



**HAL**  
open science

# Central Bank Digital Currencies in the Post-pandemic Era

Dominique Torre, Qing Xu

► **To cite this version:**

Dominique Torre, Qing Xu. Central Bank Digital Currencies in the Post-pandemic Era. Central Banking in a Post-Pandemic World, 1, Routledge, pp.34-52, 2023, 978-1-032-34670-0. 10.4324/9781003323280-4 . halshs-04194031

**HAL Id: halshs-04194031**

**<https://shs.hal.science/halshs-04194031>**

Submitted on 1 Sep 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Central Bank Digital Currencies in the Post-Pandemic Era

Dominique Torre\*

Qing Xu\*

August 2022

## Abstract

Many major central banks and peripheral institutions have scheduled the introduction of a Central Bank Digital Currency (CBDC) or researched the possible implementation of one. Some banks even engage with CBDC pilots through cross-border payment tests. Such projects mobilize advanced technologies with a reputation for security and efficiency, constituting the post-pandemic period transition to contactless and cashless currencies. This chapter aims to analyze this new phase in developing these forms of money/means of payment. In which ways do the various types of CBDCs differentiate? Which technology will make them operational? What are the motivations of central banks choosing to implement? How to create compatibility with the time-tested model of the banking industry? How to explain some big central banks promotion of such currencies given the Federal Reserve System's disinterest?

Key Words: means of payment, currencies, digitalization, blockchains

JEL Codes: E42, E58.

## 1. Introduction

Since the fall of the Bretton Woods agreements, means of payment have transitioned from material to immaterial and digitalized forms, from coins and notes to credit cards and mobile phones. Given such rapid changes, the very nature of money seems likely to evolve in turn. New mechanisms could directly link agents in need of liquidity and central banks through technology using a decentralized clearing system: mechanisms appearing under the name of Central Bank Digital Currencies (CBDCs).

In part, a strictly technological evolution, the fast development of digital innovations and technological advances pushed a fundamental revolution in the banking industry. The rise of cryptocurrencies and stable coins with blockchain utilization, the widespread use of mobile payment, and the global expansion of a cashless economy pose additional challenges for central banks worldwide. Moreover, the Covid-19 pandemic has accelerated the digital transformation of people's work and life, speeding up the adoption of digital payment while heavily decreasing the use of cash in most countries. Depending on countries and continents, this shift promoted FinTech or telephonic operators' services. Simultaneously, Facebook, in partnership with VISA, Paypal, and other partners, announced the stablecoin 'Libra' project in June 2019, and rebranded it to 'Diem' at the end of 2020 (Chiu *and al.* 2021; Pilkington 2022). Such events could not leave the central banks unaffected.

The taxonomy defines a CBDC as a new digital form of central bank money that serves three essential functions: a medium of exchange, a unit of account, and -- to some extent -- a store of value,

---

\* Université Côte d'Azur - GREDEG - CNRS, 250 rue Albert Einstein, 06560 Valbonne, France. E-mail: [dominique.torre@gredeg.cnrs.fr](mailto:dominique.torre@gredeg.cnrs.fr)

\* Université Catholique de Lille - Faculté de Gestion, d'Economie et de Sciences, 60 Bd Vauban, 59800 Lille, France. E-mail: [qing.xu@univ-catholille.fr](mailto:qing.xu@univ-catholille.fr)

though different from traditional reserves or settlement account balances (BIS 2018). Around 100 countries are exploring CBDCs (Kristalina 2022); some countries have already issued CBDCs officially, others are conducting research, while some are undertaking extensive pilots and tests for different CBDCs projects. Nine countries<sup>1</sup> have already launched CBDCs, and fourteen countries, including China, South Korea, Singapore, Malaysia, and Thailand, currently rest in the pilot stage, preparing for a potential full launch of CBDCs in the future (Atlantic Council 2022).

Section 2 briefly reviews the different experiences on CBDCs. Section 3 presents the different types of CBDCs and the technologies which activate them. Section 4 discusses the motivations of central banks. Section 5 concludes with a discussion on how CBDCs may evolve and influence the international financial system in the future.

## 2. The projects of CBDCs all around the world

In many regions, monetary authorities have kept a close eye on FinTech evolution, aiming to digitalize fiat currency by placing theory into practice. However, most major central banks do not have an immediate plan to issue CBDCs; most ponder whether to launch CBDCs in the near future or issue pilot studies to examine the implications.

As an early example, Finnish commercial banks and the Helsinki University of Technology collaborated on the experiment of pre-funded payment smart cards in 1987. In the 1990s the Bank of Finland created the Avant smart card, considered the world's first CBDC; however, the card never gained sufficient popularity, only operating until 2003 (Grym 2020). Having faced in 2000s the negative impact of dollarization, starting from 2014, Ecuador issued in parallel with US dollar, the Dinero Electrónico (DE), and discontinued the experience in 2018 (Auer & Boehme 2020; Arauz et Garratt 2021; PWC 2021).

The People's Bank of China (PBOC) focused on the research and development of CBDCs, beginning in 2014 by exploring PBOC's internal digital currency; then, two years later, establishing the Chinese Digital Currency Institute. Issued by the PBOC, electronic Chinese Yuan (e-CNY) would constitute a retail CBDC designed to meet people's daily payments needs by adopting a centralized management model and a two-tier operational system<sup>2</sup> (Working Group on E-CNY Research and Development of the People's Bank of China 2021). At the end of 2017, PBOC started working with commercial institutions to further develop and test e-CNY, eventually leading to the launch of a wide range of pilots, testing and assessing the implementation of e-CNY in different cities of China, including e-CNY tests during the 2022 Beijing Winter Olympics (Working Group on E-CNY Research and Development of the People's Bank of China 2021).

Since the early 2010s, two Chinese digital payment giants, Alipay and WeChat Pay, established by Alibaba and Tencent, respectively, provided mobile payment services accepted by most Chinese people as the primary payment method in China (Torre & Xu 2019, 2020; Xu 2022, p. 227). Chinese digital payments continued to grow during the whole decade. By the end of 2021, Chinese banks processed 274.969 billion electronic payments with a total of RMB2976.22 trillion (around USD461 trillion by using the average exchange rate in 2021 of 6.45), including 151.228 billion mobile transactions with a total value of RMB526.98 trillion (approximately USD83.25 trillion), a respective year-on-year increase of 22.73% and 21.94% (People's Bank of China 2022).

---

<sup>1</sup> The Central bank of Bahamas issued the nationwide CBDC in October 2020, seven countries in the Eastern Caribbean Union created CBDCs in April 2021, and the Central Bank of Nigeria launched e-Naira in October 2021

<sup>2</sup> The PBOC has the right to issue e-CNY; commercial banks and other commercial institutions take charge of exchanging and circulating e-CNY to the public.

