

Retail CBDCs in practice: the experience of the SandDollar, e-CNY and JAM-DEX®

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25 August 2025¹

Abstract

Central banks worldwide are considering the issuance of central bank digital currencies (CBDCs). This study examines the rollout of retail CBDCs in three pioneering jurisdictions: The Bahamas, China and Jamaica. Although early public uptake was modest in each case, recent data indicate a gradual increase in use, without disintermediation of bank deposits. With most transactions incurring no fees for consumers and merchants, these digital currencies offer potential cost savings over traditional alternatives – though market-based incentives may be needed going forward. The findings underscore the critical role of clear public communication, the need for incentives to secure private sector participation and the importance of international peer learning.

Keywords: central bank digital currencies; digital money; payment systems; early adopters.

JEL classification codes: C72, C73, D4, E42, E58, G21, L86, O32

¹ The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank for International Settlements (BIS), the Bank of Jamaica (BOJ), the Central Bank of The Bahamas (CBOB) or the People's Bank of China (PBC). All errors are our own. The authors are grateful to Karina Johnson (Eastern Caribbean Central Bank) and Yi Huang (BIS) for helpful comments and suggestions. This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

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1. Introduction

Central banks around the world are exploring central bank digital currencies (CBDCs) – a form of digital money, denominated in the national unit of account, which is a direct liability of the central bank (Group of central banks (2020); Auer et al (2022)). These can be for use by financial institutions (wholesale CBDC) or by the general public, ie households and businesses (retail CBDCs). Since each jurisdiction faces different challenges with the existing monetary system, it is no surprise that motivations for CBDC work differ around the world. For retail CBDCs, many central banks aim to improve domestic payment efficiency; promote broader innovation beyond payments; or support cross-border payments. Especially in emerging market and developing economies (EMDEs), many aim to enhance financial inclusion (Kosse and Mattei (2022); Wright et al (2022); PBC (2021); Mu (2022)).

Retail CBDCs offer many potential design options. These include the architecture, infrastructure, access and interlinkages around the CBDC, as well as tiered know-your-customer (KYC) and whether or not to pay interest. These choices likely influence the extent to which CBDCs will achieve their stated objectives. Design options also influence ultimate adoption by households and businesses. As in other industries, adoption may start very gradually, but could take off rapidly when certain conditions are met and network effects kick in. Finally, given path dependency, design choices are likely to influence monetary systems for years to come.

This paper explores the experience of three early adopters – the Central Bank of The Bahamas (CBOB), the People’s Bank of China (PBC) and the Bank of Jamaica (BOJ). The CBOB’s SandDollar, launched in October 2020, is often recognised as the first live retail CBDC that has not been discontinued. The PBC’s electronic Chinese yuan (e-CNY) is designed as a CBDC accessible to the general public (retail) and to financial institutions (wholesale), making it a universal payment instrument. It is another example of a retail CBDC in practice, but it can also cover wholesale use cases. It has been rolled out across cities in China and over 203 million wallets have been opened through the e-CNY app, jointly developed by the public and private sectors. In Jamaica, the BOJ’s JAM-DEX® was launched in July 2022 and is fully integrated with the country’s real-time gross settlement (RTGS) system. This paper discusses the motivation and plans of each central bank, specific design choices and rollout, and lessons learned to date.

Our key question is: what lessons can be drawn from the early adopters for the design of CBDCs? To identify lessons, we look into measures of adoption of CBDCs, and the initial implications of their use for the two-tier financial system. In our sample, the pace of CBDC adoption has been gradual so far. Yet hands-on experience has helped to surface useful insights, eg around technical design options, rollout initiatives, implications for stated policy objectives, and data privacy considerations. The absence of large-scale disintermediation of banks, at least during the initial phases after their launch, suggests that the hypothesised risk of deposit substitution is not yet a significant concern.

Our work relates to the growing literature on CBDCs. However, much of this is theoretical, looking at the potential impact of CBDC issuance on the banking sector, monetary policy and financial stability (see eg Williamson (2022); Fernandez-Villaverde et al (2022); Chiu and Koepll (2022)). Because CBDCs are new, and due to the relative scarcity of data on their use, there are fewer empirical studies. Leveraging data from early adopters of retail CBDCs, our paper gives insights into how CBDCs have been designed and used to date. In particular, it delves into the impact of CBDCs on the financial system and the practical implications of design choices, including how these choices can impact adoption rates. While acknowledging that the motivations for developing a retail CBDC differ and that the domestic landscape matters for design choices, we seek to draw some common threads from these three live retail CBDC projects. We offer insights for central banks, researchers and the financial sector as they navigate the evolving landscape of digital currencies and payments.

The key lessons learned are as follows. First is the importance of public communication in order to increase awareness around CBDC initiatives. Second is the need for the proper market-based incentives to ensure sustainability of the ecosystem and the active engagement of private sector

providers. While a zero-fee model makes sense initially, low but non-zero pricing for merchants may be justified in the medium run, to ensure a vibrant, self-sustaining market. Third is the importance of international peer learning, as central banks learn from one another within regional and global bodies.

The paper is organised as follows. Section 2 gives the motivations, rollout to date and plans for the selected retail CBDC projects. Section 3 discusses their design and adoption to date. Section 4 provides lessons from the projects thus far. Section 5 concludes.

2. Motivations, rollout and plans

Central banks have been exploring the idea of a central bank-issued digital currency for over a decade. Following the introduction of private cryptocurrencies like Bitcoin in 2009, a number of central banks began to explore the issuance of digital central bank money, both in its retail and wholesale versions. Due to the innovations and benefits purported by new technologies like blockchain and other forms of distributed ledger technology (DLT), various initiatives ran research pilots based on DLT. Others experimented with issuing digital central bank money using more conventional technologies. The PBC began its work on CBDCs in 2014. The Central Bank of Ecuador was an early issuer of CBDC with its Dinero Electrónico, which launched in the same year (Arauz et al (2021)) and was discontinued in 2018. In 2015, central banks in the Netherlands, the United Kingdom, Canada and Singapore began with internal experiments on digital currencies, which often resulted in research publications. Some central banks, such as the Central Bank of Uruguay (2017) and the National Bank of Ukraine (2019) began piloting CBDCs with real users on a limited scale.

The first central bank to issue a “live” CBDC (that has not been discontinued) was the Central Bank of The Bahamas (CBOB), with the SandDollar. The SandDollar went live with a pilot in December 2019 and was launched nationwide in October 2020. The Eastern Caribbean Central Bank (ECCB) issued its own retail CBDC, DCash, in March 2021. DCash was initially a pilot in select countries of the Eastern Caribbean Currency Union (ECCU) and was subsequently extended to all 8 member countries. The pilot was concluded in January 2024. The Central Bank of Nigeria (CBN) issued the eNaira in October 2021 (Ree (2023)), and the Bank of Jamaica (BOJ) issued the retail CBDC JAM-DEX® in July 2022. The PBC began piloting its e-CNY in late 2019, which was then made accessible to the general public in October 2020 for selected use cases in a growing number of cities across China. Each of these central banks has shared insights on its initiatives in both regional and global policy fora, and in many cases, they have published white papers and research on them. They have also benefited from peer learning with other central banks.

