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Challenges of Central Bank Digital Currency Implementation: A Review of Literature

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Abstract

Central Banks across the globe are examining the prospect of their digital currency called central bank digital currency (CBDC). The rise of cryptocurrency and the digitalization of the financial sector have induced countries to conduct extensive research to issue their digital currencies, while few have already issued, and some are undertaking extensive pilot tests of CBDC. In this context, the article has two objectives. First, the paper aims to introduce CBDC

as the digital currency issued and regulated by the central banks. The second objective is to investigate the set of articles published on CBDC and digital money to understand their major challenges. This paper reviews the selected literature from 2013 to 2024 from various databases using the keywords: Central Bank Digital Currency, CBDC, Cryptocurrency, and Digital Money. A total of 112 studies were selected in the first stage and after detailed assessment 42 studies were selected for review. The review finds some general as well as country-specific challenges. The different challenges of CBDC issuance and implementation are financial stability, challenges for commercial banks, operational challenges, consumer and merchants' digital financial literacy, lack of differentiation with existing digital payments, cybersecurity risks, privacy, and regulatory challenges. The study also discusses the future areas of research for CBDC. This paper is a unique attempt to review the literature on eight themes of CBDC challenges.

Keywords: central bank, digital currency, CBDC, digital money, review of literature

Introduction

In this paper, we provide a literature review of the challenges of central bank digital currency (CBDC) adoption and implementation for the government, central banks, and individuals across the globe. We further come up with some potential areas of research.

CBDC is generally understood as the digital currency issued and managed by the central banks. Kumhof and Noone (2018) define CBDC is a digital form of central bank money that is more broadly accessible than reserves, earns interest, is designed for retail transactions, and operates with a distinct structure compared to other types of currency. Bindseil (2020) conceptualizes CBDC as a type of central bank currency that is administered electronically and is open to the broader public. Engert and Fung (2017) define CBDC as an electronically stored monetary value that is a liability of central banks acting as a medium of exchange. (Bank of International Settlements, 2018) CBDC is a digital form of money that is issued and regulated by the Central Bank and is in both the retail and wholesale attributes. Retail CBDCs are general-purpose CBDCs that can be held and used by the public, whereas wholesale CBDCs are accessible exclusively to a specific group of financial institutions. This paper is based on a study of retail CBDC.

The digital finance landscape has been undergoing rapid transformation since last decayed starting from fintech to cryptocurrency and now to CBDC (Ozili, 2022b). Presently, cryptocurrencies such as bitcoin, Ethereum, etc. are gaining popularity as a medium of exchange and financial asset due to features like transaction convenience, blockchain technology, security, and enhanced settlement systems inducing an increasing number of people for its adoption (Fung, 2016). Considering the increased trading of cryptocurrency, central

banks across the globe responded either by banning, issuing warnings or some CB announced the plan to issue CBDC as a new form of digital currency (Ozili, 2022b).

Research on CBDC has attracted significant attention from policymakers and practitioners, because of several factors such as the evolving shift in consumer preference from cash to digital payment services, the rise of cryptocurrency as an important part of digital payment services, and the keen interest expressed by major technology companies in entering the payment market (Bijlsma et al., 2021a). Further, Soderberg et al. (2022) mentioned that central banks are increasingly considering the issuance of digital currencies for the public and the majority of IMF (International Monetary Fund) members are eagerly evaluating CBDCs, while only a small number of released CBDCs or conducted extensive pilot programs.

