Central Banks Digital Currency - Opportunities and Innovation

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Abstract

The issuance of a Central Bank Digital Currency (CBDC) is a very important step towards a fully digital economic environment and the consequences of such a direction are under debate by many policymakers around the world.

There is a clear interest within the space as governments around the world are exploring the viability of a digital currency and according to the latest Bank for International Settlements (2021) report: 86% of the world's central banks have begun to conceptualize and research the potential of CBDC, 60% are developing Proof-of-Concepts (PoC) and 14% are implementing pilot projects.

This paper provides a comprehensive overview for finance and investment participants about the topic of Central Bank Digital Currencies. The recent international exploration into the future of Central Bank money is complex as it is interconnected with two equally dynamic entities: Digital Currencies and Blockchain/Distributed Ledger Technology.

Key words: Central Bank Digital Currency, financial stability, monetary policy
J.E.L. classification: F33, F42, F,01, E02

1. Introduction

Central banks have a mandate for financial and monetary stability in their jurisdictions with an important agenda to promote access to safe, efficient and secure payments.

CBDC is "a digital form of central bank money that is different from balances in traditional reserve or settlement accounts" (CPMI-MC, 2018, p.3). There is substantial interest in this new form of digital money and many central banks are conducting experiments with the underlying technology of crypto assets.

A CBDC is "a digital payment instrument, denominated in the national unit of account, that is a direct liability of the central bank" (BIS, 2020, p.14).

This is an important statement to clearly differentiate from a second approach and theory that is researched, which is the "synthetic CBDC". Such concepts of stablecoins have been described in some papers as "synthetic CBDC" (Adrian T. and Griffoli M., 2019, p.4) and provide an alternative framework designed for the private sector participants to issue liabilities matched by funds held as collateral at the central bank.

All these providers of payment and financial services would act as intermediaries between the central bank and the users. These liabilities could share some of the characteristics of a CBDC, but a blueprint of such a regulatory framework is required in order to provide assurance that the liabilities are fully matched by available funds within the central bank accounts. However, this concept will not be treated as CBDC, as the end user cannot hold a claim on the central bank. A CBDC could be a significant instrument for central banks to continue to provide safer means of payment in accordance with the wider digitalization of people's day-to-day lives. Public trust in central banks is paramount to monetary and financial stability and the provision of a common unit of account & a viable store of value.

2. Literature review

The main considerations and opinions for this paper were drawn from different studies on the features, effects and risks involving the issuing and implementation of a CBDC. Our main objective is to identify the most relevant theoretical concepts regarding Central Banks Digital Currency scenarios and their usability in a real economic environment. From a theoretical standpoint, the concept of a CBDC needs to address important issues that were raised by Gurley and Shaw (1960, pp. 568-569), with regards to the provision of public and private money, along with the transmission of monetary policies (Tobin, 1985, pp. 19-29) and impacts on the central bank's objectives.

According to the research provided by Andolfatto D. (2018, p.22), the focus is on the effects of introducing an interest-bearing feature for a Central Bank Digital Currency. Andolfatto's model predicts that the introduction of a new digital form of currency will not have negative impact on the bank's lending operations as disintermediation can be avoided and he concludes that a well-designed CBDC will not threaten the main objective of the central bank, which is financial stability.

Brunnermeier & Niepelt (2019, pp.39-40) are approaching the CBDC concept as an asset compared with the bank deposits, but from a liquidity perspective. Their study is focusing on the effectiveness of the deposit liabilities being replaced by the central bank loans to the ecosystem, especially towards the commercial banks. Within their results, the equilibrium allocation is not affected as there is no consequences and effects that involves wealth distribution across households.

Fernandez-Villaverde et al. (2020a, pp.26-27) paper is approaching the bank runs model in order to derive an equivalence result, as per the research conducted by Diamond and Dybvig (1983, pp. 401-419).

Within their research, the CBDC concept replaces banks' deposits entirely and their results show that allocations conducted under private banks deposits structures is similar to the cumulated amounts under a CBDC system. Furthermore, the authors present a scenario where bank runs can be diminished through a CBDC infrastructure as the central bank commits not to liquidate its long-term assets, leading most of the depositors to keep their CBDC holdings instead of traditional deposits in equilibrium.