Canada represents another pioneer in CBDC research. In March 2016, the Project Jasper was launched by the Bank of Canada and Payments Canada, R3 (a financial innovation firm) and several Canadian financial institutions, for instance, Scotiabank, Bank of Montreal, RBC, National Bank, and HSBC (Payments Canada, Bank of Canada & R3 2017). For the first time, a central bank investigated a distributed ledger technology (DLT) experiment with private institutions (Bank of Canada 2017). On June 30, 2020, the Bank of Canada and the Bank for International Settlements (BIS) announced that they would establish a BIS Innovation Hub to promote FinTech innovation within the central banking community, strengthen collaboration on digital technologies, and enhance the global financial system (Bank of Canada 2020). On March 16, 2022, the Bank of Canada cooperated with the Massachusetts Institute of Technology (MIT) Media Lab's Digital Currency Initiative team on a twelve-month CBDC research project, exploring the potential design and implementation of a CBDC (Bank of Canada 2022). However, according to the Bank of Canada (Bank of Canada n.d.) and Canadian government, the project to implement a central bank digital currency now seems less urgent.

In December 2016, the European Central Bank and Bank of Japan (2017) announced the cooperation of a joint research project, 'Stella' to assess the impact of FinTech/distributed ledger technology (DLT) on central bank roles and financial market infrastructures. Project Stella consists of four phases: phase 1 focuses on large-value payments processing utilizing DLT, phase 2 examines securities delivery-versus-payment in a DLT environment, phase 3 studies cross-border payments, and phase 4 tests the balance between confidentiality and suitability of CBDC within a distributed ledger environment (European Central Bank 2019; European Central Bank & Bank of Japan 2020).

According to the "Report on a digital Euro", the Governing Council of the European Central Bank (ECB) set a High-Level Task Force in January 2020 on CBDCs to strengthen monetary policy and support the Euro system's strategic goals (European Central Bank 2020). Fabio Panetta (2022), a member of the Executive Board of the ECB, presented in his speech that CBDCs would endorse the accessibility and usability of central bank money in a digital world, maintain the coexistence of sovereign and private money, guarantee the smooth functioning of the payments system, and improve the confidentiality of digital payments. Nine months after the publishing of the "Report on a digital Euro", the Euro system launched a two-year investigation of the digital euro project on 14th July 2021, aiming to address key issues about the design and issuance of the digital euro (European Central Bank 2021).

Likewise, in September 2017, the central bank of Sweden, Sveriges Riksbank, launched an e-krona project of the digital complement to cash to promote a secure and efficient payment system in the future (Sveriges Riksbank 2017). Like cash, the e-krona offers a digital version of Swedish central bank currency without credit or liquidity risk, broadly available to the public at any time, all year round (Sveriges Riksbank 2018). Sveriges Riksbank (2021, 2022) conducted two e-krona pilots: the first one focused on the possible distribution models, transaction process, e-krona storage methods, and legal analysis of technical solutions; the second one continued deeper testing of the use of e-krona, discussed different wallet models and options for off-line payments, providing good support for the Riksbank's research and investigation on the design and requirements for possible issuance of e-krona.

In Japan, the Digital Currency JPY (DCJPY), a yen-denominated digital currency, is designed on a two-tiered structure with the ledger systems of commercial banks (Common Area) and (Business Process Area) (Currency Digital Forum 2021). Since the beginning of 2021, the Bank of Japan (2020, 2021, 2022) initiated experiments on the technical feasibility of the essential functions and characteristics required for CBDC, completed Proof of Concept (PoC) Phase 1 on testing the basic functions of CBDC's issuance, distribution, and redemption in March 2022, and started the PoC Phase 2 experiments in April 2022. However, according to the Executive Director of the Bank of Japan, Uchida Shinichi (2022), the Bank of Japan currently does not plan to issue CBDC, and it will continue to work on the possible design of CBDC and the way to construct a highly reliable CBDC ecosystem.

The Covid-19 accelerated digital and contactless payments and encouraged CBDCs research, tests, pilots, and issuance in developed and developing countries (BIS 2021b). In 2020, the Bank of England (2020) issued a discussion report on CBDC, focusing on retail CBDCs, presenting an illustrative 'platform' model of CBDC, and evaluating both benefits and risks of CBDC. Compared with

other countries, research and experiments of CBDCs in the United States still remain in the early stage. Digital dollar foundation (2020) cooperated with Accenture, the leader in enterprise blockchain services for the CBDC research and released its white paper about the Digital Dollar Project. The Federal Reserve's cautious attitude is undoubtedly related to the dollar's status on the international scene. What would the dollar gain from a split that could lead the central banks of many countries to question the form that their reserves should take?

Responsible for encouraging monetary and financial soundness, safety, and efficiency, the Federal Reserve has recently disaggregated the CBDC project in four work packages: “technological experimentation, economic and policy research, stakeholder engagement and outreach, and international collaboration” and collaborated with different institutions as the Massachusetts Institute of Technology's Digital Currency Initiative, Georgia State University, BIS, etc. (BIS 2021a, Board of Governors of the Federal Reserve System 2022). The Federal Reserve now fosters a general and transparent public dialogue about CBDCs, investigating the potential benefits and risks of a U.S. CBDC without a clear intention about whether to officially issue a CBDC (Board of Governors of the Federal Reserve System 2022). Moreover, the Federal Reserve mentions that the implementation of a CBDC would depend on whether or not research results could demonstrate the overall benefits of CBDC exceed the downside risks; thus, proving the CBDC as a superior method to alternatives (Board of Governors of the Federal Reserve System 2022).

### 3. Different types of CBDC and different technologies to activate them

#### 3.1 Different types of CBDCs

The first classification of CBDCs could distinguish the wholesale CBDCs and retail CBDCs (or general-purpose CBDCs). Financial institutions such as commercial banks use wholesale CBDCs for settling large-value transactions, which replace or complete central bank deposits and reserves, focusing on inter-bank settlements. In contrast, the public uses retail CBDCs or general-purpose CBDCs for day-to-day payment transactions instead of banknotes for a wide range of end users, including both individuals and firms (BIS 2018; Noriyuki & Hiromi 2019; Bank of Japan 2020; Working Group on E-CNY Research and Development of the People's Bank of China 2021; Banque de France 2021b).

Another possible classification concerns “account-based” CBDCs and “value-based” ones. The “account-based” CBDCs authorize ordinary people to access their accounts directly with a central ledger-keeper, and the “value-based” CBDCs work as a prepaid value stored locally, allowing users firstly charge a certain amount of CBDCs to e-wallet, IC cards, or smartphone applications and then making payments or transferring them with each other without being recorded in the central bank accounts (Sveriges Riksbank 2017, 2018, 2022; Noriyuki & Hiromi 2019; Banque de France 2021a).

Digitalization has multiplied the new means of payment, without crowding out the old ones. Table 1 compares the nature and properties of different means of payment available today. Table 2 represents different design of CBDCs worldwide. Additionally, a distinction exists between interest-bearing and non-interest-bearing CBDCs. Many central banks, like the Bank of China, the Bank of Japan, and Sveriges Riksbank, agree with the design of non-interest-bearing CBDCs, assuming CBDCs are the same as the physical banknotes under M0 without an interest. While according to the European Central Bank (ECB) (Mersch, 2017), CBDCs can remunerate at a certain rate level, for example, at the rate on the deposit facility.