The majority of research shows that there are varying benefits of the CBDC. Ozili in his review paper (Ozili, 2022b) highlights financial stability, financial inclusion, achieving monetary policy goals, promotion of general welfare, macroeconomics, and financial stability as major benefits of CBDC. There is also the literature showing the challenges of CBDC issuance and implementation. Even though certain countries have already implemented CBDC, and others have advanced pilot projects, the pace of implementation is slow in some countries, while in others countries the projects have been discontinued due to encountered issues (Lee et al., 2021). In several instances, these problems differ from one country to another and are related to the motivation behind introducing CBDC (Bijlsma et al., 2021b). Similarly, Náñez Alonso et al. (2020) came up with a message that the feasibility of implementing CBDC is not uniform across all countries and monetary regions. Mancini-Griffoli et. al (2019) point out nevertheless, operational, and reputational risks arising from malfunctions of the digital infrastructure or cyberattacks are likely to remain as challenges.

Materials and Methods

Following best practices for conducting a Systematic Literature Review (SLR) as outlined by (Khan et al., 2003), we started by choosing a suitable database and identifying keywords, based on a comprehensive literature review. Research papers were sourced from Web of Science (WoS), Scopus, and Google Scholar. These databases were chosen to complement each other and provide access to scholarly articles, this was the initial step in guaranteeing the inclusion of high-quality articles. The following query was used to search the title, abstract, and keywords: *Challenges and Opportunities of CBDC, implementation of CBDC, and Risk of CBDC across the globe.* The keywords were selected, based on prior literature review, to cover central banking practices and implications. The initial search criteria yielded 112 papers and using the year from 2013 to 2024 to resulted in 67 papers and a further 35 duplicate papers were eliminated. This process resulted in the selection of 42 papers for subsequent analysis.

Results and Discussion

Several literatures highlight the challenges and risks associated with CBDC. Based on the relevance we have categorized them into the following nine sub-groups.

Challenge for Financial Stability

Several studies show that CBDC issuance poses challenges and risks to the financial stability and monetary policy objective achievement. Issuance of CBDC carries a notable risk in terms of financial stability, specifically highlighting the risk of a widespread shift from bank deposit to CBDC, potentially, leading to a systemwide run (Kumhof & Noone, 2021). Implementation of CBDC has the potential to impact the transmission of monetary policy by altering the demand for base money and its composition in an unpredictable manner, and potentially influence the responsiveness of the demand for money to fluctuations in interest rates (Fernández-Villaverde et al., 2020). Lee et al. (2021) pointed out that although CBDC could enhance transparency for policymakers, the implications for credit creation as well as the impact on monetary policy and financial stability are not fully understandable. Employing a monetary general equilibrium (Kim & Kwon, 2019) studies the effects of CBDC on financial stability. They find that the supply of CBDC deposits will diminish the credit creation by commercial banks likely to raise the nominal interest rate. These changes in turn may negatively impact financial stability by elevating the risk of a bank panic and the banks may also face a shortage of cash reserves to meet depositors' withdrawals.

Challenges for Commercial Banking

CBDC serving as an interest-bearing deposit functions as a substitute to the regular bank deposit which may replace the bank's source of funding causing financial disintermediation, consequently leading to a decline in lending activity (Carapella & Flemming, 2020). CBDC potentially drains the funds away from the banks degrading their lending capacity and profitability, further, CBDC might exacerbate financial fragilities if not designed and implemented cautiously (Chen & Siklos, 2022). Bindseil (2019) demonstrated that CBDC may pose a risk to the centralized credit system of Central Banks and lead to structural disintermediation of banks. Keister and Sanches (2023) examined the policy tradeoff, they show that wider acceptance of CBDC improves efficiency in exchange while it may also drain bank deposits, decrease investment, and increase banks' costs. Lee et al. (2021) mentioned the implementation of CBDC potentially could hurt the economy if there are no restrictions on its issuance. It will reduce the demand deposit reserves of commercial banks leading these banks to face liquidity shortages and pose them to bank runs in case of market panic.

