial stability, especially if not managed carefully.

CBDCs can affect the overall systemic risk and interconnectedness of the financial system. The integration of CBDCs with existing financial infrastructure, such as payment systems and settlement networks, requires careful consideration to ensure that potential risks, including the concentration of systemically important CBDC nodes or vulnerabilities in interconnected networks, are properly managed.

3.3 Geopolitical risk

The digitization of sovereign currencies and the availability of digital payment systems have implications for international relations and sanctions. CBDCs have the potential to introduce new payment channels that may challenge the current effectiveness of sanctions and, in turn, increase geopolitical risk.

CBDCs can offer an alternative payment system that is less dependent on existing international payment networks dominated by foreign currencies. This reduced reliance on foreign payment systems could potentially mitigate the geopolitical risks associated with disruptions, sanctions or political tensions involving those systems, so countries may

find CBDCs as a means to enhance their financial resilience and reduce their vulnerability to external pressures.

The adoption of CBDCs may influence countries' choices regarding financial alliances and partnerships. Countries seeking to reduce their exposure to geopolitical risks may seek closer relationships with countries or regions that share similar goals and interests in CBDC adoption. These shifts in alliances and partnerships can reshape geopolitical dynamics and power structures, potentially leading to realignments in global economic and financial systems.

3.4 De-dollarization

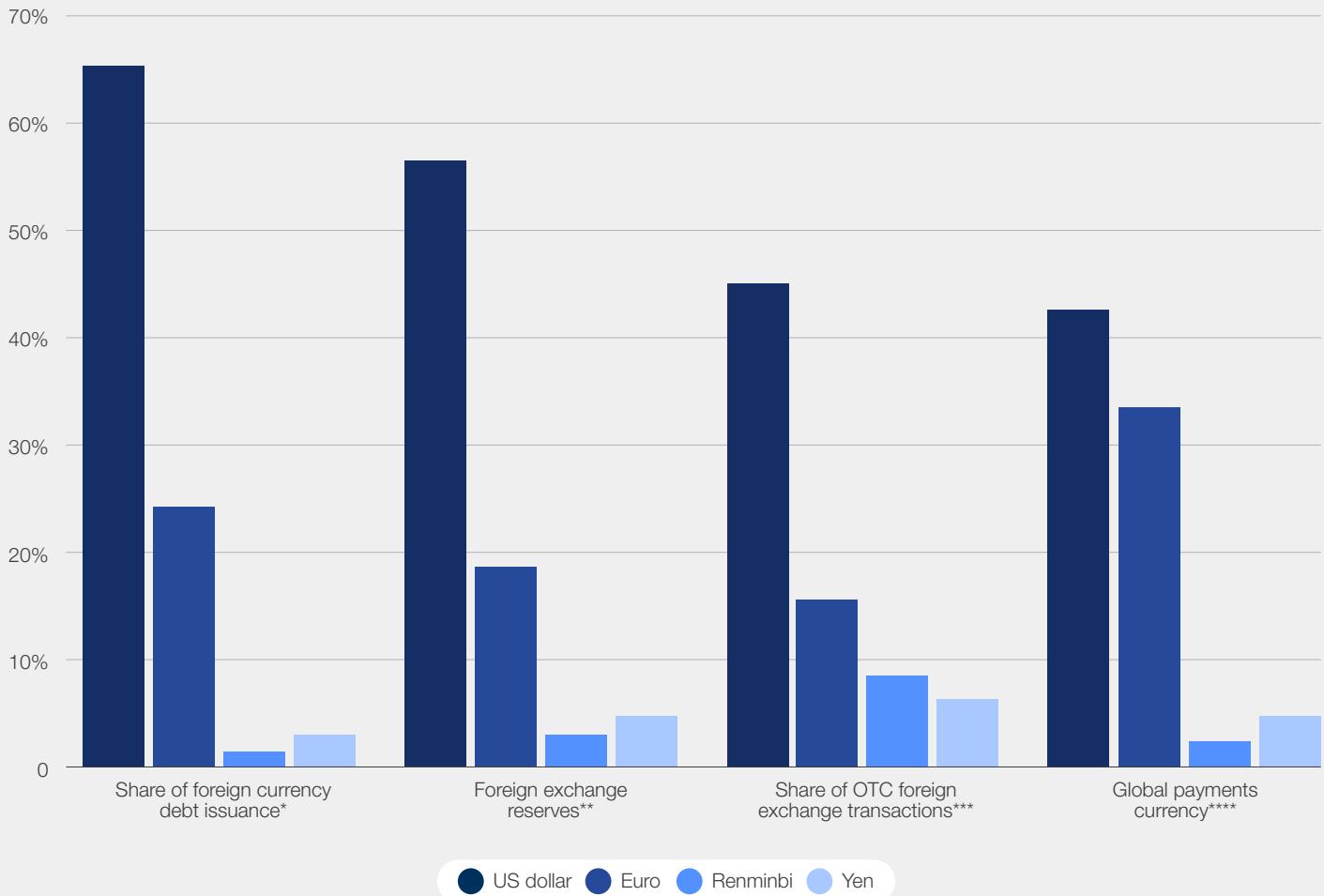
The dollar remains the dominant currency in the international system, but there are recent trends towards de-dollarization. If a CBDC is widely adopted and provides a convenient and efficient medium of exchange, it could potentially reduce the reliance on foreign currencies, including the US dollar. Individuals and businesses may prefer to use their CBDC for domestic transactions, reducing the need for holding and transacting in foreign currencies.