Based on various possible architectures, three types of CBDC ensue: indirect CBDC, direct CBDC, and hybrid CBDC (Auer & Boehme 2020). First, indirect CBDC presents a claim on financial intermediaries, the central bank keeps records of wholesale transactions; financial intermediaries handle retail transactions and issue indirect CBDC; second, direct CBDC is a claim on the central bank and is

issued by central bank who controls all types of transactions, both wholesale and retail transactions; third, for hybrid CBDC case, the central bank issues CBDC, handles wholesale transactions, and periodically registers retail transactions, while financial intermediaries keep records of retail payments.

**Table 1: Means of payment, their nature and properties**

	Widely accessible	Digital	Central bank issued	Peer-to-peer
Bank deposits	×	×		
Cash	×		×	×
Commodity money	×			×
Virtual currency		×		
Cryptocurrency (permissionless DLT)	×	×		×
Cryptocurrency (permissioned DLT)		×		×
Central bank reserves and settlement accounts		×	×	
Central bank deposited currency accounts	×	×	×	
CBDC (wholesale)		×	×	×
CBDC (retail)	×	×	×	×

Source: Self-made according to World Economic Forum (2019)

**Table 2. Design of CBDCs worldwides**

CBDC	country	officially issued or not	Retail or wholesale	Account-based or value-based	Interest bear or not	Application scenarios (domestic or cross-border payment)
eNaria	Nigeria	Yes	Retail	Account-based	No	Both
Sand Dollar	Bahamas	Yes	Both	Account-based	No	Domestic payments
JAM-DEX	Jamaica	Yes	Both	Value-based	No	Both
e-CNY	China	No	Both	Both	No	Domestic payments
e-krona	Sweden	No	Retail	Both	No	
DCJPY	Japan	No	Both		No	
Digital dollar	US	No	Both	Token-based		
Digital Euro	European Union	No	Both	Both	Could bear interest	Both

Source: self-made

### 3.2 Which technology to activate a CBDC?

Central banks use a mixture of technologies to realize core characteristics of CBDCs, such as security, privacy, stability, universal availability, etc. Blockchain technology and distributed ledger technology (DLT) are popular technologies when we talk about digital currency or CBDCs projects.

### 3.2.1 DLT

DLT is a broader term than blockchain, encompassing technologies that authorize simultaneous access, verification, and unchangeable record of a synchronized ledger within a network (BIS, 2017; Bains, 2020). “Blockchain is a subset of DLT” (Bains 2020, p. 4), and bitcoin is the first to use the “DLT in its blockchain form”. Treiblmaier and Clohessy (2020, p. 5) explained that “distributed ledgers are a type of database that is spread across multiple sites, countries, or institutions, and is typically public. Records are stored one after the other in a continuous ledger, rather than stored into block”. DLT positively influences the financial industry by “(i) reducing complexity; (ii) improving end-to-end processing speed; (iii) decreasing the need for reconciliation across multiple record-keeping infrastructures; (iv) increasing transparency and immutability in transaction record keeping; (v) improving network resilience through distributed data management; and (vi) reducing operational and financial risks” (BIS 2017, p. 1).

### 3.2.2 Blockchain Technology

Blockchain could be defined as serially connected blocks in a distributed system<sup>3</sup> containing entire transaction records, using cryptographic techniques and consensus algorithms, with the main features of security, transparency, and immutability (Ahmed *et al.* 2022; Daskalakis & Georgitseas 2020, p. 10-11). Blockchain is the fundamental technology of cryptocurrencies, widely used in a variety of domains, for instance payment transactions, smart contracts, logistics and supply chain tracking, big data, public sector, voting, anti-money laundering (AML), know your customer (KYC), sharing economy, etc (Daskalakis & Georgitseas 2020, p.17). Many research investigations on CBDC refer to blockchain technology usage, and some even tested blockchain adoption in CBDC (Currency Digital Forum 2021; PWC 2022; Zhang & Huang 2021).

### 3.2.3 Types of DLT arrangements and blockchain

According to BIS (2017), two types of DLT arrangements commonly occur: unrestricted DLT and restricted DLT. Using unrestricted DLT arrangement, participants have full access to the ledger and could use the service and play any role; multiple entities influence the validation and consensus within the network; this unrestricted access model might generate scalability and information security problems (BIS 2017). In contrast, in restricted DLT arrangement, entities have restricted access to the ledger, new participants need permission to access the network. There are three types of restricted DLT arrangement: “(1) one entity maintains and updates the ledger; (2) only approved entities can use the service; entities can be assigned distinct restricted roles; (3) only approved entities can use the service; entities can play any role” (BIS 2017, p. 8).

The classification of blockchains is quite similar to DLT arrangements. According to Ahmed *et al.* (2022) and Zhang and Huang (2021), three types of blockchains materialize: public blockchains, federated or consortium blockchains, and private blockchains:

- Public blockchains: the highest openness level, completely decentralized, anyone has equal right and access to the complete information of the network without permission.
- Federated or consortium blockchains: built by consortia with multiple organizations, medium openness level, less decentralized compared with public blockchains, the new organization needs permission from consortia to access the network. Corda, Ripple, R3 are examples of consortium blockchains.

---

<sup>3</sup> In the distributed systems, each node has a whole record of transactions, connects directly with all the other network nodes, is not controlled by a central authority.



- Private blockchains: controlled by a single organization, the lowest openness level, need permission to access the network, less decentralized compared with consortium blockchains, validators need permission from the creator of private blockchains to access the network.

Based on different design features and requirements, permissioned blockchain/DLT (private blockchain or consortium blockchain) could be more appropriate for CBDCs (BIS 2020; Zhang & Huang 2021).

## 4. Why implement CBDCs?

In an early report published in 2017, the *Committee on Payments and Market Infrastructures* of the BIS defined a list of reasons justifying the implementation of CBDCs. Namely, CBDCs should provide a “continued access to central bank money, increase payments diversity, encourage financial inclusion, improve cross-border payments, support public privacy, and facilitate fiscal transfers” (BIS 2017, p. 10-11). Nothing revolutionary in this extensive list, but rather a series of small benefits. The counterpart to these small advantages, the low costs attached to CBDCs aids in encouraging hesitant institutions; “one crucial advantage of an account-based system is that CBDC payments could be practically instantaneous and costless” (Bordo & Levin 2017, p. 8). The pros began to outnumber the cons in 2018. 63 central banks answered in 2018 to a survey proposed by Barontini, and Holden (2019). For all types of CBDCs, safety, efficiency, and stability of the payment system seemed to dominate as motives of adoption. In the case of general-purpose CBDCs, financial inclusion constituted an additional objective, as well as possibility to improve cross-border payments for wholesale CBDCs. New motives then emerged in late 2019. CBDCs “ensure public access to legal tender if cash were phased out and improve the efficiency of payment systems [but also organize the] transition towards a less-cash society, and [are in] competition from private e-money” (Ward & Rochemont 2019, p. 9-10). The still greater pressure exerted by FinTech on banking systems, the emergence of stable coins among cryptocurrencies (Tether, USD coin, etc) or proposed by Internet major content providers (Libra project), appealed an adapted reaction of central banks. The contactless revolution of the Covid-era appears to have catalyzed the acceleration of such projects, with an updated objective which appeals a detailed analysis.