Operational Challenges

In this sub-section, we review the challenges related to technology, financial innovation, and financial risk (Zhang, 2020). It involves a huge cost and time to install the

software, hardware, and human resources to operate the CBDC. Further, the major stakeholder like banks and service providers needs to invest more in research and BFIs further need to innovate business models that require complete transformation in the product and service delivery. Darbha and Arora (2020) contend that CBDCs have unseen vulnerabilities, exhibit challenges in scalability and intricate operational processes, and possess the possibility of unnecessary tradeoffs (Kiff et al., 2020). CBDC users may face added risks associated with dealing with third parties like default risk of exchange and wallet service providers, and distributors which need to be addressed by the regulators. They further explain that while market risk for CBDC is less than cryptocurrencies, other risks such as default risk of service providers and operational risks still need to be addressed (Lee et al., 2021). The effectiveness and operation of CBDC will be greatly influenced by the internet infrastructure. Despite of massive usage of digital smart devices certain segments of the population such as senior citizens and children, may not possess smartphones or have internet access, especially in rural areas.

Consumer and Merchants' Digital Financial Literacy

One of the challenges of CBDC implementation and adoption is the lack of digital literacy among its users. As Niroula and Adhikari (2019) put digitalization improves financial inclusion and transactions. The digital skills necessary to use and manage CBDC account operations represent a challenge to the CBDC implementation (Oh & Zhang, 2022). Alfar et al. (2023) showed that the implementation and acceptance of a CBDC may encounter problems in rural areas with older populations having lower levels of education (Zhang, 2020) CBDC being sophisticated in terms of settlement, certain individuals with lower levels of education might face challenge in adjusting to the literacy and operational skills necessary for utilizing CBDC. Bhaskar et al. (2022) acknowledge that many countries face low digital skills to adopt the CBDC despite its advantages in financial inclusion.

There are also some country cases where the lack of digital skills is felt in the CBDC adoption (Wright et al., 2022). The uptake of the Sand Dollar in the Bahamas is 7.9% which is very slow and can be attributed to digital knowledge (Niroula, 2024). The purpose of CBDC issuance was to promote financial inclusion, however, it is not being materialized due to the low level of digital education in the population.

Lack of Differentiation with Existing Digital Payment Services for Users

The users of CBDC may find very little or no differentiation from existing payment systems like debit cards, credit cards, and digital money transfer services which is another challenge in the adoption of CBDC (Ahnert et al., 2022). It is important to consider the factors influencing user's decisions in the payment market for the successful adoption of CBDC. Because of the existence of strong network externalities, the barriers to entry in the payment

market are exceptionally high. They further illustrate for CBDC to be successful; it must attract a significant number of merchants and consumers. For example, in China where the CBDC is in the trial phase, a lack of differentiation from other digital payment services has been found and the same situation could be detected where the digital payment services are well developed like in European Countries (Huang et al., 2020; Ozili & Alonso, 2024). Chinese users are habituated to digital payments, with more than 96% of low-amount retail transactions processed via digital payment services (Xu, 2022). In an experiment to differentiate between China CBDC and popular online payment services, CBDC could not make a distinct impression on the user.

Cybersecurity Risks

Cybersecurity is a persistent and noteworthy risk to any digital payment systems especially when there are a large number of users who need to be connected via digital media (Kiff et al., 2020). This highlights the necessity for central banks to design and manage a secure and robust ecosystem for CBDC across all its associated systems and integrations. He further indicated that a lack of proper implementation of data and cyber protection measures by the central banks could lead to incidents of data thefts and breaches that could outweigh the potential benefits of CBDC. (Viñuela et al., 2020) show that CBDC poses a potential operational risk due to disruptions and cyberattacks. Additionally, it may elevate the risk to financial integrity and pose threats to financial intermediation. Ozili (2022a) stated that central banks need to promote advanced mobile security tools among users to safeguard their mobile data from becoming targets of criminal organizations. This may require central banks to implement multilayer security systems to avoid hacking problems and data breaches (Li et al., 2021). Although CBDC has the potential to overcome the drawbacks and deficiencies of conventional cash systems, it comes with its probable risks like cyber-resilience, misdirection of funds, data loss, or leakage which needs to be thoroughly addressed to prevent financial instability.

