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The Transmission Mechanism of Monetary Policy and Central Bank Digital Currency: A New Monetary Order?

Abstract: Over the last decade, monetary policy frameworks and instruments have undergone significant modifications. In this regard, Central Bank Digital Currency (CBDC) has emerged as a new money invention to offset the advancement of cryptocurrencies and maintain central ability to distribute cash as a common good. Thus, the purpose of this study is to examine how the adoption of CBDC can change monetary policy transmission mechanism. CBDC can disintermediate the conventional banking industry and produce inflationary pressure through the money supply unless central banks adopt suitable regulatory frameworks to facilitate a seamless transition. On the other hand, a well-structured CBDC can encourage increased financial inclusion, resulting in a favourable outcome on the interest rate pass-through of monetary policy. Meanwhile, since interest-bearing CBDC can affect bank reserves, deposit rates and lending policies, it can also have an impact on the credit channel.

Keywords: Digital currency, inventions, transmission channels, industry.

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1. Introduction

Central bank digital currency (CBDC) is a revolutionary breakthrough that has raised stability concerns, due to the complete modification of central bank obligations. Accelerated by the recent COVID 19 pandemic, the Russia-Ukraine war, and the boom in the cryptocurrency market, CBDC development is already at different stages of progress. According to Alfar, Kumpamool, Nguyen and Ahmed (2023), central banks intend to launch CBDC, (which is more secure than other forms of money) in order to thrive in this digital era and remain a monetary authority by providing stable money to the public. Cukierman (2019) stated that CBDC ensures the effectiveness of monetary policy in a context that is becoming increasingly filled with privately issued digital currencies. In addition, a 2022 survey conducted by the Bank for International Settlements (BIS) reported that among the surveyed central banks, (which make up 76% of the entire population and 94% of the world's economic output), 90% were exploring opportunities to introduce CBDC. In July 2023, the Atlantic Council's CBDC tracker reported that 11 CBDCs have been launched, four of which are in operation: Nigeria's e-Naira, The Bahamas' Sand Dollar, Jamaica's JAM-DEX, and Anguilla's DCash. Meanwhile, a decentralized approach has been applied in all countries where CBDC has either been launched or is in the pilot stage, even though the majority of research involves single-tiered interest-bearing digital currency (Lukonga, 2023). Hence, central banks are not only concerned about their role as a common good (cash) supplier to the public, but also about the stability of the entire financial system since the world is slowly moving towards brand-new technological solutions for money transfers. Here, the implications of CBDC on monetary policy and financial stability raise several unanswered questions, including how CBDC can potentially alter the pass-through of monetary policy actions that influence the economy, how CBDC can impact the functioning of a financial system, the value of money, inflation, the central bank's emergency liquidity provision policy and the central bank's communication policy (Elsayed and Nasir, 2022). Recently, research and policy working papers have been published on the design features, forms, motivations, and monetary policy framework of CBDC. However, little information has been found about whether CBDC impacts the transmission channels of monetary policy. Thus, the present study first defines the existing monetary policy and its transmission channels to understand the *ex-ante* changes.

Monetary policy lag is one of the issues that makes pass-through inefficient. In this regard, new innovations in the monetary policy framework, such as CBDC, can help reduce the lags of monetary operations by directly affecting the behaviour of economic actors. For example, the introduction of interest-bearing CBDC can enable central banks to immediately affect the behaviour of households and companies, without intermediary lags (Kóczyán, Kollarik, Kiss and Simon 2022). Current literature has different views on implication of CBDC on monetary policy transmission channels. Meaning, Dyson, Bar-

ker and Clayton (2021) raised the argument that the interest rate channel can be strengthened by making CBDC more appealing than bank deposits, but it could also disintermediate banks and weaken the bank lending channel. Kaczmarek (2022) states that CBDCs could lead to substantial changes in the way commercial banks operate, which could lead to the central banks no longer being responsible for issuing electronic money. Andolfatto (2021) concluded that the introduction of CBDC may not necessarily result in adverse effects on bank lending policy, even when the monetary authority complies with monetary rules. Thus, financial stability is unlikely to be jeopardized by a well-designed CBDC. In related research, Brunnermeier and Niepelt (2019) claimed that loose monetary policy can be used to mitigate disintermediation issues, but Bindseil and Panetta (2020) contended that a differentiated interest rate policy for CBDC and other types of deposits will be more effective. Kumhof and Noone (2018) proposed that disintermediation can be mitigated by setting limited borders on the issuance of CBDC. However, limiting CBDC holdings can be challenging, since it may require legal adjustments and possibly conflict with the public's expectations of CBDC. It is worth noting that while some jurisdictions, such as the European Union, have established cash payment limits for security and fraud reasons, similar limits on CBDC may not align with the public's expected usage and convenience. This illustrates the complexity in finding appropriate limits for CBDC holdings (BIS, 2021). In this case, the rationale behind CBDC can help address these opposing arguments. For instance, if the motivation to influence monetary policy is interest-bearing CBDC (as a substitute for interest-bearing deposits), then it can carry the risk of disintermediating the banking industry. On the other hand, if CBDC is less attractive than bank deposits, then there may be a limited impact on the financial system, since there will be no alternative to bank deposits (Bordo, 2021). From another perspective, the introduction of CBDC can improve the performance of monetary operations. For instance, by offering interest on CBDC and using this rate as an operational tool, it is possible to address the issues related to the effective lower bound (Agarwal and Kimball, 2015; Bordo, 2021). Even though CBDC is a relatively new and rapidly evolving topic, there have already been several empirical studies dedicated to the subject. A notable study by Barrdear and Kumhof (2022) found that if CBDC makes up a 30% share of the gross domestic product (GDP), then it can increase the real growth of economy by 3% (due to the safety feature of the instrument), create favourable interest rates, and cause a drop in monetary transaction costs. Andolfatto (2021) conducted a study on the banking system and CBDC-bearing interest, and found that as CBDC promotes competition, it reduces monopolistic bank profits. In this case, CBDC does not have an unfavourable implication on bank lending, but it can influence lending policy in some circumstances. CBDC issuance can increase the risk of banking panics, but this risk can be mitigated if central banks set a cap on CBDC issuance or if commercial banks limit deposit convertibility when panic thresholds are reached, providing strategies to maintain financial stability (Souissi and Nabi, 2023). Finally, many studies have primarily focused on the key determinants, design features, and other technical aspects