Starting from 2020, five objectives to issue CBDCs dominate the debate. Two of the five could be considered as classical, each with a negative counterpart: (i) making the payment system more efficient without endangering the banking industry, (ii) improving the security of payments without making the financial system more unstable. The other three objectives, though seemingly of secondary importance, also merit attention, namely (iii) working to promote cross-border payments in domestic currencies, (iv) answering to the development of private stable coins, and (v) offering also, in partnership with banks, alternatives to the mobile payment solutions developed by FinTech.

### 4.1. Efficiency gains and risk of disintermediation

Almost all central banks promoting the adoption of CBDCs consider that reducing operational costs of the system of payment ultimately increases the efficiency of exchanges and general economic interactions. Such gains represent an appealing proponent to many central banks, such as the Bank of England (Barrdear & Kumhof 2016; Bank of England 2020), the Bank of India (Priyadarshini & Kar 2021, p. 7) or the Bank of Nigeria (Central Bank of Nigeria 2021). Outside central banks, the search for efficiency gains is also considered an essential operational and economic aspect (Bindseil 2019; Barontini & Holden 2019; Nájuez Alonso *et al.* 2020; Davoodalhosseini 2021; Assenmacher *et al.* 2021).

If a blockchain activates a CBDC, the role of banks would be bypassed entirely (Priyadarshini & Kar 2021, p. 5). CBDCs could also improve the capacity of central banks to control monetary aggregates and simplify monetary policy; they should have “a disciplining effect on commercial banks” (Berentsen & Schär 2018, p. 101). However, increased fragility of the banking sector would result, creating possible competition between the two forms of the official currencies, a recessionist decrease of the credit multiplier (Bofinger & Haas 2020), and an increase in refinancing cost. These dangers are understood and integrated into the Chinese project through the so-called “two-tiered” system: “the



central bank exclusively supplies the public the central bank money or base money (i.e., banknotes and central bank deposits), and commercial banks provide deposits through credit creation based on the base money.” (Amamiya 2018, p. 3). Finally, the Chinese version of CBDC (which currently remains to be a more advanced version compared to other CBDC projects) intentionally limits the role of the central bank. In this system, the central bank “does not have any direct transaction with consumers, and only acts as the lender of last resort for commercial banks, whereas commercial banks act as an intermediary by attracting consumers for deposits and offering financial services based on deposits”. (Shen & Hou 2021, p. 4). “The DCEP [Digital Currency Electronic Payment] issued directly by the central bank suggests direct transactions between financial users and the PBOC and hence the disintermediation of financial institutions” (Ibid. p. 6). “In addition, the PBOC has unambiguously required a 100% reserve rate for financial institutions [...]. In other words, the issuance of RMB 1 in DECP is backed by RMB 1 at the PBOC” (Shen & Hou 2021, p. 6). The counterpart in the non-digital currency for each secondary bank that issues in digital currency is 1 to 1 in the Chinese case, which secures the system but does not encourage banks to issue them.

## 4.2. Security gains and Risk of Instability

Safety and security constitute additional objectives of central banks when planning to implement CBDCs (Auer et al. 2021): “the traceability and potential program ability of a digital currency [...] enhance central bank supervision and the government’s control over money flows and financial activities. These two features of DCEP could help combat illicit financial activities, such as corruption, fraud, money laundering, terrorist financing, and tax evasion. However, they may potentially intensify government monitoring of society” (Knoerich 2021, p. 151). Bofinger and Haas (2020) cautiously distinguish the different versions of CBDCs (wholesale versus retail, store of value versus means of payment). The store of value version corresponds to a possible CBDC available for a large public of users, though not admitted in payments. It works as a sort of central bank deposit rather than a currency. This version could offer a safer alternative for storing liquidities, although still dominated in standard time in terms of returns by other secure liquid bonds. However, as attested by the monetary history of the United States during the 19<sup>th</sup> century, the fragmentation of reserves does not make the payment system more secure.

The key question is whether a more secure payment system in normal circumstances remains so in a pre-crisis period, particularly during a banking crisis. Using a theoretical extension of Champ *et al.* (1996) Kim and Kwon (2019) from the Bank of Korea find ambiguous results: “an increase in the quantity of CBDC can increase the likelihood of bank panic by reducing the supply of private credit, which raises nominal interest rate and lowers a commercial bank's reserve-deposit ratio. However, once the central bank can lend all the deposits in CBDC account to commercial banks, an increase in the quantity of CBDC can improve financial stability by reducing the likelihood of bank panic via an increase in the supply of private credit” (Kim and Kwon, 2019, p. 5). Kumhof and Noone (2021) study how CBDCs affect the size and composition of commercial bank balance sheets, considering situations in which the provision of credit to borrowers and the provision of liquidity to depositors are not necessarily curtailed. They conclude that the risk of instability could be controlled, though they confirm that the risk is not of secondary importance. Keister and Monnet share the views of Kumhof and Noone. “The incentives of bank creditors to withdraw funding also depends critically on what sort of policy response they expect if a run develops. If the CBDC also allows the policy maker to react more quickly to an incipient crisis, its net effect can increase rather than decrease financial stability” (Keister & Monnet 2020, p. 3). This discussion argues for the adoption of a wholesale CBDC which would remain under the control of banks and central banks and should decrease and not increase the risk of runs.

## 4.3. International motives

The Central Bank of China, but also the ECB and the Bank of England defend or have defended the idea that implementing CBDCs could improve cross-border payments. Two versions of the same argument are usually presented.

Improving the means of providing domestic currency among competitive international currencies represents a primary motive for central banks. The People Bank of China announced this objective: China expects to offer trading partners simplified payment methods - that is, direct transactions denominated in RMB can take place without involving a third-party currency exchange (US dollar in this case). Conducting transactions in this way eliminates the need to incur the cost of currency exchange, further streamlining imports and exports for China and its trading partners. In addition, the Chinese government could use its influence in the international market to accelerate the process of dethroning the US dollar. “China is trying to take advantage of a first-mover strategy and leverage its position to promote the invoicing of trade in digital yuan.” (Aysan & Kayani 2022, p. 2; Hoffman *et al.* 2020; Shen & Hou 2021; Knoerich 2022). Commercial partners in China could also use DCEP for standard payments and transactions (Lopez 2020; Wang 2022).