Challenge to Privacy

Privacy and data protection must be considered as a significant factor for CBDC design. Here, we review research conducted in a few countries. Srouji (2020) showed that people in the United Arab Emirates prefer cash over digital services since people were skeptical about digital services regarding their privacy (Bank of England, 2020). It is crucial to assess the way where privacy is maintained, and data is safeguarded in a CBDC system. Government authority must be concerned about privacy and data protection and the security matter should be incorporated cautiously while designing CBDC. Tronnier et al. (2022) also discovered that privacy is a critical factor in CBDC adoption in Germany. Ozili (2022a) focuses on the central role of protecting CBDC users in Nigeria, the protection measures included mobile data, bank applications, and backend server. Wenker (2022) pointed out the difficulty in finding the right

balance between financial privacy and crime prevention as a crucial challenge for CBDC in the Bahamas.

Regulatory Challenges

In this subsection, we review the literature related to the legal and institutional challenges for the implementation of CBDC. As Lonnberg (2013) mentions strengthening the institutional capacity of the central bank and ensuring it has the resources needed are critical preconditions for currency reform. The legal structure for CBDC comprises a set of regulations that indicate the rights and responsibilities of the parties involved in the system and a change in regulation may be needed for CBDC to be a legal tender (Mancini-Griffoli et al., 2019). Babu and Abraham (2021) concluded that Central Banks in some countries may necessitate the enactment of new laws or modification in the existing laws to issue CBDC and make them function as legal tender. In a study in China, Zhang (2020) found the regulatory framework for banking and monetary management is rigorous and requires a longer period to ensure its scientific and rational nature. At this stage promoting a legal environment for CBDC application and usage is a problem that needs to be addressed. Lee et al. (2021) state that the conventional currency in the existing legal system is a legal tender and regulated by the central bank, but CBDC in most cases is not incorporated within the scope of legal regulation as a novel digital currency. This results in potential legal loopholes in the issuance, circulation, usage, and supervision of digital currency. Similarly, the transition from physical to virtual currency poses a challenge in effectively supervising CBDC.

Similarly, Ozili and Alonso (2024) point out that the success of CBDC depends on public trust in the monetary regulator. He argues that in a country with a high level of citizens' trust in the Central Bank, the CBDC is likely to face wider adoption whereas in the countries where citizens have lower trust in the central banks might be hesitant to embrace CBDC. Kiff et al. (2020) highlight central banks are evaluating their risk management practices, governance, and internal organization while evaluating the decision for CBDC issuance. They further mention that successful implementation of CBDC requires a thorough understanding of key issues by the Board and operational staff. The authors also advise that authorities may be required to appoint expert consultants in the relevant areas like payment, cyber, operational, technological, and settlement risk.

Discussion

Central Bank Digital Currencies (CBDCs) have attracted significant interest as a possible response to the prospects appearing from the growing prevalence of digital payments and the emergence of private digital currencies. CBDCs offer various advantages, such as supporting monetary policy, reliable methods for digital payments, and financial inclusion, combating criminal activity, and enhancing the efficiency of the financial system (Ozili,

2022b). These currencies have features that can be utilized for both offline and online trades, seamlessly included in current payment systems, assist cross-border payments, and contribute to financial inclusion by assisting people currently needing access to banking services or being underserved (Kiff et al., 2020). To make the financial and monetary system more efficient majority of central banks are actively experimenting and investigating the possibilities of CBDC implementation. Despite the several benefits, it is equally important to acknowledge and tackle the challenges of using CBDC.

As our review shows there are several country-specific and general challenges in CBDC implementation including privacy and security, regulatory, digital literacy, and possible adverse impact on monetary policy and the banking industry which need to be highly emphasized by implementing authorities while issuing CBDC. Central banks may utilize various socio-economic and monetary tools to detect and combat the challenges and risks associated with the CBDC and improving investment and effort in digital infrastructure is essential to address formidable challenges and ensure the provision of reliable and trustworthy banking services (Fung, 2016).