Williamson S. (2019, p.18) is focusing its research on the welfare & policy implications and studies the concept of a digital currency as an interest-bearing asset that is a direct alternative to cash. In his study this type of asset is subjected to different theft threats and banks' commitments are analyzed in order to use the design of the CBDC as a mechanism for welfare.

Keister & Sanches (2019, p.29) characterize the agreement that implies the usage of a CBDC for increasing trade and reduced lending allocations. Their analysis is conducted through a model of a decentralized exchange that is focusing on mass adoption pattern of a CBDC. Within their results, the users are accumulating important amounts of the digital currency, in the same time, increasing transactions and trades that lead to higher quantities exchanged and consumption patterns.

3. Research methodology

In order to properly understand the design features and characteristics needed in a CBDC framework, a theoretical research methodology was applied. We have engaged a qualitative approach to assess the topic of digital currencies that can be evolved within a central bank environment, for a better understanding of the underlying effects and risks.

The qualitative thematic analysis is needed to validate concepts and scenarios for the components and the ecosystem of CBDCs, in the context where most of the financial policymakers in the world are conducting conceptual studies of innovative digital financial instruments.

4. Findings

4.1. Motivation, challenges and risks

Access - In jurisdictions where access to FIAT is declining, there is a risk that businesses and households will no longer have access to central bank money. The central banks treat this as an important responsibility to provide public access and confidence in a currency. Accessibility via a

CBDC will improve transparency and could act like a "digital banknote", that addresses and can fulfill this responsibility.

Resilience - Cash is always considered as an alternative payment method to electronic systems, especially if those networks can malfunction or stop operating. However, if access to cash is marginalized, it will be less useful as a backup method. Operational resilience could be achieved via a CBDC system that acts as an additional payment method. Compared to cash, a CBDC framework may give superior methods to distribute and utilize funds in geographically hard to access locations, especially during crises or natural disasters.

Counterfeiting and cyber risk will always present a challenge. Even though large-scale issues rarely occur, cash still presents a high risk of counterfeiting. On the same note, cybersecurity issues, with regards to CBDC, represent a major threat, as the confidence in the wider system can be shaken with any new exploit that can produce a successful cyber-attack. A similar attack over a large bank or a payment service provider will not have the same impact, as the number of endpoints in a general purpose CBDC framework will be significantly larger.

Financial Inclusion - The main barriers around digital literacy, trust, data privacy and access to IT infrastructure can enlarge the digital gap and leave sections of society way behind, especially in this fast-evolving era where concepts of digitalization are increasing.

For central banks, in many emerging market economies, a key driver for researching CBDC is the opportunity to improve financial inclusion (Boar et al., 2020, p.4). However, the potential of a CBDC system that can increase financial inclusion must address the causes of financial exclusion. These causes are complex and vary from jurisdiction to jurisdiction.

Given the complexity of this issue and possible underlying obstacles to digital inclusion, any CBDC initiative would likely need to be embedded in a wider set of reforms (CPMI-World Bank, 2020, p.43).

Cross-border Payments - Cross-border payments involve complex mechanisms that extend through time zones, regulations, jurisdictions and usually engage numerous providers or financial institutions. As a result of these processes, most of these methods are usually slow and expensive. An interoperable CBDC system could improve all the roles within a cross-border payments infrastructure.

Public Privacy - One of the most important feature for transactions involving cash is that there is no centralized entity that records information of the holdings, parties or transactions that are conducted. Many have argued that a CBDC can improve benefits with regards to the anonymity levels for electronic transactions (Bech and Garratt, 2017, p.56).

Central banks are pursuing the requirements for anti-money laundering and combating the financing of terrorism (AML/CFT) for most of the design and implementation features of a CBDC. This is clearly not the main objective, nor the primary motivation when considering the issuance of such a project. Full anonymity is not a feature that is plausible as transactions data will exist and be recorded accordingly. The main questions for data privacy, will be about who will have access to this data and under which circumstances.