The Bank of England prefers to speak of interoperability between different CBDCs at the international level: “Central banks may work together to link domestic CBDCs in a way that enables fast and efficient cross-border payments. Individual domestic CBDCs could have a design conducive to a common set of standards to support interoperability. This might enable ‘atomic’ transactions between CBDC systems: where the transfer of CBDC in one currency is linked with a transfer of CBDC in another currency, in a way that ensures each transfer occurs if - and only if - the other does.” (Bank of England 2020, p. 19). For ECB, a CBDC would be a way to “overcome the existing fragmentation and to recover the ECB’s catalytic role in promoting Europe-wide initiatives in a market that is highly dynamic, but mostly at the local level.” (Passacantando 2021, p. 120).

Auer and Boehme (2020, p. 9) propose three different scenarios to build an International Central Bank Digital Currency, ranging from providing an additional means to settle transactions among markets to a more advanced integration of international transfers. This last case seems, however, to suppose that the currencies associated with the arrangement would be linked by fixed or quasi-fixed exchange rates, like the Saudi riyal and UAE dirham that they take as examples. In these countries, local currency is anchored to the US dollar at a specific rate and are *de facto* linked by fixed exchange rates. Lastly, literature (Khiaonarong & Humphrey 2022; Torre & Xu 2022) also points out the role and advantages of CBDC for small cross-border transfers, particularly remittances.

#### 4.4. An alternative to stable coins

Standard crypto-assets/currencies are neither competitors nor a danger to central banks: their use is highly appreciated by speculators but few companies accept them as payment and few central banks as reserve currency or asset: their volatility is far too high, just the opposite of what is required of an international reserve currency. But crypto-currencies ecosystem needed at some point risk-free assets that could neutralize for a few hours or longer the positions of speculative crypto holders. Stable coins were introduced, using various financial hedging strategies to target a stable value against an announced reference, for the most international currencies. Tether (one of the most significant capitalizations of crypto-assets), USD Coin, Binance USD, and Dai belong to this family of crypto-assets. For the moment, though mainly utilized by crypto-asset holders wishing to neutralize their position momentarily, this category of crypto-currencies, given their relative opacity, could also serve other and various purposes. If sufficiently resilient, stable coins could attract many holders, presenting a possible reserve asset for individuals, financial intermediaries, or institutions reluctant to hold international currencies or sovereign bills and bonds labeled in reserve currencies. Therefore, “the official opinion of the Bank of England [...] is that CBDC should become the response of central banks to the development of stable coins by large technology companies.” (Volkova *et al.* 2020, p. 633). Tacitly, protecting the economy against tax evasion and money laundering, as facilitated by cryptocurrencies, represents a primary motive for many institutions. Another would be “to overcome the volatility risks of an asset without backing and without intrinsic value” (Náñez Alonso 2020, p. 10).

The defunct Libra/DIEM project promoted by Facebook has posed an even more dangerous competitor for central banks (Allen *et al.* 2022). The holders of Libra/DIEM would have been not mainly speculators attracted by the rapid gains of cryptocurrencies but a large population interested in the

initiatives/commercial offers of Facebook, free of any constraint related to the borders. The conversion of any currency into Libra would not have been a problem for holders of currencies or secondary importance, who are more usually attracted by conversions into dollars or other international currencies. Another problem is that savings accounts and cash managed by digital companies would have given them a systemic financial position. “a wide use of stable coin on a global scale could transform financial stability from a public good into a common-pool resource” (Kuroda 2019. p. 5). A shared view of central bankers and governments was then to regulate private stable coins (Zetsche *et al.* 2021) and to hurry the implementation of CBDCs, as public substitutes to Libra/DIEM (Shen and Hou, 2021, Aysan & Kayani, 2022). The Bank of England expressed, “stable coins will only be widely adopted if they provide functionality and efficiency benefits over existing payment systems. But given the risks they could pose; it may be worth asking if CBDC can be designed to better meet those needs.” (Bank of England 2020, p. 17).

## 4.5. The FinTech issue

Stable coins and Libra present a problem for all categories of central banks. FinTech, the success of which has led to immense financial activity, specifically poses a threat for the Central Bank of China. According to the report of Merchant Savvy (2022), China was the leader in mobile payments in 2021, with 87.3% of the population declaring using mobile contactless payment methods, compared with 45.6% of people in South Korea, 34.9% in Japan, 29.1% in Canada, 24.4% in the UK, 21.1% in France and 19% in Germany. For various motives, including the size of the Alibaba and Tencent groups, the rapid expansion and uneven competition with traditional banking sectors have prompted the Chinese Government to attempt to stifle its growing influence since 2018.

In 2018, the establishment of the NetsUnion Clearing Corporation in China prevented platforms from receiving banks’ remuneration for temporarily held payments (Shen & Hou 2021, p. 10). Alibaba accounted for around 11% of the market in China, causing authorities and financial stakeholders to fear that Alibaba could issue its own currency. In this circumstance, the Chinese CBDC would have played the role of an incumbent, with an installed base of service of payment users, aiming to protect the market from the uncontrolled dynamism of new entrants. “Regulation changes requiring Alipay and WeChat Pay deposits to be moved into PBoC accounts mean[t] that the PBoC has already clawed back a fair degree of oversight and control over funds held by those platforms.” (Hoffman et al. 2020 p. 17)

In February 2020, “the Shanghai and Hong Kong Stock Exchange suspended the much-anticipated IPO of Ant Financial, following the expression of ‘concern about excess leverage and abuse of consumer data’ by the government of China, an alleged practice that has surfaced in other jurisdictions, with other organizations and other governments” (Goodell & Al-Nakib 2021, p. 2). From this moment, commentators tended to consider that “the DCEP will be probably used as an instrument for small or medium scale payment in competition with mobile payment internally and with third party online payment externally” (Shen & Hou 2021, p. 10).

## 5. Conclusion

Arauz and Garratt (2021) relate in a passionate article the recent monetary history of Ecuador, which experienced severe inflation in the late 1990, peaking at +96% in 2000. The Treasury defaulted on its Brady bonds issues<sup>4</sup> and quickly became short of funds. The government then decided to keep the US dollar as domestic currency in an economy already widely *de facto* dollarized. This choice instantaneously stopped inflation and allowed the country to return to growth and solvency. From 2008, the government began to gain monetary autonomy by various means. First, it issued low-denomination bonds that could be used as payment, but the initiative remained unsuccessful. Then it tried to set up a

---

<sup>4</sup> Brady bonds are bonds backed by US treasury bonds and denominated in US dollars frequently used by Latin American countries during this time.

system of monetizing net claims, which eventually had to be abandoned for legal reasons. The central bank mobile money was the third initiative. The system was launched in early 2014. Creating a digital xeno-dollar had the advantage of avoiding the problems of converting at demand dollar-denominated accounts into bank notes, which requires the country to have a structural balance of payments surplus to provide a sufficient level of liquidity to the market. With a digital currency, the conversion constraint would disappear, and the country would be able to keep the name of dollar for its currency without having to depend on the Fed to obtain cash. Technically speaking, it was decided to use a very low-cost technology, namely, the USSD technology already adopted by Vodaphone and its African competitors to implement m-payment solutions in East African countries. Nevertheless, after a rapid take-off, the system stagnated and finally collapsed abruptly in March-April 2018.