of CBDC (Bhaskar, Hunjra, Bansal and Pandey, 2022). For example, a thematic review by Ozili (2023) provided a conceptual framework of CBDC and collected the main literature on the core features of CBDC, while another review by Carapella and Flemming (2020) examined how CBDC affects commercial banks, monetary policy, and financial stability. However, little is known on how CBDC affects the transmission mechanisms of monetary policy. Therefore, the present study critically reviews the existing literature by examining how CBDC affects the transmission mechanism of monetary policy. The contributions of this study are as follows. First, it can help scholars, policymakers, and practitioners better understand CBDC by identifying the main research topics in the ever-expanding literature. Second, it contributes to the literature by considering how the introduction of CBDC influences the framework and pass-through of monetary policy. Third, it discusses the scant literature on how the introduction of CBDC presents challenges to the financial system, especially the banking system. In his study, Zharikov (2022) concluded that a shared interest rate in BRICS, implemented through a gradualist approach, would allow banks to adapt with moderate income losses, while a liberal approach risks bank failures and capital flight, with expanded digital money supply benefiting consumers but reducing domestic banks' interest income.

The remainder of this paper is organized as follows. Section 2 presents an overview of CBDC, including its important features and characteristics, while Section 3 examines various studies from the perspective of how CBDC can affect the framework of monetary policy and the functioning of monetary transmission channels. Finally, Section 4 investigates the global trend of CBDC implementation, while Section 5 presents the conclusion and future research recommendations.

2. CBDC overview

In general, today's money is diverse, starting with deposits and cash and ending with cryptocurrencies and stablecoins. However, due to such diversity, people are facing a lack of interoperability within these systems (without multiple transaction chains, i.e., intermediaries). For example, deposit-money transfers have low efficiency because of long transaction chains, cryptocurrencies impose volatility risks, and cash is the least-wanted aspect in which electronic transfers can minimize the spread of infections. Thus, it seems like only stablecoins are threatening central banks (Kosse and Mattei, 2023) when it comes to winning the trust of people. To address the challenges of the global payment industry, such as elevated expenses, slow transaction processing, restricted availability, and inadequate transparency, central banks have developed their own digital currency. Bordo and Levin (2017) defined "digital currency" as an asset kept in electronic form that has a fixed nominal value and can effectively perform the same

purpose as physical cash, namely enabling all public and private transactions. As for CBDC, Meaning et al. (2021) defined it as a digital representation of fiat currency that is introduced by the central bank and possesses the capability to facilitate payment settlements. Additionally, the International Monetary Fund (IMF, 2020) defined CBDC as an innovative type of electronic currency with three important attributes: 1) it is digital; 2) it is supported and guaranteed by the central bank (ensuring its stability and credibility); and 3) it holds the legal status of being recognized as a form of valid payment within a given jurisdiction. However, it should be noted that these three criteria are not fulfilled by central bank cash, which is a liability. Conversely, commercial bank money is digital in nature, but it is not a central bank liability and not entirely legal tender. Although all of these definitions of digital currency closely depend on its core features, such as accessibility, technology, remuneration, and distribution (Meaning, Dyson, Barker and Clayton, 2018), each feature has its own risks and benefits that must be properly managed.

In terms of accessibility, CBDC is available to both individuals (retail) or businesses (wholesale) (Chen, Goel, Qiu and Shim, 2022). According to Fung and Halaburda (2016) and Bjerg (2017), accessibility is a main feature that CBDC must have because it can enhance financial inclusion, while reducing the reliance on cash, thus providing a competitive edge over similar electronic alternatives such as cryptocurrency. Although surveys conducted by the BIS reported the prevalence of retail CBDC over wholesale, several studies have firmly stated that CBDC must be widely accessible, like cash. For example, in an article by the Bank of Canada (2020), it broadened the term to “universal accessibility” to indicate maximum inclusion. Specifically, this term incorporates the central bank’s Universal Accessible Device (UAD), which is not only used without electricity (like cash), but can also be used by visually, cognitively, and physically disabled people. However, countries in which CBDC has been launched mainly rely on smartphones with no UAD. Moreover, accessibility indicates whether nonresidents, tourists, investors, and commercial users are allowed to open a foreign CBDC wallet. If they are allowed, then it could lead to local bank runs and the extinction of weaker currencies at the global level. Evidence of this is the U.S. dollar hegemony when non-U.S. citizens hold onto U.S. cash because of stability concerns regarding their respective domestic currency. Hence, when considering the accessibility of CBDC, it is important to thoroughly analyze the consequences in order to avoid the risks associated with bank runs or the depreciation of local currency because of a strong foreign CBDC. To date, there are certain views regarding how retail and wholesale CBDC can impact monetary policy. Beniak (2019) asserted that CBDC for financial institutions itself does not alter the approach and execution of monetary policy, but the effect of retail CBDC on monetary policy (which is accessible to nonfinancial firms and households) can vary, depending on how it is designed and adopted. According to Terták and Kovács (2022), central banks in industrialized nations frequently rely on middlemen and may want to restrict the public’s access to CBDC. In