If a CBDC gains international acceptance and trust, it could potentially be used as a reserve currency by other countries, leading to a diversification of global currency reserves away from traditional

reserve currencies like the US dollar. This could contribute to de-dollarization efforts by reducing the dominance of the US dollar in global trade and finance.

CBDCs could impact the landscape of international payment settlement systems. If CBDCs are interoperable across borders, they could facilitate faster, more efficient and lower-cost cross-border transactions. This could reduce the need for intermediaries and traditional settlement systems denominated in foreign currencies, potentially diminishing the role of the US dollar in international payment settlements.

FIGURE 8 | The dollar remains the dominant currency in the international system (%)



*Data for 2021 **Data for Q2 2022 ***Data for April 2022 ****Data for April 2023

Source: Deutsche Bank; Board of Governors of the Federal Reserve System; SWIFT; International Monetary Fund (IMF); BIS

3.5 Infrastructure cost considerations

Countries around the world are pursuing CBDC research and development with the intention to reap the benefits of CBDCs, especially time and cost reductions of payments. As already seen in the R&D stages, there are high costs associated with researching and piloting this innovation. Should countries choose to move forward with implementing a CBDC, there will be high costs associated with executing and maintaining this system.

Depending on its design, a CBDC would most likely entail considerable fixed costs associated with the construction of an adequate infrastructure. In addition, there are costs associated with identifying talented labour, software, cybersecurity and support costs associated with the operation of a CBDC. Staff will need to be trained and

then paid to operate the system. Licences and service fees will be paid to external providers. Finally, a substantial public education and support programme will be necessary for the successful launching and operation of the digital currency as well as a marketing effort that will be used to encourage adoption.⁶⁵

The cost of CBDC comprises the costs to businesses accepting CBDC, any potential fees charged to consumers and the costs paid by payment service providers to the central bank for using the CBDC infrastructure. If a CBDC is issued in a jurisdiction, there will need to be deliberation of how these costs will be covered, whether it is through intermediaries or not, and in the case of cross-border payments this will need to also be considered internationally.

Key motivations for interoperability principles

It is vital to use interoperability principles as a roadmap for creating efficient, frictionless payment systems.

The BIS published a set of foundational principles and core features for CBDCs. This report advanced the foundational international work by outlining common principles, key features and supporting infrastructure that is needed in order to contribute to central bank public policy objectives.⁶⁶ In addition, for retail CBDCs specifically, the G7 issued principles intended to guide and inform the exploration and potential development of national retail CBDCs with respect to these wider public policy considerations.⁶⁷ In both of these documents, there was an emphasis on ensuring interoperability.⁶⁸

Building off the existing foundation and in alignment with addressing challenges identified by the G20 for cross-border payments, these principles dive deeply into the elements of interoperability and

are intended to provide a baseline for considering interoperability in any current or future CBDC design. Although the decision to issue a CBDC and the final design choices are a sovereign concern, and there will be distinctions between CBDCs in each jurisdiction, there are several areas of alignment, as evidenced in the analysis above. With this in mind, the principles outlined below can serve as a baseline roadmap for building interoperable CBDCs.