The early adopters of retail CBDCs share similarities and differences. Notably, all are emerging market and developing economies (EMDEs). All have relatively high adoption of digital technologies such as mobile phones. And all have geographical disparities in access to financial services, eg in rural areas or on remote islands. Yet there are also key differences. The Caribbean economies (The Bahamas, ECCU, Jamaica) have relatively concentrated banking sectors with very high fees. China has a high adoption of digital finance apps, with the duopoly of AliPay and WeChat Pay controlling a majority of the market. Nigeria has growing use of digital payments, but also growing adoption of private cryptocurrencies. The Caribbean jurisdictions are relatively small open economies, with large tourism sectors and inward remittances, while China and Nigeria are large economies with strong trade openness but smaller cross-border linkages relative to the size of the economy.

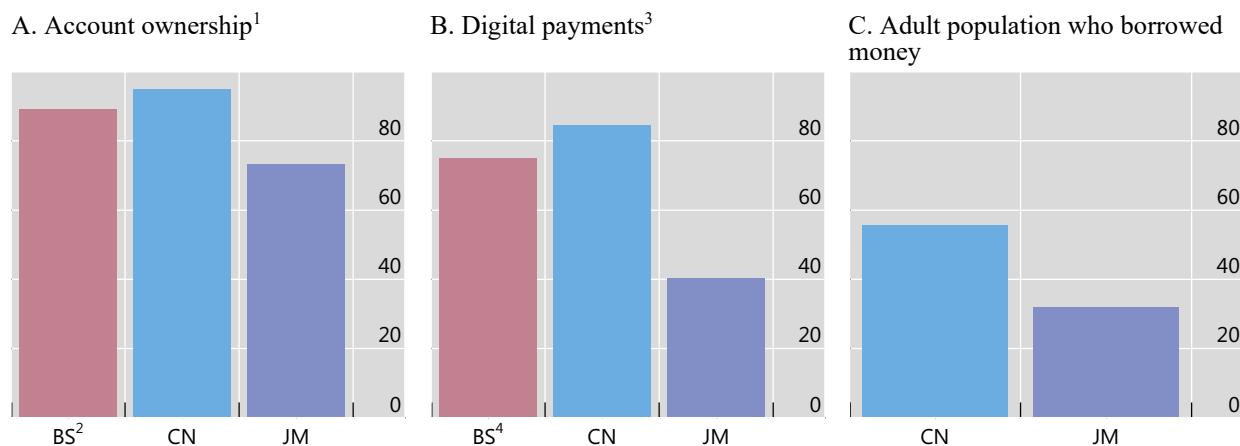
The motivation for each of the three retail CBDC projects covered in this paper also mirrors the policy challenges that each central bank faces (Söderberg et al (2022)). For instance, each of the central banks in question aims to increase financial inclusion, ie the access of individuals and businesses to a range of competing, affordably priced financial services (Her Majesty Queen Máxima (2010)). In each of the three countries, more than 70% of the population has access to transaction accounts (Graph 1.A), but a significant portion of the underserved population faces challenges due to geographic constraints (eg distance from financial institutions) and high service costs. In China, 25%

of respondents who report having no account say that this is because financial institutions are too far away. In Jamaica, the proportion of unbanked individuals encountering similar challenges stands at 30%.² In Jamaica, high services costs deter 43% of unbanked individuals from opening accounts. Meanwhile, across all three countries discussed here, the share of the population using digital payments was lower than that with access to a transaction account (Graph 1.B). In China and Jamaica, the share of those borrowing from formal financial institutions was lower still (Graph 1.C).³ This suggests that some holders of transaction accounts choose to transact entirely with cash instead of digital instruments, even if they have access to the latter. Moreover, the lack of a digital footprint (transactions data) may play a role in lower access to credit for some individuals.

Key financial inclusion indicators in The Bahamas, China and Jamaica

In per cent

Graph 1



¹ Percentage that reported having an account or personally using a mobile money service. ² Percentage that maintained at least one savings account at a banking institution. ³ Percentage that reported report using mobile money, a debit or credit card, or a mobile phone to make a payment from an account; or who report using the internet to pay bills or to buy something online or in a store in the past year. ⁴ Credit and debit card payments.

Source: The World Bank Global Findex Database; Central Bank of The Bahamas; Eastern Caribbean Central Bank; author's calculations.

A related motivation for CBDCs is greater efficiency and competition in payments. With a low-cost design, the CBOB aimed to ensure access to the digital economy for those that might be excluded. Similarly, the BOJ seeks to increase financial inclusion by making the process for opening a CBDC wallet easier than opening a bank account, and promoting person-to-person (P2P) payments. The PBC has emphasised the importance of efficiency in light of highly concentrated private sector solutions, and the fostering of increased access for underserved populations (Mu (2022)). Each central bank aims to promote low-cost or zero-cost payments and greater competition in the payments sector.

Beyond this, there are key differences in motivation. For instance, the CBOB also aims to broaden overall digital payments usage, combat illicit use of money and enhance efficiency in government services. The PBC seeks to address the shift towards digital commerce by introducing a digital form of currency and to level the playing field in light of big techs' cross-selling after their entrance into the financial sector. They also aim to provide a backup for private infrastructure and, with this redundancy, to ensure resilience of the payment system. Meanwhile, the BOJ aims to minimise the cost of cash handling for both financial institutions and merchants.

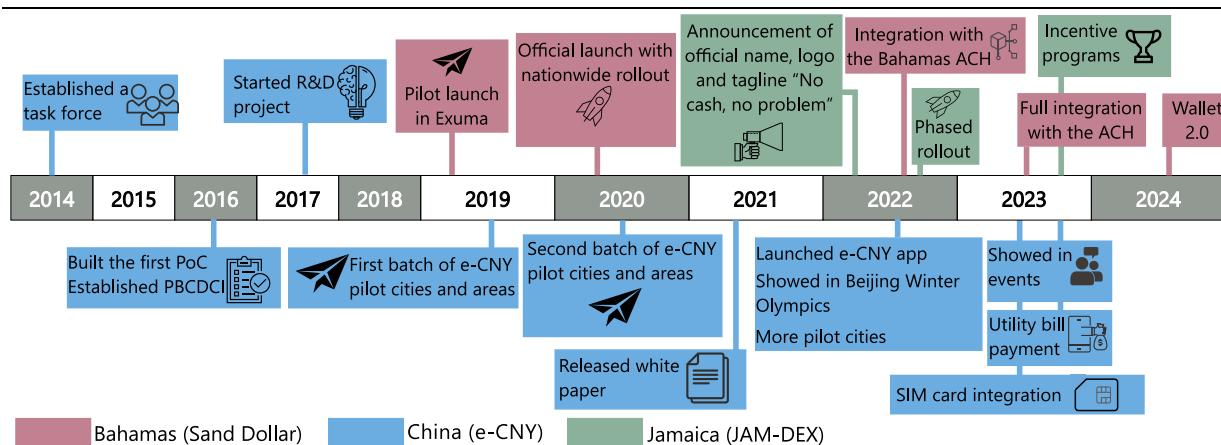
² Source: World Bank Global Findex Database, as of 2021.