this case, if CBDC is granted without restrictions, then it would not only place a floor on interest rates, but it may also affect all types of payments by altering the speed of money circulation, the extent of bank deposit withdrawals, the variability of bank reserves, the degree of currency replacement, and the direction of capital movements. However, inefficient pass-through and a low level of financial inclusion may appear because of restrictions in public access to CBDC. Therefore, when considering CBDC, monetary policy guidelines should be in line with accessibility. Furthermore, if the goal of monetary policy is to promote the participation of diverse agents in a financial system, then CBDC should be available to a broader spectrum of economic actors in order to improve transaction efficiency.

Meanwhile, technological choices for CBDC are no less important than accessibility. Recently, there were only two choices: account-based and token-based CBDC. However, synthetic CBDC has since been introduced (Adrian and Mancini-Griffoli, 2021). These three types of CBDC are explained as follows.

Account-based CBDC resembles existing checking deposits, indicating that the payment system is non-anonymous and involves long transaction chains, which is similar to commercial banks. The most frequently mentioned issue with CBDC is banking disintermediation, which refers to the potential transfer of deposits from the banking system to CBDC-denominated funds, as well as potential bank panics, due to the distrust of commercial banks. Thus, the optimal strategy for a monetary authority to avoid disintermediation is imposing a negative interest rate on higher amounts of safe assets. This can ensure that the interest rates of bank loans remain at reasonable optimistic levels, which can avert a significant surge in defaults and bankruptcies, thus supporting economic sustainability, increasing confidence levels, and reducing the probability of bank panics (Bordo, 2021). However, Barrdear and Kumhoff (2022) stated that banks are not significantly at risk from the launch of CBDC. This is because any potential run on CBDC must reduce the total amount of government bonds held by asset holders, rather than bank accounts. In fact, CBDC accounts at the central bank can only be disintermediated if they contend with regular bank deposits in terms of interest rates and services. Meanwhile, Chiu, Davoodalhosseini, Jiang and Zhu (2019) confirmed that CBDC has no negative impact on private bank intermediation. In this regard, it serves as an alternative option for customers, thereby limiting the monopoly power of banks and leading to more efficient bank intermediation. As stated earlier, if CBDC does not earn any interest, then it will not affect monetary policy if the central bank's interest rate is significantly positive. Instead, it will simply become another element that the central bank must consider. Yet, if a monetary authority wants to make interest rates negative and commercial banks follow suit with their customers, then CBDC will be more attractive than deposits for savers. This is because CBDC has almost no cost of holding, unlike cash, which includes some costs. In sum, CBDC without interest will make it more difficult for the central

bank to overcome the zero lower bound (ZLB) issue and limit its options for monetary policy (Beniak, 2019).

Token-based CBDC, on the other hand, can be more efficient in regard to universal accessibility. Since CBDC resembles physical cash (i.e., it operates as interest-free electronic cash without providing extra services to current/potential customers), the probability of disintermediation diminishes (see Table 1). This disintermediation is similar to the “cashless world” described by Woodford (2000), which is related to paying interest on CBDC in the digital age. It should be noted that both technologies have a single common feature: they are central bank liabilities. However, account-based CBDC is exclusively on the central bank’s ledger (direct CBDC), whereas token-based CBDC can be issued by private institutions with the central bank’s approval. Moreover, token based CBDC allows central banks to build a two-tier distribution model, which can enhance the use of existing resources. Yet, as with any other option, token-based technology includes its own risks, including increased velocity of money (due to instant availability) and low transaction costs. This can lead to an increase in the inflation rate, which can be challenging for countries that already have such a high rate (Lukonga, 2023).

Regarding *synthetic* CBDC or sCBDC, the BIS (2020) raised the question of whether sCBDC can actually be considered as CBDC. Specifically, sCBDC allows private financial institutions to issue digital currency and maintain a 1:1 ratio in local currency in their central bank reserves. This resembles stablecoins backed by the U.S. dollar. However, risks will emerge if CBDC competes with bank deposits (i.e., if it is remunerated). Such risks also include disintermediation and bank runs, due to the volatility in reserve money. In this regard, people will likely transfer money into a CBDC wallet because of the stability of central banks. In contrast, the more that CBDC resembles cash, the less risky it will appear (Cesaratto and Febrero, 2022).

Table 1: Technology Choices, Risk level and Consequences

CBDC	Technology	Consequences	Risk level
Remunerated	traditional bank's money, i.e., deposits (account-based)	disintermediation	high
		bank runs, due to volatility in reserve money	
Unremunerated	e-cash (token-based)	claim to Central Bank's facilities	medium
		it would be ineffective as an instrument of monetary policy unpredictable velocity, which leads to high inflation	

Source: Author’s construction based on the literature (Cesaratto and Febrero 2022, Bindseil and Panetta 2020, Meaning et.al 2021, Lukonga 2023)

The operational models of CBDC are also noteworthy. First, according to Auer and Böhme (2020), the *indirect* CBDC model (also known as the two-tiered model) involves clients holding a claim on a commercial bank, while the monetary authority solely focuses on monitoring the accounts of intermediaries. In related research, Kumhof and Noone (2018) and Adrian and Mancini-Griffoli (2021) reported that the indirect model is a digital money system in which customers have CBDC-like claims from intermediaries who hold CBDCs at the central bank. This system is not only convenient, but it also relieves the central bank from customer service tasks. However, since the central bank does not record or verify individual claims, it mainly relies on intermediary information to fulfill customer rights.

