Central Bank Digital Money (CBDC): A Literature Review

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Abstract
Money has taken many forms over the centuries, evolving with the sophistication of societies. Today, the way people use money is once again changing due to new technologies, the digitization of economic exchanges and the rise of crypto-currencies since the appearance of Bitcoin in 2009. To accompany this movement and to take better advantage of new technologies to ensure their traditional missions, central banks are engaged in reflections on the issuance of their own digital currency: the Central Bank Digital Currency (CBDC). This paper provides a framework for determining the characteristics of CBDC by comparing them with those of fiat and non-cash money, the obstacles to issuing CBDC, and the experiences of some countries in this area.

Keywords: money, central bank digital currencies (CBDC), central bank, crypto currency.


Monnaie numérique de la Banque centrale (CBDC) : Une revue de la littérature

Résumé
L'argent a pris de nombreuses formes au cours des siècles, évoluant avec la sophistication des sociétés. Aujourd'hui, la façon dont les gens utilisent l'argent change à nouveau en raison des nouvelles technologies, de la numérisation des échanges économiques et de l'essor des crypto-monnaies depuis l'apparition du Bitcoin en 2009. Pour accompagner ce mouvement et mieux tirer parti des nouvelles technologies pour assurer leurs missions traditionnelles, les banques centrales sont engagées dans des réflexions sur l'émission de leur propre monnaie numérique : la Central Bank Digital Currency (CBDC). Ce document fournit un cadre pour déterminer les caractéristiques des CBDC en les comparant à celles de la monnaie fiduciaire et non monétaire, les obstacles à l'émission de CBDC et les expériences de certains pays dans ce domaine.

Mots-clés : monnaie, monnaies numériques de banque centrale (CBDC), banque centrale, crypto-monnaie.

Introduction
The main objective of central banks is to regulate and stimulate the economy in order to maintain stability. As crypto currency mining accelerates, a very significant portion of transactions in the jurisdiction of central banks consist of alternatives to central bank-controlled fiat currency. This transformation could limit their ability to use monetary policy effectively and could threaten their ability to regulate the economy. This concern is growing as private companies seek to make their own crypto currencies.

The central bank is very often seen as a reactive, slow, and well-calculated, low-risk decision-making institution, however the rapid rise of crypto currencies has fueled inquiries into the likelihood of introducing a central bank digital currency (CBDC).

In this context, a CBDC would be a more reliable public alternative to the proliferation of private crypto currencies which could erode the demand for base money and impact the effectiveness of monetary policy mechanisms.

Without trying to cover the entire spectrum of the subject, considered so vast, we attempt through this article to present a review of the literature on central bank digital currency (CBDC). The objective is to deal the different characteristics of CBDC and compare them to existing payment options. Also, show some obstacles of the introduction of this form of currency, and the experiences of some countries in this field.

1. Forms of money and their characteristics
Economists define money (also called the money supply) as anything that is generally accepted in payment for goods or services or for the repayment of debts (Mishkin, 2013).

Throughout history and at different times in space, money has taken extremely varied forms of monetary instruments. Then gradually, economic agents sought to design monetary instruments that were easier to use (Deplace, 2017).

These different forms of money had in common that they fulfilled, satisfactorily, the three main functions that economics textbooks attribute to money savings (Quignon, 2020), it is an intermediary of exchanges, a unit of account and store of value:

- **Intermediary of exchanges**: Money serves as an intermediary of exchanges in almost all market transactions in modern economies: in the form of cash or checks, it is used to pay for the goods and services that we buy (Mishkin, 2013).
- **Unit of account**: Money is an instrument for measuring the value of goods, it simplifies the price system. By this, it facilitates market exchange, and, at the same time, the measurement of economic magnitudes (Deplace, 2017).
- **Store of value**: money is a means of deferring purchasing power to the future and of choosing the date of its future consumption. It represents a link between the present and the future.

The current forms of money that we use are the expression of the functions it assumes.

1.1. **Fiat money**
Fiat money (cash) includes banknotes and coins in circulation in the economy; it is legal tender. All users have access to it, including individuals, commercial banks, central banks and governments. Fiat money is considered a claim on the central bank, which is traditionally responsible for printing, minting and making it available.

It is issued when commercial banks exchange the demand deposits they hold with the central bank, in other words, the central bank provides cash in response to demand from citizens who want to convert money held in their accounts. This transaction is carried out through commercial banks that buy fiat currency to meet the demand of their customers (Perret, 2017).