³ This indicator is not available for The Bahamas. For further measures of access, see Demirguc-Kunt et al (2022).

Following their initial launch, each CBDC project has seen the addition of new functions and new providers over time (Graph 2). Milestones of the CBOB, for instance, are shown in red. Since the pilot launch of SandDollar in December 2019, and the nationwide rollout in October 2020, the number of active authorised financial institutions (AFIs) has increased to seven. There has been a considerable advance in the marketing and educational efforts to help spur adoption. Between January 2022 and December 2024, the number of merchant wallets rose from 565 to 2,034, and became more widespread, covering a wider selection of vendors across various industries. Starting in 2022, the SandDollar became interoperable with the local Automated Clearing House (ACH), thereby making wallet top-up and redemptions between bank accounts possible. As of December 2024, the number of ACH wallet top-ups via bank accounts totalled 620, with a value of more than B\$400,000 (USD 400,000), with redemptions totalling 61 in number and approximately B\$163,000 in value. In May 2024, the CBOB launched Wallet 2.0, a technological enhancement that allows for self-onboarding for tier 1 wallets,⁴ and other upgrades to improve the user experience.

Key milestones in the development of retail CBDCs

Graph 2



PoC = proof-of-concept. PBCDCI = People's Bank of China Digital Currency Institute. R&D = research and development.

Source: Authors' elaboration.

Milestones of the PBC are shown in blue. Since the initial task force in 2014, and the establishment of the People's Bank of China Digital Currency Institute (PBCDCI) in 2016, there have been several successive steps in the pilot. At the end of 2019, the PBC piloted the e-CNY in an initial set of cities, namely Shenzhen, Suzhou, Xiong'an and Chengdu. In November 2020, it expanded its pilot areas to include Shanghai, Hainan, Changsha, Xi'an, Qingdao and Dalian (Mu (2022)). The PBC then published its first public white paper in 2021 (PBC (2021)), which was then followed by the launch of the e-CNY app and its promotion as part of the Beijing Winter Olympics in 2022. Since then, the PBC has continued to expand its list of pilot areas and has facilitated the authorised operators' public awareness campaign. The pilot has included SIM card integration for mobile phones, which allows payments with a phone's SIM card even when the phone is switched off, as well as wearable devices, internet of things (IoT) devices, etc. The pilot also includes utility bill payments, through which e-CNY holders can pay bills like gas, electricity, water and local government fees.⁵ More recently, efforts are underway to promote quick response (QR) code interoperability between e-CNY

⁴ Tier 1 wallets are those that are easiest to open, eg by not requiring the user to submit any KYC documents.

⁵ The e-CNY app launched a portal for utility bill payments on 15 September 2023, covering a variety of daily utility services such as water, electricity and gas, across all pilot regions. As of the end of 2024, a cumulative total of 1.17 million payments had been made, amounting to RMB 114 million (~USD 16 million).

and traditional electronic payment instruments, allowing merchants to seamlessly accept e-CNY payments, without upgrading point of sale (POS) devices.

The BOJ has also seen key milestones since 2021, shown in green. The launch of JAM-DEX® went together with a publicity campaign with a logo and the tagline “*No cash, no problem*”. After its phased rollout in 2022 came incentive programmes in 2023, including cash grants from the government and loyalty points that can be redeemed for rewards including cash back (see section 3.2).

3. Design and adoption

3.1 Design choices

The design of retail CBDCs has differed in practice. One way to delineate these design choices is with the “CBDC pyramid” framework (Auer et al (2023)). This classifies CBDCs according to their architecture (ie the role of the public vs private sector), infrastructure (whether DLT or conventional technology), access (whether account or token-based) and interlinkages (for domestic or cross-border use).⁶ Building on this framework, we can add other design choices such as CBDC remuneration policy (whether or not they pay interest), fee structure (policy pricing for individuals and merchants) and use of transaction data. It is important to note that the need to interface with legacy systems has imposed certain constraints on design choices, leading to the adoption of hybrid architectures that do not neatly fit into the layers of the pyramid.

Architecture

Regarding architecture, each of the live CBDCs has private sector payment service providers (PSPs) playing an important role. All three central banks discussed here offer their CBDCs through a variety of channels. In each case, this includes roles for both bank and non-bank PSPs.

The Bahamas has a set of authorised financial institutions (AFIs) who offer SandDollar services. All supervised financial institutions can be designated as AFIs, but to date, few participate as such. Consequently, the SandDollar is distributed primarily through seven non-bank PSPs. The CBOB provides the ledger and application programming interfaces (APIs) and non-bank PSPs leverage this technology to offer the majority of customer-facing wallets. Thus, despite intentionally placing the formal financial sector in a role to participate, they remain minor participants.

In China, the PBC is integrating e-CNY with existing financial infrastructure. Through these links, the PBC is able to encourage adoption and create interoperability between different wallet providers. In addition to several major banks, big techs like AliPay and WeChat Pay offer e-CNY wallets.⁷

Jamaica is following a similar pattern with a mix of authorised provider types. These include the National Commercial Bank Jamaica Limited (NCBJ), JN Bank Limited and Sagicor Bank Jamaica Limited (SBJ). NCBJ, through its subsidiary TFOB (2021) Limited, offers the Lynk digital wallet app. Meanwhile, JAM-DEX® is fully integrated with the BOJ’s RTGS system.

⁶ Of course, in each of these categories, there may be a spectrum of options, rather than discrete alternatives. Moreover, there are a number of further (functional and technical) design choices not captured by the framework. Nonetheless, we consider this a useful point of departure to compare CBDC designs. The database of Auer et al (2023), with a classification of all retail CBDC projects, is publicly available at <https://www.bis.org/publ/work880.htm>, and is updated regularly.

⁷ These wallets can be used for a wide range of online services, such as the ride-hailing app Didi, e-commerce platform JD.com and takeaway service Meituan.

Infrastructure

The technological infrastructure of CBDCs differs starkly. For instance, JAM-DEX® uses conventional database technology, rather than DLT. The SandDollar and e-CNY use a combination of conventional database technology and DLT.

In each case where DLT is used, it is a permissioned variant, where operating a node requires the permission of the central bank, rather than permissionless DLT such as the blockchains that underlie Bitcoin and Ethereum. This design choice allows central banks to determine who participates, which underpins network security and eases compliance with existing regulation. For the SandDollar, the core ledger is fully managed by the CBOB and built using DLT. This ledger maintains all individual holdings of the SandDollar. However, individual transaction data, eg transaction participants, are maintained by the AFI managing the customer wallet (see Boakye-Adjei et al (2022)).