Second, the *direct* CBDC model involves CBDC holders who have a direct claim for monetary authority, which monitors all balances and records each transfer. Although this system is a simple way of issuing digital money without intermediaries (and much faster and more efficient than today's systems), it can be less reliable because of operational and cyber risks. Meanwhile, the central bank would have to build and maintain a large technical capacity, which is not its core competence. The customers would also lose the benefits of having intermediaries who provide customer service, risk management, and offline payments. Yet, the central bank may have the benefit of transmitting policy rate decisions to market rates faster, since it does not involve intermediaries. According to Chen et al. (2022), a BIS survey revealed that most central banks prefer the two-tiered CBDC model that fosters private sector collaboration and synergies, as exemplified by China and the Hong Kong Monetary Authority (HKMA). This preference is also consistent with their desire for greater interoperability.

Finally, the *hybrid* CBDC model is a middle-ground that enables direct claims from the central bank, while delegating payment processing to intermediaries. This system requires a legal procedure that protects claims, keeps them out of the balance sheets of payment system providers (PSPs) and requires a technical capability that enables the portability of holdings. It also requires the central bank to possess a record of all retail CBDC holdings and transfer them from one PSP to another in case of a technical malfunction. However, according to Mu (2023), before conducting e-CNY (the digital version of the Chinese yuan) trials, the People's Bank of China (PBC) was concerned that a single-tiered system might trigger a massive shift of bank assets to the central bank and disrupt the financial intermediation process. It has since been agreed that a single-tier system is not the least intrusive option. In light of all three models, the hybrid CBDC model is a middle-ground solution that is more resilient than the indirect CBDC model, but more complex for the central bank. Meanwhile, it is less complex than the direct CBDC model, since the central bank only manages the fundamental operations, while the intermediaries provide supplementary services (without interacting with retail users).

It should be noted that the motivation for introducing CBDC can vary, depending on the country's stage of advancement. For example, the central banks of advanced economies are generally more interested in enhancing the effectiveness, safety, and resilience of their payment systems, while those of emerging economies tend to focus more on increasing the access and inclusion to financial services through CBDC (Terták and Kovács, 2022). The first and foremost motivation for issuing CBDC is to enhance payment system efficiency (Chen et al., 2022; Mu, 2023; Brunnermeier and Landau, 2022; Rennie and Steele, 2021; Bank of Canada, 2020). A prevalent case for enhancing the central bank payment system is e-CNY, which can process 10,000 transfers per second. According to Mu (2023), by adopting CBDC, since the central bank payment system can simultaneously handle multiple transactions, it can also lower the barriers for accessing payment services for marginalized groups, such as the disabled, the elderly, and nonresidents, who may encounter difficulties in using local payment instruments. However, it can also pose various risks, such as cyberattacks and privacy risks, which could lead to losses of one's identity, freedom, and consumer credit information. Second, many central banks are motivated to enhance financial inclusiveness in emerging market economies (Terták and Kovács, 2022; Boar, Holden and Wadsworth, 2020; Bordo, 2021; Ozili, 2022). Although digitalization has brought significant improvements in financial inclusion worldwide, 1.7 billion people still face barriers in the access to the official financial system (Auer et al., 2022). In this case, CBDC can help many people gain access to digital finance at a lower cost, especially those in emerging or less developed countries. As for the risks, Chen et al. (2022) argued that cyberattack prevention can be more challenging because of financial inclusion expansion and connections with the wider financial and digital ecosystem. Third, monetary policy, fiscal policy, and financial stability are considered as other potential motivations for researching CBDC (BIS, 2021; Barontini and Holden, 2019; Kwon, Lee and Park 2020; IMF, 2020; Chen et al., 2022; Terták and Kovács, 2022). According to Bordo and Levin (2017), one potential reason for introducing CBDC is to facilitate unconventional monetary policy. CBDC can also offer benefits such as efficient and rapid transfer of funds by governments to individuals and businesses in times of economic stress, emergencies, or natural catastrophes such as the COVID-19 pandemic. As for the latter, the high proportion of citizens without bank accounts or the high level of corruption in emerging economies made it more difficult for people to receive money transfers during this pandemic. Regarding the financial stability aspect of CBDC, it has been documented by Brunnermeier and Niepelt (2019), Andolfatto (2021), Sanches and Keister (2021), Panetta (2022), and the BIS (2021). Although the advocates for financial stability contend that CBDC can make the financial system better by fostering greater competition and accessibility, banks may face a diminished role (disintermediation) and a higher risk of deposit withdrawals. Similarly, Kim and Kwon (2019) stated that CBDC can have negative effects on financial stability by reducing private credit, increasing nominal interest rates, and decreasing reserve-to-deposit ratios. In this regard, Bordo (2021) suggested that modern central banks can protect themselves from these

risks and increase public trust by establishing a suitable deposit insurance system. On the other hand, additional motivations for issuing CBDC mentioned in the current literature include reducing the size of the informal economy for emerging market economies (Barontini and Holden, 2019); reducing the cost of issuing and managing physical currency (IMF, 2020; Chen et al., 2022), preventing illegal activities (Engert and Fung, 2017); and balancing geopolitical concerns (Rennie and Steele, 2021). However, different CBDC designs are likely to involve trade-offs, making it difficult to simultaneously realize all motivations (BIS, 2020).