Our review further shows the issuance of CBDCs requires huge investment in digital, cyber, and monetary infrastructures, and needs to address the complexity and risk associated with payment systems. Similarly, the banking system may be stressed by increased competition from CBDCs possibly leading to a decline in their profits and diminished credit availability. The utilization of CBDCs may constrain the central banks' ability to implement effective monetary policies, possibly resulting in increased inflation or other unforeseen economic issues. In addition, several countries and their related institutions are required to advance their laws to adopt digital currencies which can take several years to validate and implement. These represent a novel approach that could have unpredictable consequences for industry, individuals, and the entire financial system.

For the effective implementation of CBDC projects central banks need to be organized, have suitable human resources, review regulations, and have adequate financial resources. Soderberg et al. (2022) highlight central banks require detailed planning and execution, supportive institutional structures, and investment in staff education, skills, and retention. Digital literacy, access to internet services, and availability of hardware might need special attention to utilize digital currency. Lee et al. (2021) introduction of CBDC requires the evaluation of current regulations to support it, additionally, the CBDC design may require an adjustment following the global monetary trends. Further, Bindseil (2019) also highlights the importance of regulation. He points advanced regulation and expertise are essential to designing effective CBDC which also requires regional cooperation and a holistic approach.

Bankers and policymakers need a comprehensive understanding of the significance of CBDC. This understanding is essential for regulating and guiding the strategic utilization of CBDC within the banking industry to promote the safety and efficiency of payment systems. (IMF, 2023).

The research on CBDC and its impact on monetary policy is still ongoing. The CBDC designs are researched from the angle of challenges for the domestic economy, the international aspects of CBDC are still relatively under investigation and require more thorough insight (Bank of International Settlements, 2020). CBDC needs to be carefully designed to ensure the potential benefits for monetary and financial stability, as well as the wider benefits of introducing CBDC for the public could be realized without jeopardizing the Central Bank's objectives and the financial sector's ability to provide credit and other services to the wider economy (Ozili, 2022b). Individual countries may form an empowered committee to facilitate engagement and consultation with the stakeholders to prioritize tasks and improve resource efficiency and effectiveness (Bains & Wu, 2023).

This review shows that much research in the CBDC challenges, and its remedy is required. As a literature gap, we need further research to find the optimal CBDC design and examine country-specific CBDC requirements (Ozili, 2022b). Measure and compare whether the benefits and advantages are high enough to issue digital services compared to the cost and disadvantages (Fung, 2016). Central banks need to investigate data protection legislation, central bank cyber resilience, and compliance with international standards (Kiff et al., 2020). Soderberg et al. (2022) mention only a few have circulated CBDC, some are conducting pilots, and many are analyzing the prospects of CBDC issuance. He further highlights several areas that may require further investigation such as technological uncertainty, the strength of manpower, institutional structures, understanding the needs of potential users, and cross-border payments for successful CBDC implementation.

Conclusion

CBDC is in the early stage of development and finding common experiences of CBDC issuance across the countries may not be replicable in other countries due to the socioeconomic and technological environment variation. Ahnert et al. (2022) rightly mention that a successful implementation of CBDC requires the central bank to strike a balance for optimal adoption in this digitally evolving market. Thus, there are still open questions, and CBDC remains an emerging area for exploration raising challenges and opportunities. In this light, we searched the articles in our paper and identified some challenges related to CBDC issuance and implementation. In summary, the challenges identified are financial stability, challenges for banks, operation challenges, consumers' and merchants' digital financial literacy, lack of differentiation with existing digital payment services for users, cybersecurity risks, challenges

to privacy, and regulatory challenges. Hence to fulfill the central bank's objectives, the CBDC requires further research into their design, technology, financial impact, and other country-specific factors.

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