In order for CBDCs to be interoperable, it is key to consider these aspects at the early design stages and ensure that they are reflected throughout. With interoperability included from all angles, this will form a stronger future financial system by minimizing friction and enabling more efficient payment systems.



CBDCs could also aide in upgrading and connecting payment systems – both domestically and across borders, with all the benefits of having interoperable systems.

UNSGSA Queen Máxima, IMF – World Bank Annual Meetings
Seminar on CBDCs and Financial Inclusion



CASE STUDY 3

Interoperability of the internet

The internet as we know it today was developed over a thirty-year period between 1969 and 1999. Its original architects, largely a group of academics and engineers, supported with funding from the US Defense Advanced Research Projects Agency, faced several challenges that also arise in the context of CBDCs. First, already in the internet's nascent phase, implementations of local networks, often small and disconnected, started to pop up on university campuses and larger corporations. Second, the technology used varied widely between these nascent implementations, making it impossible for information to traverse the various networks, even if these were connected to one another. Third, competing commercial interests between internet service providers added governance challenges to the ensuing technological challenges.

Two components are instrumental in ensuring the extraordinary degree of interconnectivity and the lasting success of the internet: packet switching and common messaging standards. Packet switching is a method of information transmission that separates the content and header of a message. The header contains information that the network infrastructure uses to decide what to do with the message. This design makes it possible to provide fault-tolerant redundant routing of messages from the source to the destination and is at the heart of the internet's resilience. Common messaging standards were developed in the form of the TCP/IP protocol, first published in 1974 by Vint Cerf and Bob Kahn. This suite of protocols, ensures that two different computers connected to the internet have a way of finding one another and exchanging application-level information. Without the TCP/IP protocol, it would be impossible to develop applications that run on different kinds of computers because no two computers would be able to communicate.

Taken together, packet switching and common messaging standards also underpin a fundamental dogma of the early internet pioneers: that all messages should be treated equally by the infrastructure- in other words, the internet is neutral. These two principles also prevent monopolization of the internet, which was a key concern during a time most long-distance phone lines were owned by a single provider, AT&T.

The two principles at the heart of the internet's technological and commercial success can readily be translated to central bank digital currencies. To implement "token switching" as an equivalent of packet switching, policy-makers need to ensure that CBDCs are issued on technology that guarantees funds are processed domestically and cross-border irrespective of the content of the transaction. All transactions must be routed to their destination within a network, or across different networks by the network infrastructure simply by trying to find the most efficient path to the destination. Furthermore, it is crucial to develop a "value protocol" as an equivalent of the internet protocol. This value protocol needs to set common standards for the processing of transactions across a broad range of technology and governance choices. The new ISO 20022 standard is quickly becoming a contender to be the value protocol of future payment systems.

Today, a fragmentation of the payment landscape into CBDCs, stablecoins and private crypto assets is already observed. Interoperability via token switching and common messaging standards defined in the value protocol could ensure "money neutrality" and prevent further drifting into a world of walled gardens, i.e. isolated and enclosed ecosystems based on a specific stablecoin or CBDC which limit competition, disempower users and further monopolization and centralization.



Principles for CBDC interoperability

CBDC interoperability encompasses standardization, robust scalability, resilience, collaboration and inclusivity across borders.

CBDC interoperability refers to the ability of different CBDC systems to seamlessly interact and transact with one another. While there is no universally agreed-upon framework for CBDC interoperability, several foundational principles can guide its development. These principles include both ones that are widely applicable to interoperability and also specific principles for interoperable governance, legal and regulatory regimes, identification and authentication arrangements, various payment systems, and technical solutions.

As a next step, these principles can provide a foundation for the creation of an agreed-upon set of CBDC interoperability standards. There are several standard-setting initiatives underway including the Digital Currency Global Initiative (DCGI), hosted by the International Telecommunication Union (ITU) to study the requirements for technical standards for central bank digital currency and stablecoins. There are three working groups on policy and governance, architecture, interoperability and use-cases, and security. This initiative, alongside others, should ensure a multistakeholder approach to confirm agreement and identify the organization that will have oversight and enforcement of these standards.