3. CBDC and Monetary Policy Transmission Mechanism

3.1. The Potential of CBDC to Change the Monetary Policy Framework

The monetary policy framework consists of tools, operational and intermediate targets, and ultimate goals (Warjiyo and Juhro, 2022), while the main monetary policy tools that central banks have are open market operations, reserve requirements, policy rates, re-lending and re-discounting (including the use of the term *repurchase market*), and credit policy (sometimes coordinated with trade policy). In other words, these tools are used to control macroeconomic aspects such as price stability, inflation, and exchange rates. There has been some research on how the implementation of CBDC can change the monetary policy framework. Schilling, Fernández-Villaverde and Uhlig (2020) showed that the CBDC initiative can create a difficult trilemma for central banks, in which they must choose between operational, financial, and price stability objectives. The authors also argued that CBDC can only enable two of these goals at the same time, implying a trade-off among these three objectives. Kahn, Kahn, Singh and Alwazir (2022) suggested that because CBDC is valued at a 1:1 ratio with existing currency and is obtained through the exchange of other currency or assets, it does not fundamentally alter the way monetary policy is carried out. However, CBDC includes the possibility of enhancing the influence of monetary authority over monetary policy and increasing its ability to generate seigniorage. According to Meaning et al. (2018), account-based CBDC that bears interest can serve the objectives of monetary policy in a similar way as the current practices of central bank reserves. In fact, it is plausible to conjecture that pass-through can become even more effective for a given policy instrument adjustment.

Another aspect of CBDC is how it changes the reserves of the banking system. According to the Fed's Research and Analysis Paper (Federal Reserve of America, 2022), CBDC can affect monetary policy and interest rates by changing the reserve supply in banks. The volume and volatility of the public's demand for a noninterest-bearing CBDC might also be on par with other variables that influence the reserve volume of banks, including shi-

fts in physical currency or overnight repurchase agreements. In this situation, a decrease in CBDC that leads to a rise in reserves will simply make them more plentiful, with a minimal impact on the federal funds rate. Likewise, this rate will be unaffected by the decline in reserves caused by the rise in CBDC, provided the initial supply of reserves is sufficient to act as a buffer. According to Kóczyán et al. (2022), CBDC can have a positive impact on monetary conditions, due to its potential for promoting perfect competition and efficiency. In a related study, Meaning et al. (2021) showed that CBDC with a variable interest rate may be used to control macroeconomic indicators (e.g., output and inflation), as the primary tool of monetary policy. Additionally, central banks can use the asset purchase (quantitative easing) program more efficiently with CBDC. Contrary to the current functioning of asset purchases, central banks do not need commercial banks as intermediaries. Instead, central banks directly buy assets from firms and corporations by crediting their CBDC accounts. In this regard, Keister and Sanches (2018) argued that CBDC execution may promote a move away from bank deposits, resulting in increased funding costs for banks. However, the central bank can address this issue by carefully selecting the interest rate on CBDC and striking a balance between these competing concerns.

If there is minimal friction in the market (akin to the Friedman rule), then the central bank pays a higher interest rate for CBDC. However, in the case of a higher-friction environment, the central bank should offer a lower interest rate (or even a negative one) in order to enable bank deposits to carry a liquidity premium, thereby aiding banks in partially overcoming investment friction. In this way, digital currency can be a valuable tool for a monetary authority to manage overall liquidity. Mancini-Griffoli et al. (2018) mentioned that CBDC has the potential to improve the liquidity provision to financial institutions and enable faster resolution of runs. The most significant effect on monetary policy may come from public account-based CBDC. This is because value-based systems, which restrict CBDC access to commercial banks, mainly involve changes to the way that money is transferred between parties. With an account-based system, CBDC must create guidelines for managing public accounts, which will compete with those offered by private banks (Beniak, 2019). According to Barrdear and Kumhof (2022), CBDC can be seen as an extra tool for monetary policy, which can help smooth out fluctuations in the aggregate output.

It should be noted that after CBDC adoption, central banks may possibly encounter new facilities in the monetary policy framework. First, CBDC has the potential to revolutionize fiscal policy by facilitating direct monetary transfers to citizens, commonly referred to as *helicopter money* or *QE for the people*. In this case, a monetary authority can directly transfer funds from its central bank treasury account to the accounts of citizens through CBDC, bypassing the need for commercial banks. This approach can avoid disturbing monetary policy, while enabling the government to provide immediate

support to citizens during an economic crisis. However, the BIS (2020) has raised concerns about the potential risk of a monetary authority's autonomy if fiscal assistance were delivered through CBDC. Critics have also argued that such transfers could blur the line between monetary and fiscal policy, as well as reduce the autonomy of central banks. Nonetheless, post-Keynesian economists remain skeptical about this challenge and argue that CBDC can be a powerful tool for achieving both social and economic goals.

Second, the disappearance of cash can have significant implications for monetary policy, particularly the negative interest rate environment. In this regard, CBDC can potentially facilitate a policy of negative interest rates, which can allow the central bank to overcome the ZLB (Bordo, 2021; Brunnermeier and Landau, 2022). This is because CBDC can broaden the monetary policy tools, enabling the central bank to imply negative interest rates on reserves and deposits to stimulate spending. If CBDC were to completely replace cash, then it could eliminate the zero-rate option that banknotes currently provide, making it easier for the central bank to implement negative interest rates. Meanwhile, to avoid these prices, the people may be encouraged to utilize foreign money (or even cryptocurrency) if cash was unavailable. This could effectively reduce the transmission of policy rates and raise the dangers to financial stability. Moreover, any central bank that issues CBDC to improve the transmission of negative rates will most likely encounter resistance and acceptance challenges, which will also reduce the efficiency of rate transmission.