As data protection legislation continues to evolve, one important task for these institutions will be to identify the balance structure between public privacy and reducing illegal activities by all means available.

4.2. Monetary policy, financial stability and risks

Depending on factors like concept, design and adoption of a CBDC, all of these may trigger different market structure effects. There is a risk of disintermediating banks that may lead to destabilizing runs into central bank money.

All these risks will clearly undermine financial stability and may propagate other consequences. Our recent history with regards to public money runs, imposed the existence of deposit insurance and complex bank resolution frameworks in order to protect the retail depositors.

A major concern is that a widely available CBDC could make such events more frequent and severe, by enabling "digital runs" towards the central bank on an unprecedented scale and with greater speeds (CPMI-MC, 2018, pp.16-17). In such a scenario, if banks were to lose deposits to a widely adopted CBDC they may look for different alternatives for their funding needs and a solution

could arise from the wholesale funding. To a certain extent, this will possibly disrupt the credit supply in the economy with significant impacts on the economic growth.

There has been a great deal of academic research on the risks of disintermediation and runs into central bank money. However, feasible solutions have been presented through a more "cash-like" model which transcends the "deposit-like" CBDC. Innovative design features and system safeguards will differ for each individual jurisdiction and the same can be said with regards to the risks, which will require significant research by the central bank to assess. A central bank should have robust means to mitigate any risks for the financial stability before any CBDC concept is issued.

The risk presented by implementing stablecoins and foreign nationalities CBDCs comes from the adoption patterns of the users: if the users adopt such instruments in significant numbers, the usage and power of the domestic sovereign currency could dimmish. An extreme scenario of such a concept is that we could see a national currency being substituted by another, with the central bank of that specific jurisdiction, losing control over the monetary matters (Brunnermeier et al, 2019, p.28).

This domination or take-over scenario of alternative units of account can be mitigated by offering an efficient and comprehensive CBDC by the central bank. An alternative would be a balance, provided by the central bank along with the payment providers, to ensure a fit-for-purpose payment system that gradually improves efficiency.

4.3. Foundational principles

The main public policy objectives of the central banks haven't changed and these work towards providing a trusted money infrastructure with a mandate for monetary and financial stability. Based on geo-politic and analytical factors, the specifics of these policies may be different, from jurisdiction to jurisdiction. However, from a CBDC perspective, the common foundational principles, for the consideration of issuance of such an instrument, derive from the common objectives:

Uniformity – New digital variations of money developed and supplied by a central bank should continue promoting the fulfilment of the current public policy objectives and should not obstruct with the ability to carry out the principal mandate for financial and monetary stability. A CBDC should maintain the uniformity of a sovereign currency, allowing the users to use different forms of money mutually.

Coexistence – As the main mandate for central banks involves stability, any new venture in unchartered territories of innovations should be done with prudency and responsibility. It's important that new and old forms of money coexist in support of the policy objectives. The framework should address a system where a new form of digital money should complement the existing one and support it for as long as there is sufficient demand for it.

Innovation and efficiency – The key drivers for efficiency in any payment system are innovation and competition. For a better optimization of the payment's ecosystem, innovative implementations of novel technologies need to be introduced to the general public. The participants should be allowed to compete for market share in order to provide accessible and user-friendly products.

Find below the necessary features of a potential CBDC system to fulfil the foundational principles:

Table no. 1 Core Features of a CBDC

Convertible	To **maintain singleness and uniformity of the currency** a CBDC should exchange at par with cash and private money.
Convenient	All payments involving CBDC should be simple, efficient and convenient, **as easy as using cash** or other means of electronic payments like: taping a card or scanning a QR code with a mobile device. This will encourage accessibility and adoption.

Accepted and available	Acceptance of a CBDC should be promoted in the same way as cash, from point-of-sales to any peer-to-peer transactions. A requirement in this scope is for the digital currency to have the **ability to make offline transactions and be available 24/7/365.**
Low cost	Low entry technological barriers should be provided with minimal equipment requirements. Payment involving CBDC should be **very low or at no cost** to end users.