1.1.1. **Forms of fiat money**
The fiduciary qualifier of this currency comes from the fact that it can only be used if the economic agents have confidence in it. A distinction is made in this group between coins and banknotes:
- **Coins**: These are coins that are mainly used to top up payments (Deplace, 2017). They are legal tender in all countries.
- **Banknotes**: It is manufactured by central banks (just like coins) it is the latter which monetizes them and puts them into circulation.

1.2. **Scriptural money**
Scriptural money is that recorded in the accounts of banks or similar financial institutions. It consists of the sight deposits of non-financial economic agents (companies and households) in these establishments (Pons, 2019). This currency can be used by means such as checks, transfers, or cards.

Contrary to fiat money, the scriptural money of banks is not a means of payment having legal tender. It does, however, represent a right to a legal means of payment insofar as a bank's customers can exchange their bank deposits for banknotes, i.e., against central bank money (Wermuth, 2019).

1.3. **Central Bank Digital Currency**
In an international context marked by the emergence of several crypto currencies and the decline in demand for fiat money, reflections on the provision of central bank digital currencies have been initiated within several issuing institutes.
The Governor of the Bank of France, François Villeroy de Galhau, cited in his speech of December 4, 2019\(^1\), the three purposes of the creation of a central bank digital currency. The first is the preservation of the link between the official currency and the citizens, made essential especially in societies in which the use of cash is in decline. The second purpose concerns the minimization of central bank intermediation costs. Finally, the most important is “the assertion of the sovereignty of political authorities in the face of private initiatives such as Libra” (Quignon, 2020).

1.3.1. Definition and forms of CBDC:
Notwithstanding those approaches vary from one financial institution to another and that there is no single definition, a central bank digital currency can be considered as "digital central bank money different from the balances of traditional reserve or settlement accounts"\(^2\).

In general, there are two forms of CBDC, wholesale CBDC and retail CBDC (Bech & Garratt, 2017):

- **Wholesale central bank digital currency (WCBDC):** It is defined as a CBDC that would be used exclusively by the central bank and commercial banks or other financial institutions, for financial transactions between them. This central digital currency could be created via distributed ledger technology, such as blockchain\(^3\) (Adam et al, 2020).

- **Retail central bank digital currency (RCBDC):** The retail is a CBDC that would be accessible to everyone, in other words, it is usable by the public. The only distinguishing criterion between wholesale MBDC retail is accessibility (Bech & Garratt, 2017). According to the Bank for International Settlements (BIS), there are two types of retail CBDC: the first is based on central bank accounts and the second is based on digital tokens (Maldonato, 2019).

1.3.2. Characteristics of CBDC:
The first characteristic of a central bank digital currency is that it could only be created or destroyed by a central bank (Pfister, 2019). In fact, the specific characteristics of a CBDC depend on the initial motivations of the central bank.

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\(^1\) Speech by François Villeroy de Galhau, Central bank digital currency and innovative payments, Paris, 4 December 2019

\(^2\) The definition proposed by the Committee on Payments and Market Infrastructures of the Bank for International Settlements.

\(^3\) Blockchain: “it is an innovative technology that allows transactions to be carried out, whether financial or not, guaranteed by everyone, without the need for a trusted third party. After each transaction, a new line is added to the block, forming an unbreakable chain: the blockchain. The history of each transaction is entered into the decentralized and redistributed ledger. The complexity of the algorithms used makes these transactions tamper-proof” (Soudoplatoff & Caseau, 2016)
Nonetheless, we look at a few features below, although generalizations are tricky due to the variety of central bank digital currency designs.

- **Accessibility**: a distinction must be made between wholesale CBDC, which can only be accessed by banks and other financial institutions, and retail CBDC, which is accessible to all non-financial agents (households and businesses).
- **The underlying technology**: CBDC can be centralized (i.e., classic bookkeeping) or decentralized, for example if it is based on Distributed Ledger Technology\(^4\), with varying degrees of decentralization possible (Letondu, 2020);
- **Access technology**: access can be based on accounts (whose ownership is linked to an identity) or on “tokens”\(^5\) (linked to the possession of a key);
- **Confidentiality/Anonymity**: The degree of anonymity largely depends on the access technologies, as accounts are tied to identities, while tokens enable anonymity. However, confidentiality goes beyond this technological choice, since certain architectures of CBDC based on "tokens" and on DLT could allow third parties to keep payment traces linked to a customer profile (BRI, 2020);
- **Instantaneous**: Payments can be processed in real time (24/7), or with a delay.
- **Remuneration**: CBDCs may bear interest, possibly with negative interest rates, or may not incorporate the technical provisions allowing it (Letondu, 2020).