Access

Access in each of these CBDCs is mainly account-based. This means that some user identification is required to open a CBDC wallet.⁸ CBDC transactions take place by updating the wallet balance of each of the parties, rather than by exchanging a bearer instrument.⁹

To date, most users transact in CBDC using a smartphone app. In The Bahamas, the SandDollar app is available in the Apple app store and Google Play; users then choose which AFI they are working with, and enter a code provided by the AFI to open and validate the wallet. Since the launch of Wallet 2.0, users who seek to obtain a Tier 1 wallet can onboard themselves, and do not need authentication by the PSP. Alternatively, users of PSP mobile wallets automatically have the ability to make SandDollar transactions without downloading a separate app. A physical payment card can also be used to initiate SandDollar payments, though the latter is used less frequently. Similarly, there is one smartphone app for the e-CNY, which allows the user to select which bank or non-bank PSP to use when opening the wallet.¹⁰ In Jamaica, the JAM-DEX® is accessible to retail users through the Lynk and JN Pay apps, which can be downloaded in the Apple app store and Google Play. In addition to CBDC payments, the Lynk app allows for remittances, bill pay and mobile credit and data.

All three central banks use a tiered wallet system with additional wallets for merchants and businesses. Tiered wallets support three policy goals. First, wallets with fewer KYC requirements are more accessible to those who lack official government identification, which can support increased adoption by the unbanked. Second, implementing holding and transactions limits are designed to mitigate potential effects of disintermediation, especially in the context of a digital bank run. Third, to minimise illicit activities, tiered wallet designs then often map holding and transaction limits to the level of KYC checks required to open a wallet, with increased identification required for higher limits.

For instance, in The Bahamas, the base tier wallet only requires a phone number and can hold up to B\$500 (USD 500), with an aggregate transaction value of B\$1,500 per month. A standard wallet requires a government-issued ID, and has a holding limit of B\$8,000 per month, with aggregate per annum transactions up to B\$120,000. There are merchant wallets with larger balance and transaction

⁸ Here, we are using the distinction put forward by Kahn (2016): “In a token-based system, the thing that must be identified for the payee to be satisfied with the validity of the payment is the “thing” being transferred – “is this thing counterfeit or legitimate?” In an account-based system, however, the identification is of the customer – “Is this person who she says she is? Does she really have an account with us?” Note that this differs from the use of “token” in other contexts, such as in the tokenisation (encryption) of credit card details, or the tokenisation (digital representation) of assets.

⁹ An exception is the token-based mode in e-CNY, for offline and out-of-power use cases, which can be regarded as a digital version of cash.

¹⁰ In some cases, users can link their CBDC wallet to a bank account. In The Bahamas, this allows users to accept incoming payment or balances that exceed the SandDollar wallet limit, with the excess being remitted to their bank account. In China, users can make e-CNY payments from a bank account even if the holdings in their e-CNY wallet are insufficient or zero. This so-called “top up as you pay” function is discussed further below.

limits, set on a case-by-case basis. In China, the most basic wallet can be opened with a phone number and has a single payment limit of CNY 2,000 (~USD 350), a daily cumulative limit of CNY 5,000 and balance limit of CNY 10,000. Wallets with higher limits require additional forms of identification. For instance, a corporate wallet requires official government registration of the business, ID of the legal owner, and other relevant information.

The JAM-DEX® requires full identifying information even for a basic wallet. For instance, with Lynk, the Lynk Lite wallet requires name, date of birth, e-mail address, phone number and tax registration number. The higher tier, called Lucky Lynk, requires a national photo ID. Lynk Lite has a transaction limit of J\$40,000 (~USD 250), while Lucky Lynk has a transaction limit of J\$100,000 (~USD 650). Still, despite the higher requirements than for other CBDCs, the process for opening these wallets is typically easier than that required to open a bank account, and is designed to spur an increase in people joining financial institutions (Mcintosh (2021)).

Across all three jurisdictions, merchant wallets require identifying information such as official government registration of the business. For the self-employed, personal or merchant wallets can be selected based on required transaction levels and amounts.

Interlinkages

Central banks clearly state that retail CBDCs are intended for domestic use only. Yet this can include use by foreign nationals. The CBOB offers the lowest tier wallet to international visitors. Tourists and other visitors can use a US phone number to open a SandDollar wallet with an AFI and make payments with any merchant who accepts SandDollar. To date, adoption by foreigners has been low.

The PBC also allows tourists and foreign visitors to open a (low-tier) e-CNY wallet with a foreign mobile phone number.

BOJ makes clear that JAM-DEX®, “like banknotes and coins, is for Jamaica Dollar transactions only – payments and transfers”.¹¹ However, the Lynk wallet does allow for receipt of Western Union and MoneyGram remittances to their smartphones, which can then be used for domestic transactions with JAM-DEX®.

Remuneration

Remuneration is a design choice that is most often considered in the context of the potential for disintermediation of commercial banks by CBDCs. This is a topic of much debate among policymakers, economists and academics. The concern is that users may choose to hold funds as CBDC rather than bank deposits, and that funding for commercial banks, and consequently productive lending by banks, could dry up. However, empirical evidence is lacking and there is no consensus on the extent to which this risk will materialise. Beyond this, offering remuneration could be considered at odds with designing a “cash-like” CBDC.

For both these reasons, each of the selected central banks is not currently paying any interest on CBDC holdings. However, this may change over time. From a practical perspective, in jurisdictions where current account deposits bear interest, remuneration on CBDC with a relatively lower rate would not provide an incentive for users to convert their deposits into CBDC. This is the case in China. From a theoretical perspective, a CBDC, as a universal payment instrument hosted by commercial banks in a two-tier system, shares some functions with banking deposits and could thus pay interest. Some recent studies have posited that interest rates paid on CBDC within an intermediate range may not have adverse impacts on bank intermediation (Chiu et al (2023); Infante et al (2023)).

¹¹ See CBDC FAQs » Bank of Jamaica (boj.org.jm)

Fee structure

The cost of CBDC payments is generally zero or very low. To achieve a system where transaction costs are lower than with other channels, these three central banks do not charge service providers (eg AFIs) to process payments. However, these service providers may charge merchants for payments, and for additional services (eg integrating payment services through automation software).