Finally, one of the primary benefits of CBDC is its ability to protect uniform currency. This is because most currency is created by private banks, which may lead to fragmentation within the monetary system. However, because central bank currency can be exchanged at par, it is perceived as safe and reliable. With the introduction of CBDC, this safety and reliability can be further enhanced, since it can help prevent a division in the monetary system where various types of money become less interchangeable. This fragmentation can create distrust for the value of currency, which can have a detrimental impact on the economy. Hence, by introducing CBDC, policymakers can ensure that a uniform currency is maintained, which can provide stability and certainty to financial markets and the wider economy.

The aforementioned effects of CBDC on the monetary policy framework arise from the implementation of direct and hybrid distribution models, which require central banks to make significant adjustments to their existing policies. In contrast, synthetic CBDC that utilizes an indirect distribution mechanism is more akin to the conventional monetary policy framework. In other words, it does not necessitate significant changes to the existing framework. Under this scenario, central banks can continue to utilize their

traditional tools to regulate the money supply, since synthetic CBDC does not directly affect the money supply or circulation. Therefore, the adoption of CBDC and its impact on the monetary policy framework require careful consideration of the distribution model utilized in its implementation.

3.2. The Impact of CBDC on the Current Monetary Policy Transmission Mechanism

The growing use of electronic payments, which has resulted in a decline in cash, has called into question the central bank's significance as the monetary authority and the primary role of monetary instruments (Serrate and Lopez, 2021). According to one survey, more than 70% of central banks active in CBDC development favour a two-tiered approach, with the majority (76%) considering compatibility with the current payment system (Kosse and Mattei, 2022). Regardless of whether a central bank opts a single- or two-tiered distribution structure, CBDC in a digital wallet is kept in the central bank's ledger and cannot be lent out. On the other hand, single-layer CBDC poses an additional danger to monetary policy, since it has the potential to impact payment system organization and monetary policy. Meanwhile, the majority of nations are exploring an unremunerated and two-tiered retail CBDC model in which financial institutions oversee distribution and customer-facing operations. In this case, since the effect of retail CBDC on monetary policy is contingent on the level of CBDC adoption, scheme choices that promote high adoption (e.g., complete anonymity, token-based technology, no fees, and interoperability) can increase monetary policy risks, whereas those that restrict high adoption (e.g., transaction caps and full disclosure) can reduce such risks (Lukonga, 2023).

Although CBDC has the potential to strengthen monetary pass-through, it also carries the risk of potentially higher inflationary pressures. This is because the implementation of CBDC may cause the amount of money (M) or the velocity of money (V) to grow faster than the actual GDP. In other words, the introduction of CBDC may lead to an increase in the overall money supply, triggering an inflationary spiral. This can be problematic for countries that have implemented inflation-targeting regimes, since they will need to conduct additional monetary operations to ensure that the appropriate inflation rates are maintained, especially when the credibility of the central bank has been debated. These additional monetary operations can include adjustments to interest rates or the implementation of other policies designed to manage the money supply and ensure that inflation remains under control (Lukonga, 2023).

One of the innovations of CBDC is its interest-bearing aspect. As for the traditional interest rate channel, it works through financial intermediaries, mainly commercial banks. However, the introduction of CBDC enables central banks to directly influence interest rate conditions without commercial banks. In this regard, Mancini-Griffoli et al. (2018) found that the interest rate channel can be significantly impacted by CBDC, due to its potential to increase financial inclusion. Meanwhile, since unbanked populations have access to banking services, central banks can influence household consumption and saving behaviours. Consequently, monetary policy decisions may be more efficient because they involve more participants. It should be noted that the stabilization policy of central banks can only be strengthened by the introduction of CBDC if its interest rates are close to zero (Armelius, Boel, Claussen and Nessén, 2018). Since CBDC rates will have a greater impact on deposit rates in commercial banks, the interest rate channel will be most affected (Beniak, 2019). Meaning et al. (2018) asserted that the initial stage of the monetary transmission mechanism with CBDC functions in a similar manner to the current process. Specifically, the central bank can adjust the interest rate or the quantity of CBDC to align short-term money market rates with the target corridors. In other words, central banks use CBDC (instead of account-based money) to affect money market rates. However, if the central bank adjusts interest rates on CBDC, while deposit rates in commercial banks remain unchanged, then it can result in the reallocation of financial resources from deposits to CBDC. This phenomenon can potentially strengthen the second stage of the transmission of monetary policy. Regarding the speed of transmission, it depends on how banks react to deposit outflows. According to Bordo and Levin (2017), banks that prioritize customer relationships are less susceptible to deposit outflows. Regarding the interest rate for CBDC holdings by banks, it can be used to determine the direction of monetary policy, while this rate held by nonbanks can be employed to manage the demand for such currency (Meaning et al., 2021). Armelius et al. (2018) pointed out that CBDC that does not bear interest can potentially increase the lower bound on interest rates by eliminating the storage costs associated with physical banknotes. Since this could further constrain the efficiency of monetary policy, the advantages of CBDC adoption must be critically assessed. Bordo (2021) suggested that the main instrument of central banks for monetary policy should be the interest rate on CBDC. In this case, the digital currency rate acts as the minimum level for interest rates in the financial system, after which any changes in the CBDC rate will impact a broad range of short-term interest rates, thus ensuring the efficacy of monetary policy. Central banks may also be able to switch from the *floor system to the corridor system*, with the interest rate on CBDC as the policy rate (Meaning et al., 2018). Specifically, in order to maintain desired clearing rates in the secondary market for reserves, the central bank employs a corridor to regulate the quantity of reserves. In contrast, in the floor system, the central bank increases the supply of reserves to meet demand. In this case, the central bank pays an interest rate on the accounts (or at least a portion of the balances) held with it overnight to reduce this demand (Goodfriend, 2002). Bordo and Levin (2017)

argued that with interest-bearing CBDCs, there will no longer be a significant need to maintain an inflation buffer. Currently, physical currency creates a significant obstacle for central banks to lower their policy rates in response to severe adverse shocks. However, this obstacle can be removed by implementing a graduated fee schedule on transfers between cash and CBDC. This will allow central banks to reduce their policy rates more effectively than they would with physical currency.