### 1.4. The Currency Flower

Based on the characteristics cited above and others, the Bank for International Settlements (BIS) has presented taxonomy of currency in the form of a Venn, called the money flower, (Bech& Garratt, 2017) to differentiate forms of central bank digital currency (CBDC) from other forms of money.

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\(^4\) DLT: "the digital version of the registers which offer a certain number of guarantees which were not previously possible with a paper support and a centralized management ".

\(^5\) Token: in computer language it can refer to digital access keys or asset representations on blockchains and in the cryptocurrency world a token refers to a digital asset that can be transferred between two parties without the need for a third party's authorization.
Figure 1: the money flower


The money flower presented in Figure 1 generally focuses on combinations of these four properties:
- **The issuer**: a central bank, a commercial bank, or a person (when the currency took the form of a commodity (BIS, 2018)
- **Form of money**: digital or physical (a metal coin or a paper note)
- **Accessibility**: wide (commercial bank deposits for example) or limited (such as central bank reserves)
- **The transfer mechanism**: decentralized or centralized, i.e., it can be either peer-to-peer or through a central intermediary (BIS, 2018).

Moreover, the currency is generally based on two technologies; either on “tokens” (for example banknotes or physical coins) or on “accounts” (this system depends on the ability to verify the identity of the account holder).

According to the above properties, it is possible to distinguish between the different forms of money as follows:

**Fiat money**: taking the example of cash money, it is issued by the central bank, physical and is not electronic, accessible and peer-to-peer.

**Scriptural money**: like bank deposits, they are not issued by the central bank, they are generally electronically accessible, but they are not peer-to-peer because the
transfer of resources from bank deposits involves at least one bank commercial, and in some cases the recipient's bank and the central bank.

**Central bank digital currency:** Wholesale CBDC, for example, is issued by the central bank, it has an electronic form, and limited accessibility as it is used only by the central bank and financial institutions, and peer-to-peer. This is also the case for the retail CBDC except that it is accessible to everyone.

2. **Obstacles to the introduction of the CBDC**

Actually, the introduction of a central bank digital currency (wholesale or retail) could have many advantages: Curbing the growth of crypto currencies and preserving monetary sovereignty, favoring the financial inclusion, improving the efficiency of the payment system, widening the scope of monetary policy instruments (Wermuth, 2019), however, exploiting this potential is not so easy, several are the limits and obstacles that still need to be overcome.

2.1. **Legal obstacles:**

The introduction of a central bank digital currency would raise very important legal questions; can central banks issue their own digital currency? Can the CBDC be considered a real currency? Should the CBDC be legal tender (supple)? (Bossu, Itatani, & Margulis, 2020).

Without a clear and relevant answer to these questions, the monetary and financial system would struggle to adopt a CBDC, and the digital space could be full of private alternatives.

In fact, the probable implications that the issuance of a CBDC could have on the monetary and financial system would require a change in the existing legal environment, or even the development of a regime specific to this new form of money (Vaupleane, 2019).

The BRI pointed out: “In some countries there are legal considerations. Not all central banks have the power to issue digital currencies and expand account access, and issuing these currencies may require legislative changes, which may not be feasible, at least in the short term.

In addition, the legal framework for the issuance of central bank digital currency depends on whether or not it relates to the regulatory framework for fiat money or whether a new legal framework should be created for this new form of money. It is therefore the characteristics of each type of CBDC (wholesale or retail) that could determine the applicable legal framework.

2.2. **Technical obstacles**

As far as the technical aspect is concerned, the circulation of the various crypto-assets is essentially associated with Distributed Ledger Technology; however, it is
not the case for all the experiments of the CBDC which have already taken place at the international level:

- A central bank digital currency could be managed through a blockchain. This is the case with the Bank of Canada (Jasper project) and the Monetary Authority of Singapore (UBIN project) projects.
- A central bank digital currency could be issued through accounts or mediums without leveraging blockchain. In this case, the units of digital currency are not comparable to crypto-assets but rather to a form of electronic money. This is the case of the Riksbank (e-krona project).