Source: Bank of International Settlements, (2020). Available at https://www.bis.org/

Table no. 2 System features

Secure	Both the infrastructure and participants of a CBDC system should be **safe from cyber-attacks** and other threats. This should also include ensuring effective protection from counterfeiting.
Instant	**Instant or near-instant final settlement** should be available to the end users of the system.
Resilient	A CBDC system should be **extremely resilient to operational failures,** natural disasters, electrical outages and other unforeseen disruptions. There should be alternatives for end users to make offline payments if network connections are not available.
Available	End users of the system should be able to make payments **24/7/365**.
Throughput	The system should permit and be able to process a **very high number of transactions**.
Scalable	The system should be scalable in order to accommodate a potential expansion with **greater future volumes of transactions** and operations.
Interoperable	The system needs to assure the transition of funds between different environments. The flow of funds between public and private sector need to **interact seamlessly across systems** even with the traditional payment networks.
Flexible and adaptable	A CBDC system should be **flexible and adaptable to changing conditions** and policy objectives.

Source: Bank of International Settlements, (2020). Available at https://www.bis.org/

Table no. 3 Institutional features

Robust legal framework	A central bank should have **clear authority** over the issuance of a CBDC concept.
Standards	A CBDC system, along with all its participants, need to conform to a proper **regulatory framework and standards**. All entities offering custody, storage, transfer or other related services should comply with the standards in a similar manner as the current providers of financial services.

Source: Bank of International Settlements, (2020). Available at https://www.bis.org/

4.4. CBDC Concepts under Development

As more resources are deployed within the research of CBDC instruments and the underlying technology, many design concepts are evolving having similar architectures. All these design choices are openly addressed which is an essential step for an efficient and reliable functioning system implementation. The CBDC research is still in infant stages with limited pilot testing and large-scale implementation. The more data is collected from such concepts, the better results and understanding of the risks and impacts of the design options.

Architecture designs

The underlying technology used to deploy any CBDC system is extremely important as it will have a major impact for the fulfilling of the central banks' objectives. Distributed Ledger (DLT) or Blockchain Technology are the front runner infrastructures of such concepts, but there is no inherent reason for such a system to be developed using conventional centralized systems. The association of CBDC and these innovative technologies is natural as the introduction of smart contracts can play an important role within the development of programmable money.

The elements of decentralization could introduce some potentially useful features like resilience and availability, especially for the design choices of the CBDC architecture, but they have to be carefully vetted and understood based on the risks, challenges and impacts.

The current available research shows that there were identified some fundamental and complementary design features for a CBDC architecture design that need to be implemented:

- Interest-bearing feature;
- A cap or limit on individual holdings.

Based on the Bank of International Settlements (2018) report, in a CBDC system, a payment is a transfer of a central bank liability, recorded on a ledger. In designing a CBDC ledger, there are five key factors: Structure, Payment authentication, Functionality, Access and Governance.

Each of the design factors mentioned above will have a connection on how a CBDC system meets the core features set out earlier.

The structure of a digital ledger can be formed using:

1. Centralized Infrastructure – where an intermediary is required to vet, manage and transfer the liabilities. This concept makes it easy to introduce anti-fraud and traditional cyber security features;
2. Decentralized Infrastructure – where Peer-to-Peer (P2P) transactions and offline payments are secured using the cryptographic consensus algorithms of the underlying technology;
3. Hybrid Model Infrastructure – This concept takes the advantages of both centralized and decentralized infrastructures. The downside of such a model will be the complexity of design that brings all the moving parts and risks associated with each individual infrastructure.

Proof of Concepts

Digital Euro – The main agenda for the Eurosystem (ECB, 2020, pp.9-15) is to find the best alternative in designing the digital euro, so that there are no undesirable implications with regards to the financial industry, participants and macroeconomics along with its mandate fulfilment. Any potential shocks that may come with the digital euro implementation or design could affect the funding costs and intermediation function of banks, especially within crises or market stress environments. A digital euro potential scenario could expand the size of the Eurosystem's balance sheet and increase the exposure to shocks, furthermore impacting the larger capital flows, from and into the financial markets.