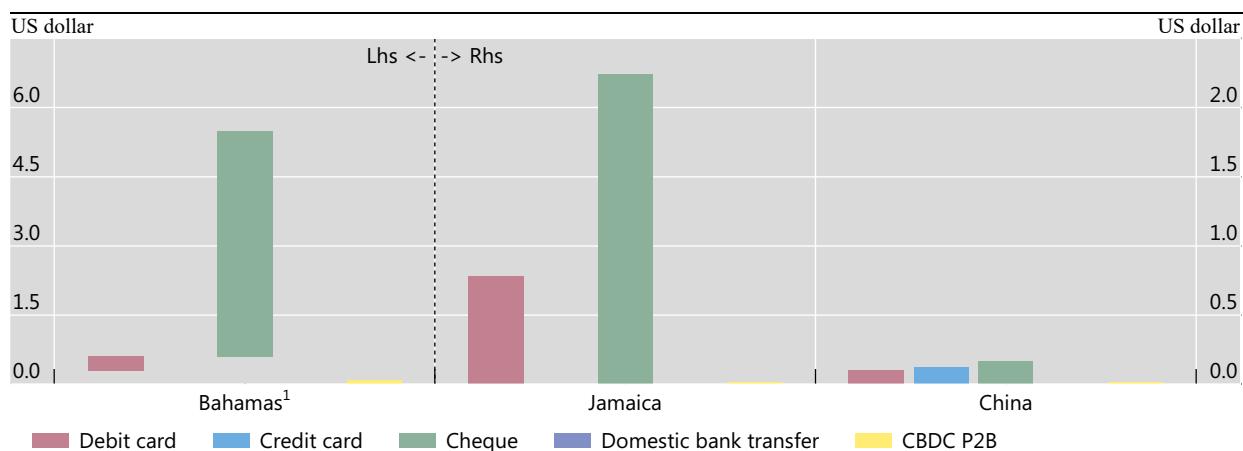
In The Bahamas, non-banks cannot charge fees for person-to-person (P2P) CBDC payments, but can charge for other services. In China, transactions are free for both authorised operators (ie banks) and end users. However, the option remains open for merchants to be charged fees in the future. In Jamaica, P2P CBDC payments are free of charge, but fees may be imposed on additional services.

All three implementations aim to enhance financial inclusion, and thus require an affordable pricing structure, both for P2P and person-to-merchant (P2M) transactions. For consumers, transacting with CBDCs must match the features of cash, thus requiring that the initiation of CBDC payments is free in all cases. Pricing strategies for merchants as payees differ. But when compared to other payment instruments, transaction costs are an order of magnitude lower. For instance, for a USD 25 transaction, debit card fees range from USD 0.30 to USD 0.62 in The Bahamas, while cheques cashing fees range from USD 0.60 to USD 5.50. Costs in Jamaica would be USD 0.75 for debit cards, and USD 2 for cheques. In China, existing debit card, credit card and cheque fees are much lower (less than USD 0.20, ie less than 1% of the transaction value), but are still more than free (Graph 3).¹²

CBDCs payments are cheaper than existing payment options

Average cost to merchants for a 25 USD transaction

Graph 3



Source: Bank of Jamaica; Central Bank of The Bahamas; People's Bank of China; author's calculations.

¹² Of course, credit card, debit card and CBDC transactions face differences that may influence the scale of fees. For instance, credit cards may offer anti-fraud protection and the ability to reverse transactions. This is generally not possible for CBDC payments in the live systems.

Management of data

One of the most sensitive issues in CBDC design is the collection, storage and management of data. This includes identity information of users when opening a wallet, information on CBDC balances and transactions and any derived data, such as geolocation of transactions, spending patterns, etc.

The use of a two-tier architecture with banks and other PSPs offering wallet services can help to build in important data protections. For instance, in The Bahamas, the CBOB runs the system and the full ledger of retail transactions, but individual users are not identifiable to the central bank. AFIs have access to users' identity information, but not the full ledger of transactions.¹³ In Jamaica, PSPs offering digital wallets receive all transaction information, whilst the BOJ on their CBDC system receives transaction data excluding any personally identifiable information.

In China, by employing DLT and reserve arrangements, the e-CNY platform aims to protect consumer privacy, while ensuring transparent transactions and regulatory supervision. To achieve this balance of privacy and supervision, the PBC is employing advanced data analysis using artificial intelligence (AI), supported by a unified big data management platform. This approach enables the use of supervisory technology (suptech) applications and the generation of macroeconomic statistics, in aggregate, while limiting visibility into individual transactions.

3.2 Adoption

Adoption trends

The impact of CBDCs hinges on adoption. Of course, broad adoption of retail CBDCs does not necessarily equate to success, as the ultimate measure of success depends on specific policy goals of each central bank. Adoption by an underserved community in a particular geographic location may well fit into a central bank's policy objective yet translate into fewer wallets, but a high volume of transactions. Conversely, for other use cases (eg payroll), the goal may be many new wallets with fewer, but higher value transactions. In any case, tracking adoption is key to understanding the impact of retail CBDCs over time and across the jurisdictions in which they are issued.

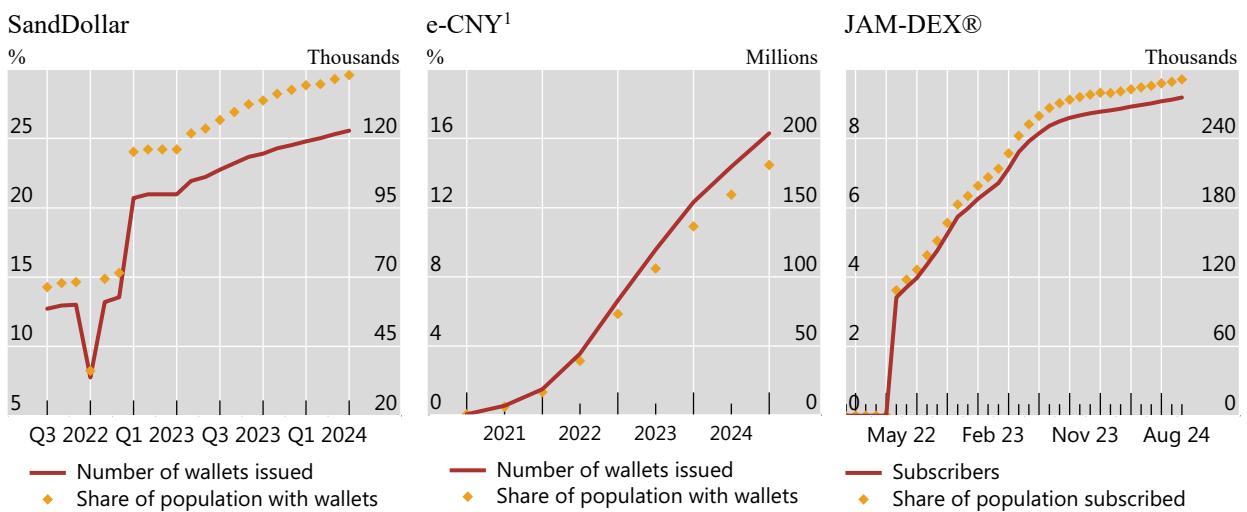
Since CBDC launch, each of the three central banks has seen a steady increase in total number of wallets and active users (Graph 4). In The Bahamas, there were over 135,000 registered wallets as of December 2024. There were 2,034 registered merchant wallets and 7 active participating AFIs. In China, there were a cumulative total of 203 million wallets issued as of December 2024. In Jamaica, there were 260,000 wallets as of November 2024. Relative to the population, the Bahamas has the highest adoption to date, with wallets equivalent to about 30% of the population. In China, this proportion is around 14%, and in Jamaica 10%.¹⁴

¹³ In cases where law enforcement agencies need access to individual transactions, they need a warrant from a court, and need to go to both the AFI (for identity information) and the central bank (to retrieve transaction data).