At this point, the following question is raised: How might the bank lending channel be impacted after the introduction of CBDC? Meaning et al. (2018) raised an interesting point about this effect through costs. Specifically, the implementation of CBDC can eliminate the extra costs associated with traditional banking system transactions, giving nonbank providers a competitive advantage over commercial banks. Consequently, banks may be reluctant to increase lending rates, as a reaction to policy rate changes and out of fear of losing ground to nonbank providers. Meanwhile, the choice of external funding sources made by the banks to replace diminishing deposits brought on by the outflow of money to the central bank can determine the effect on bank lending rates and lending channels. As for the pass-through from the policy rate to retail rates, it may be higher if commercial banks use central bank financing. According to Mancini-Griffoli et al. (2018), the central bank may not have the same level of control over lending rates as it does now, especially if banks favour interbank funding. However, it should be noted that deposit loss and the resulting need to secure external funding from various sources present problems for financial stability, which may have a negative effect on the smooth functioning of monetary pass-through (Denmarks Nationalbank, 2017). The effect on the expectation channel is not yet obvious. Table 2 summarizes the CBDC effect on the different transmission channels in the present study.

Table 2: CBDC Effect on Different Transmission Channels

Monetary Policy Transmission Channels	Effect of CBDC
Interest rate channel	CBDC enhances financial inclusions thus monetary policy pass-through
Credit channel	could also strengthen, as it has effects on bank balance sheets and profits and thus their non-deposit funding cost and lending rates
Expectations channel	unlikely to be affected
Exchange-rate channel	unlikely to be affected

Source: Author's construction based on literature (Mancini-Griffoli et al. 2018, Mehrotra, Nadhanael 2016, Bernanke 2007, Meaning et al. 2018)

Finally, the exchange rate channel is less affected, since any exchange rate variation resulting from CBDC can affect both exports and imports. Meanwhile, shocks in larger

economies may pose asymmetries to the independence of the monetary policies of small open economies, which may function via uncovered arbitrage between the interest rates of nations with CBDC (Ferrari, Mehl and Stracca, 2020). Exchange rate changes may also be magnified because of spillover effects after monetary shocks. However, they can be lessened by pursuing rule-like policies and coordinating monetary policy. Only if nonresidents were permitted to utilize CBDC for speculative purposes can this alter the exchange rate channel of monetary transmission. Yet, during flight-to-safety events, the issue would not be confined to a small number of advanced economies. Instead, it may be a problem for central banks in emerging markets, due to the likelihood of significant fluctuations in CBDC flows (depending on risk appetite). This is similar to the situation with other emerging market assets, which are also subject to significant fluctuations in flows during times of economic uncertainty (Löber and Houben, 2018). Ferrari et al. (2020) examined the effects of CBDC on external shocks, optimum monetary policy, and well-being in a two-country model. They found that, although the introduction of CBDC increases the external spillovers of shocks and the international connections between the two countries, the magnitude of these effects mainly depends on the design of CBDC.

4. The Global Trend of CBDC Implementation

In general, retail CBDC initiatives have made more progress than those of wholesale CBDC. As of December 2022, retail CBDC has been issued by central banks in The Bahamas, Nigeria, and Jamaica, as well as eight member countries of the Eastern Caribbean Currency Union (ECCU), which include; Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines. Several other countries, including China, Ghana, India, Kazakhstan, Korea, Russia, Sweden, and Thailand, are in pilot phases, while more than 90 countries are conducting active research. Table 3 presents the classification of CBDC projects in terms of participants and purposes.

Table 3: Classification of CBDC Projects in Terms of Participants and Purposes

	Project	Participants	Purpose
Wholesale	Multiple CBDC Bridge	Thailand, China, Hong-Kong, and UAE	To expedite, reduce the cost of, and improve the efficiency of transfers and foreign exchange operations
	Project Dunbar	Australia, Singapore, Malaysia, and South Africa	To allow international settlements across multiple CBDCs
	Project Mariana	France, Switzerland, Singapore, and the BIS	To facilitate exchange between Swiss franc, euro and Singapore dollar on the wholesale level
	Project Jura	France and Switzerland	To conduct an experiment using wCBDC for cross-border settlement on a DLT platform
	Onyx/Multiple wCBDC	France and Singapore	Cross-border payment test with the Monetary Authority of Singapore that used JP Morgan's Onyx unit
	Project Helvetia	Switzerland and the BIS	Examined the possibility of issuing CBDC onto SIX's, commercial infrastructure operator's, distributed digital asset platform
	Project Jasper	Canada, UK and Singapore	Cross-border testing with the Bank of England and Monetary Authority of Singapore
	Project Aber	Saudi Arabia and the UAE	Launched a bilateral CBDC pilot project, decentralized ledger facilitates cross-border transactions
	Project Cedar/Ubin	US and Singapore	Explores cross-border, multi-currency transactions with DLT
Retail	Project Sela	Israel, Hong-Kong and the BIS	To explore the cybersecurity implications of two-tier, retail CBDC
	Project Icebreaker	Israel, Norway, Sweden and the BIS	To test interconnection and interoperability between distinct retail CBDCs
	Project Rosalind	UK and the BIS	To understand how CB ledgers can effectively communicate with private sector vendors
	Project Polaris	Nordic Centers	To explore security and resilience in CBDC systems
Retail and wholesale	Project Aurum	Hong-Kong and the BIS	CBDC prototype which could issue both retail and wholesale tokens
	Project Nexus	Eurosystem, Malaysia, Singapore, Indonesia, Philippines and Thailand	To connect national instant payment systems for cross-border transactions in under 60 seconds
	Project Tourbillon	BIS Swiss center	Explores how to improve cyber resiliency, scalability, and privacy