Whether to use Distributed Ledger Technology depends on the intended use (wholesale or retail). However, issuing a CBDC to the public could be based on “electronic money” type distribution, either peer-to-peer, by the central bank, or through one or more intermediaries (banks, public entities, etc.).

In addition, blockchain could be exploited to integrate smart contracts, these are “cryptographic boxes that contain value and only unlock it if certain conditions are met” (Buterin, 2014).

2.3. Operational Obstacles

The range of operational risks that can arise from the introduction of a central bank digital currency is a major obstacle to such a project, especially for retail CBDCs. These risks are generally currency integrity, cyber security, money laundering or terrorist financing. The issue is then that of the reputation of the central bank, in other words its most important asset for conducting monetary and exchange rate policies (Letondu, 2020).

- The issue of cyber security would take on increasing importance for the central bank as fiat money is replaced by CBDC. Not only the probability of a cyber-attack could increase, but also the amounts involved could be increased tenfold given the ease of transferring significant amounts electronically. Two key aspects are to be considered at this level: Systemic resilience and Data theft / identity theft...
- Integrity of the currency: Integrity is an essential element to maintain confidence in the currency whatever its form. For example, a CBDC based on Distributed Ledger Technology, could be exposed to the risk of "double spend" if a malicious user were to control most of the nodes. This is also the case if offline storage devices were hacked.

It should be noted, then, that the introduction of a central bank digital currency should satisfy the most demanding security objectives and comply with the regulations in force.
3. Overview of central bank practices in terms of CBDC

To support technological development and improve the efficiency of the payment system, several central banks have started to think about implementing their own digital currency with the aim of offering alternative fiduciary money and not to replace it.

Currently, some central banks are focused on adopting new technology solutions, including Distributed Ledger Technology, for wholesale CBDC. In this case, the latter would be held solely by banks and financial institutions. It would allow identification and would not carry any interest (Perret, 2017). This model could improve the efficiency of the wholesale payment system and it would present only a few disadvantages for the public.

Indeed, several central banks, including the European Central Bank, Central Bank of the Bahamas, Bank of Japan, Sveriges Riksbank, Bank of Canada and the People's Bank of China have already experimented with wholesale CBDCs for transactions between financial institutions. These experiments are in the evaluation phase and, sometimes, the preliminary results indicate that the Distributed Ledger Technology is still immature to be adopted for the issuance of a CBDC (Chapman, Garratt, & Hendry, 2017).

Certainly, central bank digital currency is getting more attention than ever. But the motivations and conditions for its introduction vary from country to country, as do policy approaches and technical designs (Auer, Cornelli, & Frost, 2020). Below are the experiments of three countries about CBDC

3.1. The Central Bank of the Bahamas: the Sand dollar

So far, of all the CBDC projects those are initiated around the world, the Central Bank of the Bahamas could be the most advanced (Auer, Cornelli, & Frost, 2020).

As part of a continuation of the Bahamas Payments System Modernization Initiative (PSMI), which began in the early 2000s, the Central Bank launched the Sand Dollar Project to issue its own digital version of the Bahamas dollar and set up the right digital payment system infrastructure to support the functioning of a digital currency ecosystem. Indeed, it introduced a Bahamian digital dollar, starting with a pilot phase in Exuma in December 2019, extending to the first half of 2020 in Abaco (CBOB, 2019).

Under the Sand Dollar Project, the Central Bank is developing and piloting a general-purpose digital version of the Bahamian dollar with wholesale and retail applications. As provided for in the Central Bank Bill, the Bank would have the statutory power to issue currency in digital form and develop regulations to govern the instrument (Rolle, 2019).
Indeed, the *sand dollar* project was officially launched in October 2020 by the Central Bank of the Bahamas, authorizing six financial institutions to support it: “Omni Financial”, “Kanoo”, “SunCash”, “Cash N Go”, “Mobile Assist” and “Money Maxx”.

The Central Bank of the Bahamas has adopted a token-based model; the digital dollar would be available for use on all payment platforms and existing or proposed electronic wallets (*E-wallets*). Once a user is on boarded, they will receive a digital account from *E-wallets* accessed through physical devices such as payment cards and/or mobile devices. However, businesses will be treated separately from individuals, they will benefit from the integration of their digital currency account with a deposit account held in banks (CBOB, sand dollar project, 2019).