¹⁴ In each jurisdiction, it is possible for one user to have more than one wallet, leading to some double-counting.

Total wallets and active users of CBDCs are rising

Graph 4



¹ Because each user can open one wallet per authorised operator, and there are 10 authorised operators, the number of users may be smaller than the number of wallets.

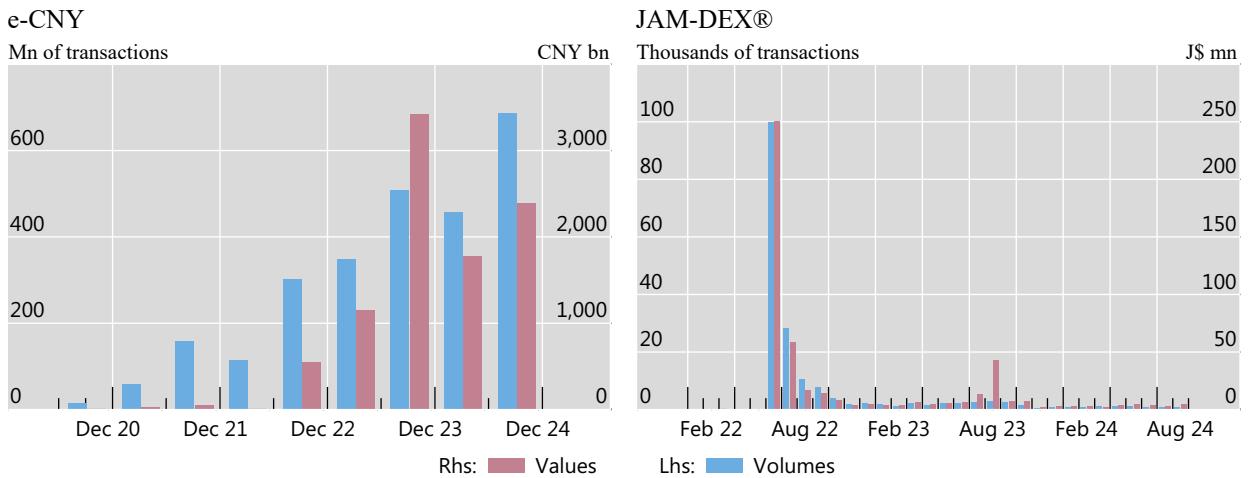
Source: Bank of Jamaica; Central Bank of Bahamas; People's Bank of China; author's calculations

CBDC transactions have also been rising (Graph 5). In China, the number and value of e-CNY transactions has grown steadily, except for a temporary drop in January 2022. The two-tier e-CNY system leverages the resources and technology of authorised operators with the goal to build a market-driven system that promotes innovation and competition. The PBCDCI also works with commercial banks to support corporate use cases like payroll and loans. The higher uptake in early 2023 reflects adoption of payments by businesses, with new large value e-CNY transactions by enterprises driving the large increase in transaction value.

JAM-DEX® was officially launched in June 2022 with a large issuance of CBDCs within that month. Indeed, the first 100,000 users each received J\$2,500 (~USD 16) from the government of Jamaica, bringing J\$250 million (~USD 1.6 million) of JAM-DEX® into circulation. Then in 2023, an initiative focused on low KYC wallets, granted the first 60,000 customers J\$2,500 from the Government. And a loyalty program was initiated where individuals using JAM-DEX® wallets would receive loyalty points that can be redeemed for rewards including cash back (Patterson (2023)). Prior to that, the pilot phase already allowed for transactions, although at a much smaller scale. Since the launch, JAM-DEX® has seen a decline both in transaction volumes and value. This decline can be attributed to a lack of merchants and digital wallet providers currently in the market, which limits the usability of JAM-DEX®. To combat the decline in use, the BOJ initiated a JAM-DEX® merchant strengthening plan. This aimed at onboarding additional digital wallet providers, merchants and use cases to bolster Jamaica's CBDC infrastructure.

Transactions are rising in China, not yet in Jamaica

Graph 5



Source: Bank of Jamaica; People's Bank of China.

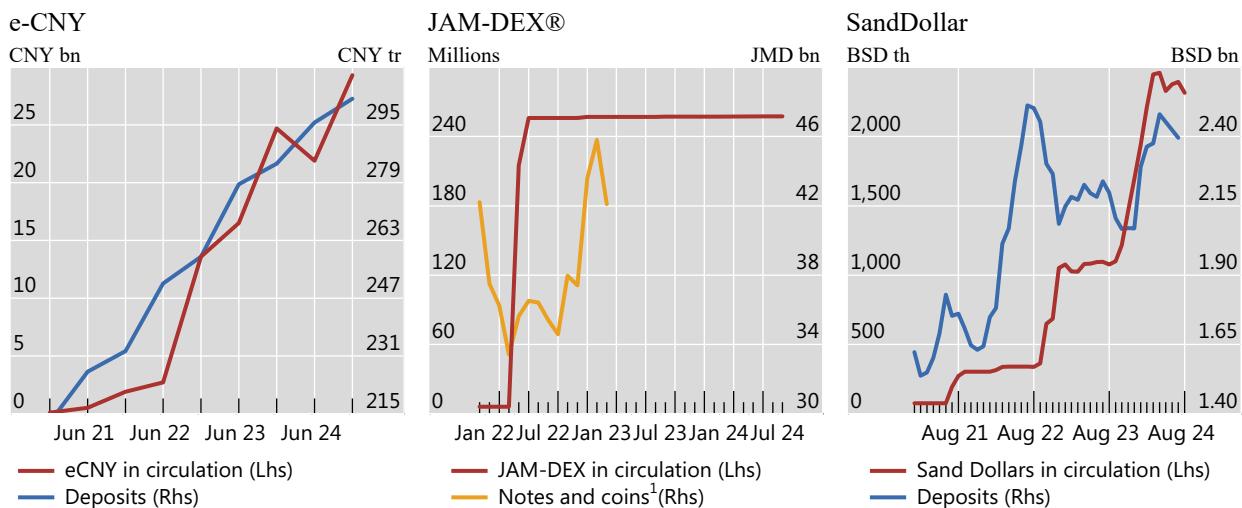
CBDCs in circulation

Growing adoption can also be reflected by CBDCs in circulation. In each jurisdiction, this has risen since CBDC launch (Graph 6, red line). These numbers can be compared with alternative payment instruments, such as bank deposits, e-money and cash (notes and coins) in circulation. In each case, CBDCs in circulation are still at a far lower level (note the difference in primary vs secondary axes). This reflects both the early stage of projects, and their design. For instance, in China, the introduction of a “top up as you pay” function means that users can withdraw funds directly from a bank account when making an e-CNY payment, such that they don’t need to hold funds in their e-CNY wallet. This can allow for transactions to take place without an increase in CBDCs in circulation.