TABLE 9

Generally applicable principles

Principle	Description
Standardization	Establishing common standards across CBDC systems can facilitate interoperability. Adopting international standards can enhance compatibility and ease of integration.
Openness and inclusivity	Interoperability should promote inclusivity by enabling open participation from various stakeholders.
Scalability	CBDC interoperability should be designed to handle a large number of transactions and support future growth. The underlying infrastructure and protocols should be scalable and accommodate increased demand without compromising efficiency or security.
Resilience and business continuity	Interoperability systems should be resilient to disruptions and capable of maintaining operations. DLT could be a method used to enhance system reliability and minimize single points of failure.
Stakeholder collaboration	Collaboration between central banks, regulatory bodies, financial institutions, technology providers and industry stakeholders is essential for creating an interoperable CBDC ecosystem. Engaging in partnerships, standardization efforts and pilot projects can facilitate the development of interoperability frameworks and drive innovation in cross-system transactions.
Cross-border integration	CBDC interoperability should address cross-border transactions, facilitating seamless transfers and exchanges between different CBDCs. Interoperability frameworks should consider foreign exchange regulations, settlement procedures and mechanisms to enable efficient cross-border transactions while maintaining compliance.

5.1 Governance

Transparency and accountability: CBDC governance should be transparent, with clear policies, rules and procedures that are publicly accessible. The decision-making process should involve accountability mechanisms to ensure responsible and efficient management of the CBDC across stakeholders. For each jurisdiction, it should be clear who has access to CBDC and how CBDC can be used (retail, wholesale, digital settlement instrument), as well as whether there is a centralized or decentralized ledger.

Oversight authorities: Each jurisdiction may choose a different authority for oversight of the CBDC system. It should be clear which authority will serve this role in a sovereign capacity, and there should be an aim to agree upon a governance body to have oversight over the cross-border elements that can ensure interoperability.

User accessibility and inclusion: CBDCs should be designed to be inclusive and accessible to all members of society, regardless of their socioeconomic background or technological literacy. Efforts should be made to ensure that marginalized populations and underserved areas have equal access to CBDC services. The system design should clearly define the entry processes for banked, underbanked and unbanked users.

Inter-jurisdictional cooperation: International cooperation and coordination are essential for the successful implementation of CBDCs across borders. For cross-border payments, central banks should work together to establish common standards, protocols and frameworks to facilitate cross-border interoperability.

5.2 Legal and regulatory

Standards and protocols should be developed to enable interoperability between different CBDC systems facilitating efficient and secure transactions.

Consistency with national laws: Payment interoperability should be included as a policy goal or mandate. CBDC legal and regulatory frameworks should conform with the existing laws and regulations of the issuing country.

Interoperability frameworks: Standards and protocols should be developed to enable interoperability between different CBDC systems facilitating efficient and secure transactions. Common technical standards and protocols can help streamline integration and interoperability.

International standards and best practices: CBDC frameworks should be developed in accordance with internationally recognized standards and best practices, such as those set by international organizations like the Financial Stability Board (FSB), International Monetary Fund (IMF), and Basel Committee on Banking Supervision (BCBS). Adhering to these standards helps ensure interoperability and facilitates cooperation among jurisdictions.

Regulatory cooperation and information sharing: Collaboration and information exchange between

central banks, financial regulators and other relevant authorities should be encouraged to facilitate effective supervision and oversight of CBDCs that have international dimensions. This cooperation helps in addressing potential risks, ensuring compliance and promoting consistency across jurisdictions.

Consumer protection: Legal and regulatory frameworks should include provisions to safeguard the interests of CBDC users, ensuring transparency, fairness and protection against fraud or abuse. Clear guidelines on dispute resolution, liability and consumer rights should be established.

Privacy and data protection: Interoperability principles should prioritize the protection of user privacy and personal data. CBDC systems should adhere to relevant data protection laws and regulations, ensuring that user information is managed safely and securely, shared only with authorized parties and not used for purposes other than those explicitly consented to by the users. It is important to establish means for enabling the capacity of the right to be forgotten with accepted policies and regulations.

5.3 Identification and authentication

Universal means for identification: CBDC systems should support a universal and standardized identification framework that allows individuals and entities to establish their identities across different CBDC systems. This can involve the use of unique identifiers or digital identities that can be recognized and accepted by multiple CBDC platforms.