Ecuador was a small country without practical experience of central banking. However, even for major central banks, how to innovate in monetary organization is not obvious. Where none of the motives mentioned in section 5 appear to be relevant from a national or regional point of view, the financial authorities still do not consider it reasonable to accelerate the implementation of a CBDC. Accordingly, the Federal Reserve System's Deputy Governor Christopher Waller expressed in Summer 2021: "What problem would a CBDC solve? Alternatively, what market failure or inefficiency demands this specific intervention? After careful consideration, I am not convinced that a CBDC would solve any existing problem that is not being addressed more promptly and efficiently by other initiatives." (Waller 2021, p. 2). But what is the right choice for the dollar and the US financial system is not systematically the right choice for all currencies and all financial systems around the world.

Despite most central banks being engaged in CBDC research and pilots, until now, no major central bank has officially issued a CBDC. Each one still faces challenges in the design of CBDCs and possible technology implications. But for many of them, the decision relies on economic grounds and must solve the trade-off between the benefits of modernizing the payment system, its capacity to respond to private initiatives, and the uncertainties that the new currency would bring to bear on the resilience of the banking intermediation system, particularly if it is not limited to wholesale transactions. China's next moves will provide an important clue to the future of partner banks' initiatives.

## References

- Ahmed G. Gad, Diana T. Mosa, Laith Abualigah, Amr A. Abohany 2022, 'Emerging Trends in Blockchain Technology and Applications: A Review and Outlook', *Journal of King Saud University - Computer and Information Sciences*, ISSN 1319-1578, <https://doi.org/10.1016/j.jksuci.2022.03.007>.
- Allen, F, Gu, X & Jagtiani, J 2022, 'Fintech, Cryptocurrencies, and CBDC: FinancialStructural Transformation in China', *Journal of International Money and Finance*, 124, 102625.
- Assenmacher, K, Berentsen, A, Brand, C & Lamersdorf, N 2021, 'A unified framework for CBDC design: remuneration, collateral haircuts, and quantity constraints', *ECB Working Paper*, July. Working Paper No. 2578
- Amamiya, M 2018, 'The Future of Money', Lecture at the Japan Society of Monetary Economics, Tokyo, October 20.
- Arauz, A & Garratt, R 2021, 'Dinero Electrónico: The rise and fall of Ecuador's central bank digital currency', *Latin American Journal of Central Banking*, 2(2), 100030.
- Auer, R & Boehme, R 2020, 'The technology of retail central bank digital currency', *BIS Quarterly Review*, pp. 85-100 March,
- Auer, R, Frost, J, Gambacorta, L, Monnet, C, Rice, T & Shin, H S 2021, 'Central bank digital currencies: motives, economic implications and the research frontier', *Annual Review of Economics*.
- Atlantic Council 2022, 'Central Bank Digital Currency Tracker', viewed 4 April 2022, <https://www.atlanticcouncil.org/cbdctracker/>

Aysan, A F & Kayani, F N 2022, 'China's transition to a digital currency does it threaten dollarization?', *Asia and the Global Economy*, 2(1), 100023.

Bains, P 2020, 'Blockchain Consensus Mechanisms. A Primer for Supervisors', *Etats Unis: International Monetary Fund*.

Bank of England 2020, 'Central Bank Digital Currency—Opportunities, Challenges and Design', Discussion Paper, March.

Bank for International Settlements 2017, '*Distributed ledger technology in payment, clearing and settlement. An analytical framework*', CPMI, ISBN 978-92-9259-031-4, <https://www.bis.org/cpmi/publ/d157.pdf>

Bank for International Settlements 2018, '*Central bank digital currencies*', CPMI, Markets Committee Papers, No 174, <https://www.bis.org/cpmi/publ/d174.pdf>

Bank for International Settlements 2020, 'Central bank digital currencies: foundational principles and core features', <https://www.bis.org/publ/othp33.pdf>

Bank for International Settlements 2021a, '*Central Banks and the BIS Explore What a Retail CBDC Might Look Like*', press release, September 2021, <https://www.bis.org/press/p210930.htm>

Banks for International Settlements 2021b, '*Covid-19 accelerated the digitalisation of payments*', viewed 12 May 2022, [https://www.bis.org/statistics/payment\\_stats/commentary2112.htm#graph2](https://www.bis.org/statistics/payment_stats/commentary2112.htm#graph2)

Banks for International Settlements 2022, '*Project Helvetia: A multi-phase investigation on the settlement of tokenised assets in central bank money*', <https://www.bis.org/publ/othp45.pdf>

Bank of Canada 2017, '*Project Jasper Primer*', [https://www.payments.ca/sites/default/files/project\\_jasper\\_primer.pdf](https://www.payments.ca/sites/default/files/project_jasper_primer.pdf)

Bank of Canada 2020, '*Bank of Canada partners with the Bank for International Settlements to launch innovation centre*', <https://www.bankofcanada.ca/2020/06/bank-canada-partners-bank-international-settlements-launch-innovation-centre/>

Bank of Canada 2022, '*Bank of Canada and Massachusetts Institute of Technology announce joint Central Bank Digital Currency collaboration*', viewed 12 April 2022, <https://www.bankofcanada.ca/2022/03/central-bank-digital-currency-collaboration/>

Bank of Canada n.d., 'Central bank digital currency (CBDC)', <https://www.bankofcanada.ca/research/digital-currencies-and-fintech/projects/central-bank-digital-currency/#:~:text=Simply%20put%2C%20a%20CBDC%20is,able%20to%20be%20used%20online>

Bank of England 2020, 'Central Bank Digital Currency - Opportunities, Challenges and Design', March 2020, Discussion Paper, <https://www.bankofengland.co.uk/paper/2020/central-bank-digital-currency-opportunities-challenges-and-design-discussion-paper>

Banque de France 2021a, '*Digital Euro experiment Combined feasibility – Tiered model*', July 2021, [https://www.banque-france.fr/sites/default/files/media/2021/08/02/821220\\_digital\\_euro\\_en.pdf](https://www.banque-france.fr/sites/default/files/media/2021/08/02/821220_digital_euro_en.pdf)

Banque de France 2021b, '*Wholesale Central Bank Digital Currency experiments with the Banque de France*', November 2021, [https://www.banque-france.fr/sites/default/files/media/2021/11/09/821338\\_rapport\\_mnbc-04.pdf](https://www.banque-france.fr/sites/default/files/media/2021/11/09/821338_rapport_mnbc-04.pdf)

Bank of Japan 2020, 'The Bank of Japan's Approach to Central Bank Digital Currency', [https://www.boj.or.jp/en/announcements/release\\_2020/data/rel201009e1.pdf](https://www.boj.or.jp/en/announcements/release_2020/data/rel201009e1.pdf)

Bank of Japan 2021, 'Commencement of Central Bank Digital Currency Experiments', [https://www.boj.or.jp/en/announcements/release\\_2021/rel210405b.pdf](https://www.boj.or.jp/en/announcements/release_2021/rel210405b.pdf)

Bank of Japan 2022, 'Commencement of Central Bank Digital Currency Experiments (Proof of Concept Phase 2)', [https://www.boj.or.jp/en/announcements/release\\_2022/rel220325f.pdf](https://www.boj.or.jp/en/announcements/release_2022/rel220325f.pdf)

Barrdear, J & Kumhof, M 2016, 'The macroeconomics of central bank issued digital currencies'. *Bank of England Staff Working Paper* No. 605.