As a key part of avoiding disintermediation, these CBDCs were purposefully designed as a means of payment, rather than a store of value. The lack of remuneration and limits to both holding and transaction amounts have likely contributed to total CBDCs in circulation remaining as only a small fraction of the total value of deposits in all cases. There is thus no indication of a substitution effect with current deposits to date. It may be that retail CBDCs are filling a gap in existing retail payment instruments, and/or substituting for cash payments. Of course, these developments should be further assessed if the size of CBDC holdings grows.

CBDC in circulation is growing, but remains small relative to deposits

Graph 6



¹ Aggregate total balances held by all commercial banks.

Source: Bank of Jamaica; Central Bank of Bahamas; People's Bank of China; author's calculations.

Adoption barriers and promotion activities

Central banks are working to overcome barriers to adoption. Some barriers relate to: (1) lack of awareness and financial literacy; (2) the economics of payment markets; and (3) societal factors such as views toward privacy.

To address lack of awareness and financial literacy, each of these central banks has leveraged educational campaigns to raise awareness and increase adoption. For example, the CBOB has launched various initiatives to foster both adoption by consumers and merchants. It has funded publicity campaigns, hired SandDollar ambassadors to go to communities and help users to open wallets and make transactions and organised town hall meetings and virtual seminars and workshops. It has also enlisted commercial banks and electronic money service providers to conduct educational campaigns to increase digital financial service adoption efforts.

For the e-CNY pilot, the PBC has coordinated with authorised operators to release promotional materials focusing on key features, including ease of use and tailored functionality for underserved groups (eg those with visual impairments). The e-CNY has also been promoted through the distribution of digital "red packets".¹⁵ The initiative was successful and "red packets" have been widely used, in particular, for government subsidies. Since 2022, local governments in the pilot areas have carried out more than 260 rounds of subsidy distribution via e-CNY red packets.¹⁶ Commercial banks also offer programmable "red packets" for their customers, where users have certain conditions (eg amount limits, specified merchants, expiry dates) to spend their e-CNY.

In Jamaica, the incentive programme for users saw strong uptake, while the programme for merchants was less successful. In March 2022, the BOJ, on behalf of the Government of Jamaica,

¹⁵ Red packets are traditionally envelopes used for giving cash as a gift, for instance at Chinese New Year. The digital red packets have become popular on WeChat Pay and elsewhere, as a means to send money in digital form. As such, the PBC chose to pilot this same functionality with e-CNY.

¹⁶ These e-CNY red packets feature smart contracts, where conditions can be set flexibly to define the distribution and use of subsidies. This ensures that the subsidies will be distributed exclusively to the target group and will be consumed in alignment with the defined purpose, improving the efficiency of subsidy distribution and mitigating moral hazards. e-CNY red packets have become an important vehicle for distributing consumption subsidies in the pilot areas. These were particularly helpful during the recovery from the Covid-19 pandemic, given the need to increase consumption demand.

provided JAM-DEX® totalling J\$ 2,500 (~ USD 16) to the first 100,000 JAM-DEX® registrants. By June 2022, the programme was fully subscribed for individual wallet holders. In 2023, an incentive programme focused on JAM-DEX® adoption by merchants. Yet here, only about 100 customers signed up for the JAM-DEX® Loyalty Programme, where users received a 2 percent cash back for up J\$5,000 (~USD 32) monthly when using JAM-DEX®.

The BOJ co-authors believe the programmes contributed to a boost in adoption. The 2022 incentive programme, which targeted individual users, seems to have had larger impact. After the announcement of the incentive in March 2022, in the following weeks (27 March – 9 May) a total of 90,176 new subscribers registered for a JAM-DEX® digital wallet. This surge in adoption accounts for 33% of the total number of JAM-DEX wallet holders as of 31 August 2024 which stands at 275,627.

Other barriers relate to the economics of payments markets. The issuance of CBDC as a payment instrument, with payment rails for end users and merchants, unveils a two-sided-market (Rochet and Tirole (2003)). In this context, prices for each side of the market (users and merchants) play a crucial role in adoption (or lack thereof), impacting network effects. For example, the CBOB provides certain free transactions for both users and merchants, with the hope of triggering network effects that will allow adoption to become self-reinforcing above a certain threshold. The CBOB has also promoted the SandDollar as the principal or only accepted means of payments at national and CBOB sponsored events (Robards (2022)). The goal of these activities is to ensure that through multilateral partnerships, financial instruments are easily accessible, reliable and available for use by consumers and merchants.

The PBC is fostering adoption through the promotion in parallel of retail, commercial and public use cases. The promotion of commercial use cases occurs through the planned launch of overlay services such as payroll. Integration with big tech players and traditional bank accounts in the domestic payments landscape, including interoperability with QR code payments, is also expected to increase the uptake of e-CNY. Finally, the PBC is promoting government use cases like taxation, public services and fiscal subsidies.

Finally, barriers to adoption can relate to other societal factors, such as views toward privacy protections. Here, central banks have been working to further develop and clarify the safeguards around user data. In this light, it is useful to consider both institution-based (“soft”) privacy-enhancing designs and technology-based (“hard”) solutions (Auer et al (2025)).

4. Lessons to date

The launch of retail CBDCs provides highly valuable insights for central banks, economists and the general public. By moving from research to actual implementation, the central banks discussed in this study are pushing the frontier of knowledge not only on CBDCs but on digital payments and the design of payment infrastructures more generally. The outcomes of projects to date – both expected and unexpected – are thus a highly fruitful area for research.

A key point of departure is to ask: are the policy goals of central banks being met? In many cases, the answer is a tentative yes.

In The Bahamas, the SandDollar has already helped thousands of individuals gain easy access to digital payments, thus providing an alternative to (less accessible, and often expensive) banking services. The recent rollout of Wallet 2.0 makes opening a SandDollar wallet faster, more convenient and easier for users, which can underpin gains in access and usage. In addition, the introduction of a CBDC has enhanced the domestic payments space by making payments more efficient through digitisation. Dovetailing with this innovation, businesses have also been able to improve their operations by adding another digital means of payment, thereby increasing the ease of business for consumers, which ultimately drives gains for their sales volumes. Some businesses have been able to

adopt the CBDC in their payroll functioning, which has also aided adoption. While this progress is good, the CBOB hopes to introduce offline functionality, which enables greater access and efficiency gains, particularly for remote populations and to assist in the aftermath of a climate event.