As digitalization is a very common topic from the start of the COVID-19 pandemic, a digital euro seems to be the best formula to provide access to a safe form of money in a fast-changing digital ecosystem.

A digital euro concept could be a viable option to be issued in order to:

1. support the digitalization of the European economy and the strategic financial stability of the European Union;
2. in response to a significant decline in the role and usage of cash as a means of payment;
3. as a new monetary policy transmission channel.

DCEP (Digital Yuan) – People's Bank of China (PBoC), which is the China's central bank, has been the front runner on the research, development and implementation of a Central Bank Digital Currency. The available reports show that a concept of a digital currency was started in 2014 and the development has been at the forefront of the financial industry.

Digital Currency Electronic Payment (DCEP) is China's CBDC project.

Discussions within the financial sphere have concluded with the long-term vision of DCEP as an internal system of settlements which has as main goal the replacement of the Society for Worldwide Interbank Financial Telecommunication (SWIFT) operations.

The PBoC explains that one of the short-term objectives of the DCEP is to meet the needs of retail payments for businesses and individuals. Another definition that circulates, identifies DCEP as a "retail CBDC".

As China is leading the race within the development of CBDC, it's expected to become the first economy to fully launch such a project. The program entitled Digital Currency Electronic Payment (DCEP), has launched in March 2020 one of the largest real-world pilot of a CBDC in several important cities around China (Orrick, Herrington & Sutcliffe, 2021).

4.5. CBDC's effects on commercial banks, monetary policy and financial stability

The main question that needs to be addressed when designing a CBDC is how will such a concept affect commercial banks, monetary policy and financial stability. Clearly, a CBDC programed to pay interest will have a direct approach towards the commercial bank deposit systems. A consequence reaction of such a potential substitute will come from the banking side with a change of the deposit rates that affects the bank's main funding cost. Fundamentally, the quantity of the bank deposits, along with the bank-intermediated lending may change. As a result, the introduction of a CBDC concept may replace the banks' main source of funding and cause disintermediation of commercial banks, which in turn may lead to a decrease in their lending structures.

Andolfatto D. (2018, p.22) studies in his paper, the effects of introducing an interest-bearing CBDC. The research is conducted on a monopolistic banking sector which raises the deposit rate, to be equal to the interest rate of the CBDC. In this scenario the bank makes positive profits in equilibrium.

The analysis suggests that the main benefit of a CBDC concept increases the number of depositors and the demand for deposits with favorable terms, with an important impact on financial inclusion and a consequence towards the diminishing usage of FIAT.

The implementation of a complex system as the one of a CBDC may deliver future unforeseen macroeconomic shocks that requires the design of such a concept to have safeguards in the circumstances that digital bank runs occur or as per the mass portfolio choices of the users.

Such scenario involves understanding the monetary tools involved and leveraging the CBDC design as a tool itself to protect the policy objectives of the central bank.

In the paper of Fernandez-Villaverde et al. (2020b, p.45) a digital bank run via a CBDC is presented. Their framework highlights that in such an event the bank can reduce the value of withdrawals by increasing the price levels, as their model present a CBDC that represents a deposit held at the central bank. The impact of such a raise in prices will be felt within other macroeconomic indicators or targets. The results of the study show that negative rates from a CBDC perspective can keep inflation in check, especially during crises or financial panics that lead to bank runs.

As per the report provided by the Bank of England and conducted by Barrdear and Kumhof (2016, pp. 65-67) an approach via a Dynamic Stochastic General Equilibrium (DSGE) model has been analyzed to study the cyclical effects and shocks of a CBDC for the macroeconomy. The model is using sticky prices, average and adjusted costs to study interest rates, taxes, debt and impacts on the GDP, under the assumption that the design of the digital currency can be exchanged at par with government debt. Their findings show that the introduction of such a model of digital currency can help in decreasing interest rates and distortionary taxes with a long-run consequence of GDP increase. The authors also study the impact of liquidity shocks over business cycles. The results presented show that welfare can be affected if liquidity issues with regards to supply and demand of CBDC are to be disturbed from different business shocks.