Barontini, C & Holden, H 2019, 'Proceeding with Caution - A Survey on Central Bank Digital Currency', *BIS Papers*, 101.

Berentsen, A & Schär, F 2018, 'The case for central bank electronic money and the non-case for central bank cryptocurrencies', *Federal Reserve Bank of St. Louis Review*, 100(2), pp. 97-106.

Bindseil, U 2019, 'Central bank digital currency: Financial system implications and control', *International Journal of Political Economy*, 48(4), 303-335.

Bofinger, P & Haas, T 2020, 'CBDC: A systemic perspective (No. 101)', WEP-Würzburg Economic Papers.

Board of Governors of the Federal Reserve System 2022, 'Money and Payments: The U.S. Dollar in the Age of Digital Transformation', <https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf>

Bordo, M D & Levin, A T 2017, 'Central bank digital currency and the future of monetary policy (No. w23711)', National Bureau of Economic Research.

Central Bank of Nigeria 2021, 'Design Paper for the eNaira', [https://enaira.com/download/eNaira\\_Design\\_Paper.pdf](https://enaira.com/download/eNaira_Design_Paper.pdf)

Champ, B, Smith, BD & Williamson, S D 1996, 'Currency Elasticity and Banking Panics: Theory and Evidence', *Canadian Journal of Economics*, 29, 828-864.

Chiu, J, Sablik, T & Wong, R 2021, 'Should Central Banks Worry About Facebook's Diem and Alibaba's Alipay?', *Richmond Fed Economic Brief*, May, 21-17.

Currency Digital Forum 2021, 'Digital Currency DCJPY White Paper', [https://www.decurret-dcp.com/assets/forum\\_20211124wp\\_en.pdf](https://www.decurret-dcp.com/assets/forum_20211124wp_en.pdf)

Daskalakis, N & Georgitseas, P 2020, 'An Introduction to Cryptocurrencies: The Crypto Market Ecosystem', Routledge.

Davoodalhosseini, S M 2021, 'Central bank digital currency and monetary policy', *Journal of Economic Dynamics and Control*, 104150.

Digital dollar foundation 2020, 'The digital dollar project - Exploring a US CBDC', [http://digitaldollarproject.org/wp-content/uploads/2021/05/Digital-Dollar-Project-Whitepaper\\_vF\\_7\\_13\\_20.pdf](http://digitaldollarproject.org/wp-content/uploads/2021/05/Digital-Dollar-Project-Whitepaper_vF_7_13_20.pdf)

European Central Bank & Bank of Japan 2017, 'BOJ/ECB joint research project on distributed ledger technology', [https://www.ecb.europa.eu/paym/intro/news/shared/20170906\\_stella\\_report\\_leaflet.pdf](https://www.ecb.europa.eu/paym/intro/news/shared/20170906_stella_report_leaflet.pdf)

European Central Bank 2019, 'Third phase of Stella project completed', <https://www.ecb.europa.eu/paym/intro/news/html/ecb.mipnews190604.en.html>

European Central Bank 2020, 'Report on a digital Euro', [https://www.ecb.europa.eu/pub/pdf/other/Report\\_on\\_a\\_digital\\_euro~4d7268b458.en.pdf](https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro~4d7268b458.en.pdf)

European Central Bank 2021, 'Eurosysteem launches digital euro project', <https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210714~d99198ea23.en.html>



- European Central Bank & Bank of Japan 2020, '*Balancing confidentiality and auditability in a distributed ledger environment*', [https://www.ecb.europa.eu/paym/intro/publications/pdf/ecb.miptopical200212\\_01.en.pdf](https://www.ecb.europa.eu/paym/intro/publications/pdf/ecb.miptopical200212_01.en.pdf)
- Goodell, G & Al-Nakib, H D 2021, 'The Development of Central Bank Digital Currency in China: An Analysis', Available at SSRN 3906358.
- Grym. A 2020, 'Lessons learned from the world's first CBDC', *Bank of Finland Economics Review*, 8.
- Hoffman, S, Garnaut, J, Izenman, K, Johnson, M, Pascoe, A, Ryan, F, & Thomas, E 2020, '*The flipside of China's central bank digital currency*', Canberra: Australian Strategic Policy Institute.
- Keister, T & Monnet, C 2020, 'Central bank digital currency: Stability and information', Unpublished, Rutgers University and University of Bern. [https://sammf.com/wp-content/uploads/2020/10/6\\_paper\\_Keister-Monnet.pdf](https://sammf.com/wp-content/uploads/2020/10/6_paper_Keister-Monnet.pdf)
- Khiaonarong, T., & Humphrey, D. 2022, 'Falling Use of Cash and Demand for Retail Central Bank Digital Currency', IMF Working Paper 22/27.
- Kim, Y S & Kwon, O 2019, 'Central bank digital currency and financial stability', Bank of Korea WP, 6.
- Knoerich, J 2021, 'China's New Digital Currency: Implications for Renminbi Internationalization and the US Dollar', in Bilotta, N., & Botti, F. (2021). *The (near) future of central bank digital currencies: risks and opportunities for the global economy and society*, op. cit. pp. 145-166.
- Kristalina, G. 2022, '*The Future of Money: Gearing up for Central Bank Digital Currency*', Washington DC, IMF Speech, February 9, <https://www.imf.org/en/News/Articles/2022/02/09/sp020922-the-future-of-money-gearing-up-for-central-bank-digital-currency>
- Kuroda, H. 2019, 'Payments innovations and the role of central banks: Addressing challenges posed by stablecoins', Speech at the Symposium for the 35<sup>th</sup> Anniversary of the Center for Financial Industry Information Systems. Bank of Japan. December 4<sup>th</sup>.
- Kumhof, M & Noone, C 2021, 'Central bank digital currencies - Design principles for financial stability', *Economic Analysis and Policy*, 71, 553-572.
- Lopez, C 2020, 'Digital Currency: A Global Regulatory Framework is Needed', in S. Rochemont, *A Cashless Society in 2019*. Institute and Faculty of Actuaries. <https://www.actuaries.org.uk/system/files/field/document/A%20Cashless%20Society%20in%202019.pdf>
- Merchant Savvy 2022, 'Adoption Of Mobile Contactless Payments Increased Globally', <https://www.merchantsavvy.co.uk/mobile-payment-stats-trends/>
- Mersch Y. 2017, '*Digital Base Money: an assessment from the ECB's perspective*', Speech Helsinki, 16 January 2017, <https://www.ecb.europa.eu/press/key/date/2017/html/sp170116.en.html>
- Náñez Alonso, S. L., Echarte Fernández, M. Á., Sanz Bas, D., & Kaczmarek, J. 2020, 'Reasons fostering or discouraging the implementation of central bank-backed digital currency: A review', *Economies*, 8(2), 41.
- Noriyuki, Y & Hiromi, Y 2019, 'Digital Innovation, Data Revolution and Central Bank Digital Currency', Bank of Japan Working Paper Series, No.19-E-2.
- Panetta, F 2022, '*Central bank digital currencies: defining the problems, designing the solutions*', Member of the Executive Board of the ECB, to a panel discussion on central bank digital currencies at the US Monetary Policy Forum, 18 February 2022, [https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220218\\_1~938e881b13.en.html](https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220218_1~938e881b13.en.html)