In China, the e-CNY pilot has yielded useful insights, having verified and improved its design features, thus establishing a foundation for a future full launch. The PBC co-authors note the following:

- A CBDC can extend payment services provided by central banks in the digital era. The e-CNY provides a 24x7, non-stop service to the general public, supporting 10,000 transactions per second at present, with higher throughput expected in the future. Inclusion of a variety of participants including commercial banks and financial institutions, as well as PSPs and telecom operators, has supported a wide range of use cases.
- A CBDC can reduce fragmentation in the financial system. With its status as legal tender, the e-CNY can reduce fragmentation by serving as an interoperable instrument across payment platforms to ensure singleness of money across public and private monies. For instance, Alipay and WeChat Pay have already achieved interoperability through the e-CNY. Wallets offered by all e-CNY authorised operators are interoperable with the e-CNY serving as the medium of exchange. Meanwhile, leading online platforms like Taobao, JD.com, Meituan, Didi, Ctrip and millions of WeChat mini-programs and channels now support e-CNY payments, providing consumers with more choices.
- A CBDC can overcome barriers to entry. The e-CNY is building a level playing field by providing unified infrastructure for different types of market participants, with a focus on consumer protection by mitigating unfair competition practices like technology barriers and cross-selling. The e-CNY provides new opportunities for market participants to innovate financial products and business models. Not only banks, but big techs can benefit from this programme by improving compliance capabilities and reducing operating costs.
- A CBDC can enhance financial inclusion. The e-CNY is designed to provide access to financial services to the unbanked and underbanked living in remote areas or with low incomes. It has accessible solutions for senior citizens and people with physical disabilities – such as a voice-based smartphone interface that was specifically designed for blind and visually-impaired users. Finally, it offers payment services to short-term visitors from abroad without providing identity information or holding a bank account in mainland China.
- A CBDC can also help foster the digitisation of social governance. e-CNY smart contracts have been deployed to facilitate public policies implementation such as poverty alleviation and consumption promotion. Government agencies can participate in the design of e-CNY smart contracts to improve public spending with tailored fiscal funds distribution in targeted region, industry, goods or services.
- Going forward, the PBC is considering further innovations as part of a broader context in the monetary and payment system. For example, while e-CNY is currently a liability of the central bank, the PBC is also exploring a new model where designated commercial banks can directly convert e-CNY, making it a commercial bank liability backed by reserves with the central bank. Potential further models include tokenised deposits and tokenised e-money or “synthetic CBDC”. Key motives for these ideas are to encourage commercial banks to participate, to compensate them for AML/CFT responsibilities and to avoid disintermediation – and meanwhile to realise the singleness of money across retail and wholesale use cases.

In Jamaica, JAM-DEX® has helped to promote digitalisation of payments, and the hope is to build further on the progress to date. To promote digitisation and financial inclusion, the BOJ is working closely with the Tax Administration of Jamaica (TAJ) with the intention to provide the option to conduct specific tax payments via JAM-DEX®. In May-April 2025, the BOJ rolled out the use of JAM-DEX® to make property tax, fitness fee and traffic ticket payments online. The BOJ is also

working with technology providers to develop JAM-DEX® payments via point-of-sale devices at the merchant.

Overall, three key lessons can be drawn from these early experiences.

The first is the critical importance of public communication about CBDC projects to the general public. Lack of awareness of CBDC initiatives, misinformation and lack of trust can each be very damaging to the success of a CBDC project. Central banks have adopted different strategies to generate awareness about their CBDC projects and to communicate about key features and answer questions. For example, the CBOB ambassadors programme, operated by the Adoption Unit, deploys persons into the field to educate businesses and consumers on the SandDollar, and to assist them with starting the onboarding process. This hands-on assistance has helped to engage more users, both from a business perspective and a consumer perspective.

The second is the importance of incentives to bring the private sector on board. As with other digital payment infrastructures, such as fast payment systems, commercial banks and other private sector parties may resist joining an infrastructure that has lower fees and may reduce the ability to collect rents (Cornelli et al (2024)). While the bulk of the AFIs for the CBDC in The Bahamas are non-bank PSPs, the CBOB continues its efforts to bring commercial banks and credit unions onboard. There has been some traction on this end, but it is still a work in progress. More generally, it is crucial that a retail CBDC platform be integrated with the larger financial ecosystem (see Noll (2024)). In the long run, a market-oriented incentive mechanism (with non-zero pricing for merchants) would also be indispensable to ensure sustainable development of the ecosystem.

The third lesson is the importance of peer learning. The Caribbean central banks have benefited from the exchange of insights across one another, and have shared their insights with other central banks around the world. The PBC has benefited from engagement in global fora such as the Committee on Payments and Market Infrastructures (CPMI), where it has both shared insights on the e-CNY work and gotten input from peer central banks from across the G20 and beyond. Further discussions in international fora, and publication of research on the experiences with CBDCs, can thus help to gain insights and further improve the design of retail CBDCs over time.

5. Conclusion

A decade after the first experiments, central bank digital currency remains a relatively new innovation. While monetary economics can draw on thousands of years of experience with metal coins, and hundreds of years of experience with banknotes and commercial bank accounts, the evidence base for CBDCs is quite limited. In this light, the on-the-ground experience of early adopters of retail CBDCs is extremely valuable, shedding light on how a new form of central bank money is conceived, issued, adopted and used in practice. While economic theory can attempt to predict the macro- and microeconomic impact of CBDCs, this cannot substitute for the insights available from central banks that have put digital money into the hands of real-life consumers, merchants, PSPs and financial institutions.

In exploring the experience of three early adopters – the Central Bank of The Bahamas (CBOB), the People’s Bank of China (PBC) and the Bank of Jamaica (BOJ) – we draw lessons on how such initiatives can meet their objectives. We note that while all CBDC projects are relatively new, each of the three central banks have already begun to adapt their approach in response to early adoption signals. Both the CBOB and PBC worked to promote adoption, recognising the importance of directed efforts to bring CBDCs into people’s daily lives. These use cases included payroll, government programmes and direct integration into the banking system (eg integrating with the Automatic Clearing House) and mobile wallets (eg AliPay). Meanwhile, early direct financial incentives did not result in the desired increase in JAM-DEX® transactions. However, the BOJ has already improved upon the approach with its merchant promotion targeting those with businesses like restaurants and

gas stations. This ongoing adaptation shows that even within individual jurisdictions, there can be changes in approach that can be insightful to study over time.

There has also been much debate on the theoretical impact on current financial systems, most notably the risk of disintermediation. Early insights show this risk (at least in the case of zero-interest CBDCs) appears not to have materialised. CBDCs in circulation are still only a fraction of bank deposits, and there is little evidence of substitution. Similarly, despite central banks offering direct (and often free) participation for financial institutions in the CBDC ecosystem, adoption among them remains low. Finally, the need for public communication and education is confirmed. Central banks, never having had to market cash, are still working to create awareness, trust and demand for CBDC. For this, we see novel approaches, with the CBOB leveraging local ambassadors, the PBC and the e-CNY authorised operators developing promotional materials in partnership with merchants, and the BOJ implementing loyalty points.

Overall, insights from these early adopters demonstrate that CBDC success depends on substantially more than making the “right” technical design decisions. To drive adoption, it is necessary to align incentives among end users, merchants and financial system players to create the requisite demand and network effects. Additionally, awareness and educational campaigns in partnership with local trusted entities can go a long way in demonstrating value to those who the policy goals are designed to support. In line with the purpose of this paper, a future area of research includes analysing the impact of peer learning. With numerous cross-border projects completed and joint research papers written, understanding the transferability of lessons learned across jurisdictions, given different political, economic and social climates would add insight into repeatability of success. Second, evaluating the potential impact of applying marketing best practices and development of go-to-market plans for CBDCs could also help fill the gap in techniques to drive adoption.

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