Strong authentication: CBDC systems should employ robust authentication mechanisms to ensure the secure access and use of digital currencies. This may include multi-factor authentication, biometric verification or other advanced authentication methods to prevent unauthorized access and fraud.



5.4 Payments

Integration with existing payment systems: CBDC should be designed to integrate with commercial banks, non-bank payment service providers and other digital payment platforms. This integration ensures that CBDC can operate with traditional payment solutions and enables easy transferability between CBDC and existing payment instruments.

Compatibility with digital wallets and mobile applications: CBDC should be compatible with a range of digital wallets and mobile applications, allowing users to store, transfer and transact with CBDC. Interoperability principles should ensure compatibility across various operating systems and devices to promote widespread user adoption and use.

Compatibility with other CBDCs: There are several types of CBDC use cases emerging from pilots and projects. For example, CBDC can take the form of digital cash, purpose-bound money, digital settlement asset or as a monetary “anchor” for tokenized private money.

Compatibility with other payment choices: Other forms of digital payments, such as cryptocurrencies, stablecoins, bank coins, tokenized assets, need to be considered and be able to interoperate with CBDC.

Automation of payments: CBDC interoperability should focus on the automation of integrations prioritizing system-wide processing of incoming and outgoing messages, thus dramatically reducing or eliminating the need for pre- or post-processing being done outside the CBDC system itself.

5.5 | Technical

• Robust security measures should be implemented to protect the integrity of CBDC systems and ensure user privacy.

Technology agnostic: CBDC solutions should be built to interoperate with DLT and non-DLT-based solutions and be interoperable across chains, including private, permissioned or public blockchains. In a CBDC system with intermediaries, the design will need to support payment portability to avoid users being locked into a single intermediary.

Messaging standardization: Establishing common technical standards is important for interoperability. This includes defining uniform data formats, communication protocols, messaging standards, encryption mechanisms and transactional interfaces. Common standards, like ISO 20022 and common blockchain standards, can be used to ensure seamless integration with different payment systems.

Connectivity: CBDC systems should be designed with secure connections, which requires defining compatible network protocols, secure communication channels and reliable data exchange mechanisms.

Inter-ledger compatibility: CBDC systems should be compatible with existing payment infrastructures, including traditional payment systems and other DLT based systems. Inter-ledger compatibility enables interoperability between CBDCs based on different blockchains (or non-DLT based). Open-source code bases can be considered to promote compatibility.

Interoperable APIs: CBDC systems should provide well-defined and standardized APIs that allow easy integration with legacy payment systems and other financial infrastructure. These APIs should support transaction processing, settlement, identity verification and data exchange, enabling seamless integration.

Bridging mechanisms: To achieve interoperability with cryptocurrencies and stablecoins, CBDC

should incorporate bridging mechanisms that enable the transfer of value between different blockchain networks. These bridging mechanisms could use technologies like atomic swaps, interoperability protocols or interoperability-focused blockchains to facilitate the exchange of assets between CBDC and other digital currencies. Bridging should be compatible, standardized and part of interoperability APIs.

Security and privacy: Robust security measures should be implemented to protect the integrity of CBDC systems and ensure user privacy. This involves employing strong encryption algorithms, secure key management practices, authentication mechanisms and privacy-enhancing technologies like zero-knowledge proofs, etc. Verification of data should be possible without revealing the actual contents of the data to the verifier.

Secure and trusted oracles: Oracles play a crucial role in interoperability between CBDC and external systems, providing trusted real-time data on asset prices, exchange rates and transaction details. CBDC systems should incorporate robust and secure oracle mechanisms that ensure the accuracy, reliability and integrity of the information obtained from external systems.

Testing and certification: CBDC systems should undergo rigorous testing and certification processes to validate their interoperability and security. Independent audits and assessments can help identify potential vulnerabilities and ensure compliance with technical standards.

Stability and upgradeability: CBDC interoperability should be stable and behave deterministically. Upgradeability for the system should be designed as a proper protocol in order to effectively exchange upgrade details in advance, allow institutions to prepare for the upgrade and eliminate any downtime.

Recommendations

Public-private collaboration, international cooperation and regulatory consistency are crucial for CBDC interoperability.