- Passacantando, F 2021, 'The Digital Euro: Challenges and Opportunities', in Bilotta, N., & Botti, F. *The (near) future of central bank digital currencies: risks and opportunities for the global economy and society*, op. cit. pp. 113-130.
- Payments Canada, Bank of Canada & R3 2017, 'Project Jasper: A Canadian Experiment with Distributed Ledger Technology for Domestic Interbank Payments Settlement', [https://www.payments.ca/sites/default/files/29-Sep-17/jasper\\_report\\_eng.pdf](https://www.payments.ca/sites/default/files/29-Sep-17/jasper_report_eng.pdf)
- People's Bank of China 2022, 'The overall operation of the payment system in 2021', [http://www.gov.cn/xinwen/2022-04/03/content\\_5683319.htm](http://www.gov.cn/xinwen/2022-04/03/content_5683319.htm)
- Pilkington Marc 2022, 'De Libra 1.0 à Libra 2.0 (Diem) : entre échec programmé et pertinence renouvelée pour l'économie politique', *Revue d'Economie Politique*, 132-3, pp. 397-420.
- Priyadarshini, D & Kar, S 2021, 'Central bank digital currency (CBDC): critical issues and the Indian perspective', IEG Working Paper, N° 444.
- PWC 2021, '*Monnaies digitales de banque centrale : vers une adoption mondiale. Enjeux des nouvelles infrastructures monétaires et opportunités pour les entreprises*', viewed 11 April 2022, <https://vu.fr/vzUe>
- PWC 2022, 'PwC global CBDC index and stablecoin overview 2022', <https://www.pwc.com/gx/en/new-ventures/cryptocurrency-assets/pwc-global-cbdc-index-stablecoin-overview-2022.pdf>
- Shen, W & Hou, L 2021, 'China's central bank digital currency and its impacts on monetary policy and payment competition: Game changer or regulatory toolkit?', *Computer Law & Security Review*, 41, 10557
- Sveriges Riksbank 2017, '*The Riksbank's e-krona project: Report 1*', [https://www.riksbank.se/globalassets/media/rapporter/e-krona/2017/rapport\\_ekrona\\_uppdaterad\\_170920\\_eng.pdf](https://www.riksbank.se/globalassets/media/rapporter/e-krona/2017/rapport_ekrona_uppdaterad_170920_eng.pdf)
- Sveriges Riksbank 2018, '*The Riksbank's e-krona project: Report 2*', <https://www.riksbank.se/globalassets/media/rapporter/e-krona/2018/the-riksbanks-e-krona-project-report-2.pdf>
- Sveriges Riksbank 2021, '*E-krona pilot Phase 1*', <https://www.riksbank.se/globalassets/media/rapporter/e-krona/2021/e-krona-pilot-phase-1.pdf>
- Sveriges Riksbank 2022, '*E-krona pilot Phase 2*', <https://www.riksbank.se/globalassets/media/rapporter/e-krona/2022/e-krona-pilot-phase-2.pdf>
- Torre, D & Xu, Q 2019, 'La Chine aux avant-postes de la digitalisation des paiements', *Revue d'économie financière*, 2019/3 (N° 135), 99–114.
- Torre, D & Xu, Q 2020, 'Digital payment in China: adoption and interactions among applications', *Revue d'Economie Industrielle*, 172(4), 55–82, <https://doi.org/10.4000/rei.9471>
- Torre, D & Xu, Q 2022, 'Remittances, telephonic operators, Fintechs and Central Bank Digital Currencies', *Digital Economics Summer (3EN)*, 8<sup>th</sup> Edition, Louvain la Neuve, July.
- Treiblmaier H. & Clohessy T 2020, 'Blockchain and Distributed Ledger Technology Use Cases: Applications and Lessons Learned', Germany: Springer International Publishing
- Uchida S. 2022, 'Possible Design Choices of CBDC. Opening Remarks at the Third Meeting of the Liaison and Coordination Committee on Central Bank Digital Currency', Bank of Japan Speech, [https://www.boj.or.jp/en/announcements/press/koen\\_2022/ko220413b.htm/](https://www.boj.or.jp/en/announcements/press/koen_2022/ko220413b.htm/)

Volkova, T G, Sevryugin, Y V, & Firsova, S N 2020, 'Central bank digital currencies as the instrument of national economic sovereignty consolidation', In Proc., 2nd Int. Scientific and Practical Conf. 'Modern management trends and the digital economy: From regional development to global economic growth' (MTDE 2020), May. pp. 632-637.

Waller, C J 2021, 'CBDC: A solution in search of a problem', Speech at the American Enterprise Institute. August 5.  
<https://www.federalreserve.gov/newsevents/speech/files/waller20210805a.pdf>

Wang, H 2022, 'China's Approach to Central Bank Digital Currency', Available at SSRN.  
[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4036466](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4036466)

Ward, O & Rochemont, S 2019, 'Understanding Central Bank Digital Currencies (CBDC)', Institute and Faculty of Actuaries.  
<https://www.actuaries.org.uk/system/files/field/document/Understanding%20CBDCs%20Final%20-%20disc.pdf>

Working Group on E-CNY Research and Development of the People's Bank of China 2021, 'Progress of Research & Development of E-CNY in China',  
<http://www.pbc.gov.cn/en/3688110/3688172/4157443/4293696/2021071614584691871.pdf>

World Economic Forum 2019, 'Central Banks and Distributed Ledger Technology: How are Central Banks Exploring Blockchain Today?',  
[http://www3.weforum.org/docs/WEF\\_Central\\_Bank\\_Activity\\_in\\_Blockchain\\_DLT.pdf](http://www3.weforum.org/docs/WEF_Central_Bank_Activity_in_Blockchain_DLT.pdf)

Xu, Q 2022, 'East Asia and East Africa: Different Ways to Digitalize Payments', in Ratajczak-Mrozek M., & Marszałek, P. (eds.), *Digitalization and Firm Performance. Examining the Strategic Impact.*, Palgrave MacMillan.

Zetzsche, D. A., Buckley, R. P., & Arner, D. W. 2021, 'Regulating Libra', *Oxford Journal of Legal Studies*, 41(1), 80-113.

Zhang T & Huang Z. 2021, 'Blockchain and central bank digital currency', *ICT Express*, ISSN 2405-9595, <https://doi.org/10.1016/j.icte.2021.09.014>.