The study of Keister and Monnet (2020, pp.28-30) analyze the effects of policies in periods of financial distress with a clear focus on the property and the role a CBDC can play as means of payment. The observations made by the authors for the stressful periods of financial instability help in creating the right design choices for a digital currency prototype and also for the policies response to mitigate bank runs or other risky financial conditions. Their results show that by appropriately choosing the interest rate on the CBDC, allows a more efficient response in order to stabilize the financial system. This fast-revolving environment powered by implemented tools within the design of a CBDC allows any government to adopt the proper policies for improving overall welfare.

5. Conclusions

The payments landscape is in a vibrant stage as the speed of technological advancement is changing business models around the world, along with the central banks' ability to deliver feasible policies and financial stability. Governments around the world are deploying a lot of resources in order to understand the arguments, for and against the issuance of a CBDC, as there are many moving parts especially for the design, features, architecture and infrastructure options.

Clearly there will be no "one size fits all" model, as each jurisdiction will be required to create and adapt special design features that will provide efficiency and support based on the local financial and economic circumstances.

The decision of a central bank to engage in the issuance of a CBDC will require an assessment of the value it brings and the opportunities of such a system can create in order to pursue and achieve its main objectives. These decisions need to take in account various new risks that were not foreseen.

One important benefit that CBDC can bring for the transmission channels is to increase the speed to which changes in the bank's policy rate are passed on to households and businesses and could change the amount and cost of credit to the economy by the banking sector. For these reasons, a CBDC should be carefully designed to ensure that potential benefits for monetary and financial stability along with the wider benefits of introducing CBDC to the public, could be achieved without putting in danger the objectives of the bank and the sector's capacity to provide credit and other services to the economy in general.

There are many reasons for adopting a CBDC, such as promoting financial integration & inclusion by improving the efficiency & security of transactions, and lowering the cost of cross-border payments. In countries with underdeveloped financial infrastructure, the benefits of a CBDC will be more evident. For countries that are seriously affected by inflation or by international sanctions, issuing a CBDC is a potential and viable solution.

From our point of view, the use of a CBDC can help the central bank to keep track more accurately of the money supply, structure, speed, financial multipliers, time and space distribution, thus improving the accuracy of monetary policy operations. The use of CBDC for retail will capture all payments associated with most of the activities that are not currently reflected in reports, statistics and national accounts

The mentioned opinions regarding the challenges and risks, which come with any innovation from different technological, economic, systemic, ethical and legal aspects, are associated with the adoption of a CBDC and need to be thoroughly understood and assessed.

Issuing a CBDC can also have negative effects on the economy itself. If the public can get digital currency directly, without any form of limitation, the demand for deposits or reserves of the commercial banks can be reduced. Banks will face a lack of liquidity and can trigger "bank runs" in case of financial panic or other crises.

Traditional currencies of the current financial system are operating in a highly regulated environment by the authorities, thus a concept as a CBDC needs to be included in the scope of the legal regulation as a new form of digital currency. Therefore, there may be legal loopholes in the issuance, usage, circulation and supervision of such a concept. Difficult and complex security scenarios need to be vetted as we move into a digital era where it can become cumbersome to analyze swaps between digital financial assets or where new financial instruments can be constructed having the foundation of digital currencies.

As most of the research available, we also emphasize on the design choice of a CBDC, as there is a danger that we might end up creating central "honeypots" of data, collected from payments and other operations conducted via a CBDC. This statement is based on the similarity of most of the CBDC concepts that require to have control management over some parts of the system. Whether or not this sensitive data needs to be collected is still a question under scrutiny by most of the engaged research entities, but we can all agree that it needs to be protected.

Even though this is not a race, there is a clear competitiveness engaged with regards to which nation will provide the first real operating CBDC system. In our opinion, it is not really important who will be first or second, it's about understanding all the risks, effects and impacts that can influence our economic livelihoods and making sure that such an instrument is properly implemented.

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