6.1 For central banks

Public-private collaboration: Foster partnerships between central banks and the private sector to leverage existing payment infrastructures and technologies. Collaborations with established financial institutions, payment service providers and fintech companies can help accelerate the development of interoperable CBDC solutions.

Thought leadership and advocacy: Act as thought leaders and advocates for CBDC interoperability. Engage in industry forums,

conferences and policy discussions to share expertise, promote best practices and advocate for the importance of interoperability in advancing digital currencies.

Education and awareness: Educate stakeholders, including policy-makers, financial institutions and the public, about the benefits of CBDC interoperability. Increased awareness can garner support, encourage adoption and address concerns related to privacy, security and financial inclusion.

6.2 For policy-makers

Regulatory consistency: Promote regulatory consistency and clarity across jurisdictions to minimize legal and compliance barriers to CBDC interoperability. Policy-makers should work together to create an enabling environment that supports cross-border transactions and ensures compliance with relevant AML and know your customer (KYC) requirements.

Participate in international forums: Policy-makers should actively participate in international

forums to contribute to the development of global standards and policies related to CBDC interoperability. Collaboration and knowledge sharing at these platforms can help shape the interoperability landscape.

Foster innovation and research: Policy-makers should actively foster innovation and research in the field of CBDC interoperability. This can involve supporting research initiatives to explore emerging technologies that can enhance interoperability.

6.3 For the private sector

Regulatory sandboxes and innovation hubs: Engage in regulatory sandboxes or innovation hubs that allow for experimentation with CBDC interoperability solutions. This promotes public-private collaboration and knowledge sharing opportunities between the public and private sector.

Interoperability testing and pilots: Conduct interoperability testing and pilots with central banks and financial institutions to identify and address technical challenges and operational considerations.

This iterative approach allows for the refinement of CBDC interoperability frameworks and ensures robustness before full-scale implementation.

Participation in standards development: Actively participate in the development of CBDC interoperability standards. Engage with standard-setting bodies, industry associations and working groups to contribute to the establishment of consistent technical standards and protocols that promote interoperability.

6.4



Financial market infrastructure

Interoperable clearing and settlement systems:

Develop or enhance clearing and settlement systems that support interoperability between different CBDCs. Design infrastructure that enables seamless transfer and settlement of CBDC transactions across multiple platforms, including efficient cross-border transactions.

Standardization of messaging formats:

Adopt standardized messaging formats and protocols that facilitate the exchange of information and value between different CBDC systems.

Collaborate with central banks, industry consortia and standard-setting bodies to establish common data formats, messaging standards and interoperability frameworks.

Share insights: Financial market infrastructure players have been operating in the payments interoperability space and have deep knowledge and lessons learned from their work. These lessons can be implemented and drive interoperable CBDC systems.

Conclusion

The decision-making process for issuing a CBDC varies among central banks, reflecting their distinct priorities and circumstances. Nevertheless, despite these differences, there are areas of alignment across jurisdictions that lay the groundwork for both domestic and cross-border interoperability. It is crucial for central banks to prioritize interoperability considerations early in the design process by adhering to a set of guiding principles.

To facilitate global coordination and ensure harmonious implementation of CBDCs, the development of a comprehensive set of principles and standards becomes imperative. Drawing upon previous research and collaborative efforts, this set of principles can serve as a robust foundation, guiding central banks to proactively consider interoperability from the outset of their CBDC initiatives. By adopting these principles, central banks can work towards creating a cohesive and interconnected CBDC ecosystem.

Looking ahead, the next crucial steps involve continuing the dialogue among central banks, policy-makers and stakeholders to further refine and establish a universally applicable set of standards. This process should be undertaken in an interdisciplinary manner, taking into account various perspectives and expertise. Additionally, it is essential to reach a consensus on the entity responsible for overseeing and enforcing these standards, ensuring their effective implementation and adherence across jurisdictions.

By fostering ongoing public-private collaboration, sharing knowledge and establishing a coherent framework of principles and standards, central banks can promote interoperability and mitigate potential challenges in the development and implementation of CBDCs. Ultimately, a globally coordinated approach will facilitate seamless domestic and cross-border transactions, enhance financial inclusivity and contribute to the advancement of the digital economy.

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