### 3.2. The people’s bank of China: the E-Yuan

Since 2014, China has started its studies on the CBDC by creating a research institute dedicated to digital currencies and finding ways to improve the Chinese Yuan system with blockchain, it is considered one of the most advanced countries in this field.

The period between 2014 and 2018, research has seen a slowdown in the development process, as the decentralized nature of crypto currencies or blockchain is inconsistent with the Yuan as a legal national currency.

Nevertheless, the studies quickly accelerated towards the end of 2019 with the appearance of private crypto currencies like *Diem* from *Facebook* (formerly *libra*) and the domination of two payment giants *Alipay* from the financial company *Ant Group* and *We Chat Pay* from the *Tencent* mobile payments market (Auer, Cornelli, & Frost, 2020).

In April 2020, the People's Bank of China became one of the first central banks in the world to embark on a trial of its own digital currency under the name "DCEP: Digital Currency Electronic Payment" in four cities.

Unlike the wholesale CBDC, whose use will be limited to transactions between the central bank and financial institutions, the DCEP will be a retail digital currency issued by banks and payment service providers to individual digital wallets approved by People's Bank of China (Randhawa, 2020).

### 3.3. The Sveriges Riksbank: the E-Krona

Another advanced CBDC project is the Sveriges Riksbank, it is the oldest central bank in the world. In Sweden, as a highly digitized economy, the use of fiat currency has been on the decline for some years. Notably, Sweden's economy is experiencing "the largest and fastest decline in cash in the world (Riksbank, 2019)", the Riksbank was at the forefront of global discussions on the probability of issuing a CBDC.
Indeed, the Riksbank has conducted studies on several technologies and approaches. In 2017, she developed a proof of concept for the E-Krona project. Again, a CBDC should be designed as a complement and not a replacement for fiat currency (Auer, Cornelli, & Frost, 2020).

In 2020, the Riksbank entered a more concrete phase of this project. To test the appearance and operation of an e-krona, it launched a project "the e-krona pilot", in collaboration with the company Accenture, to work out a possible technical platform for the said project. The aim of the project is for the Riksbank to learn more about how a technical solution for e-krona works. By testing this technical solution, the Riksbank will be able to use it as a basis for comparison with other technical solutions and models for a possible digital crown (Riksbank, 2021).

3.4. The Bank of Canada: The Jasper Project
The Bank of Canada is among the central banks that have produced an exceptional body of research and strategic studies about digital currency. She outlined a detailed plan of the conditions under which Canada should develop a CBDC. It has thus defined potential architectures and accumulated relevant technical knowledge through a series of projects on new payment technologies, also in cooperation with other central banks (Auer, Cornelli, & Frost, 2020).

Project Jasper is a very important reference point in the Canadian payments system. This is the first time a central bank has participated in a Distributed Ledger with the private sector to understand how this technology could transform the wholesale payment system.

In fact, thanks to the Jasper project, the public and private partners were able to learn a lot more about the technical aspects. They also recognized the complexity of the processes involved, and tried to overcome technical obstacles by cultivating collegiality. This project made it possible to carry out a complete comparison of the various technologies of distributed ledgers, by confronting all the points of view (those of the supervisory authority, the operator, and the participant) (Chapman, 2017).

Conclusion
During the 21st century, the monetary and financial scene of the world economy has undergone profound transformations: changes in financial systems, redefinition of the activity of banks, multiple innovations in means of payment and financial products, etc.

CBDC is a new form of central bank money that can be distinguished from fiat and scriptural money. There are different design choices for a CBDC, including: access, degree of anonymity, operational availability, and interest-bearing features (Coeuré & Loh, 2018).
Indeed, issuing a CBDC could be good for the economy. However, it would raise thorny questions, especially regarding the role of the central bank and the private sector in the money supply. This would notably be the case for retail CBDC, while a wholesale CBDC could meet the expectations of financial institutions.

The choice could therefore be to not issue CBDC or to issue only wholesale CBDC. In countries where the declining use of cash would lead to the emergence of public demand for digital means of settlement, the issuance of retail CBDC would also be a possibility (Pfister, 2019).

The extent of the impact of the introduction of retail CBDC on the demand for cash would depend on the magnitude of the demand for this new form of currency, but also on its substitutability for cash (Adam & al, 2020).
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