Source: Author's construction based on literature (Sethaput and Innet 2023) <https://www.atlanticcouncil.org/cbdctracker/>

However, in nations where CBDC has been previously adopted or where pilot programs are currently under way, such adoption has been relatively slow. Some examples are as follows. Approximately two years after its launch, CBDC accounts for less than 0.1% of the currency in circulation in The Bahamas, while one year after its launch, public acceptance of the e-Naira in Nigeria is still at an incredibly low 0.15%. In Jamaica, although the uptake of CBDC (JAM-DEX) has been slow, it is somewhat increasing. As of March 2022, DCash made up only 0.16% of the circulating currency in the ECCU, while

the PBC stated that as of the end of December 2022, the amount of e-CNY in circulation was only 0.13% of the total amount of money in circulation (M0).

Despite the challenges that CBDC can cause, some countries are speeding up their adoption, due to the risks of future financial instability. These risks were first posed by Facebook's Libra coin, which influenced China to launch the e-CNY. Further risks for central banks were posed by COVID-19 and the Russia–Ukraine War (Zhang, Wang, Wei and Zhao, 2021), in which sanctions caused the boom of the cryptocurrency market. As a result, China launched the Digital Currency Electronic Payment (DCEP), a national digital currency, in 2017 (Aysan and Kayani, 2022). According to economic experts, the early development of China's DCEP is expected to support the country's endeavour to internationalize its currency, the renminbi (RMB). These experts also argue that China's position as an early mover in the field of digital currency is crucial in terms of gaining a competitive advantage and potentially exerting an influence on a global scale (Knoerich, 2021). The major objective of the DCEP is to create a digital payment system that is accepted in China as legal currency (Gu, 2020), with the central bank fully supporting it at a 1:1 ratio to RMB fiat money. The DCEP also aims to replace cash (the M0 money supply) without affecting the amount of money in circulation. According to Knoerich, it bears no interest and is not subject to transaction or payment limitations. Currently, China leads the way in CBDC implementation with its DCEP system, which is already available in several cities. In the future, the DCEP has the potential to encourage larger circulation of the Chinese RMB on a global level. This could subsequently lead to the weakening of the cross-border payment system, which is currently dominated by the U.S. dollar. Meanwhile, the widespread adoption of the DCEP could potentially transform the existing global financial ecosystem, since it offers a seamless and efficient transaction system that is not only secure, but also cost effective. Moreover, the increasing use of DCEP could facilitate greater trade and investment opportunities between China and other countries, thereby allowing the former to exert greater influence in the international financial arena (Zhang et al., 2021). In related research, the e-CNY could facilitate the structural transformation of the financial system in China if it is successfully adopted over the long term (Allen, Gu and Jagtiani, 2022), whereas Alwago (2022) argued that although the U.S. dollar's dominant position is under threat, the political and economic conditions are not favourable for the globalization of the RMB.

As for the e-CNY system itself, it is built on a two-tier structure, with the PBC responsible for issuance and redemption, interoperability, and wallet ecosystem management. In the first tier, the PBC issued digital currency to intermediaries, including China's four largest state-owned commercial banks (the Bank of China, the Industrial and Commercial Bank of China, the China Construction Bank, and the Agricultural Bank of China) as well as payment providers such as Alipay from Alibaba, WeChat Pay from Tencent, and China UnionPay (Zhou, 2020). This allowed different stakeholders to utilize the-

ir comparative advantages in various aspects of payment (e.g., product development, system application, use case analysis, brand strategy, business processing, and maintenance and support) and create a more efficient e-CNY ecosystem that is driven by the market (Mu, 2023). In the second tier, the intermediaries provide digital currency to individuals and enterprises in retail industry. By adopting a two-tier operational system, the e-CNY system can reduce its impact on the financial system, while ensuring fair competition. This approach avoids significant changes to the existing currency circulation system and maintains the established two-tier structure of the monetary system. Consequently, it remains neutral in terms of competition within the savings market. In other words, the introduction of a two-tier CBDC will not increase banks' reliance on interbank lending or hinder their lending capabilities, thereby mitigating the risk of disintermediation. Yao (2018) suggested that the introduction of CBDC in China can improve the stability of the value of money and serve as an effective tool for implementing macroeconomic policies. The implications of these findings that, by utilizing the features and capabilities of CBDC, policymakers can potentially exert greater control over the monetary system, enabling more precise and targeted implementation of macroeconomic policies to achieve the desired economic outcomes.

5. Conclusion

The current literature highlights the necessity for CBDCs to respond to the rise of private cryptocurrencies. As cryptocurrencies, such as Bitcoin and Ethereum, become increasingly popular, central banks are exploring the possibility of issuing their own digital currency to maintain control over monetary policy and financial stability. In this regard, CBDC can be an alternative to private cryptocurrencies, offering a stable and regulated form of digital currency. However, it is essential to mention that the relationship between CBDCs and private cryptocurrencies is complex and multifaceted. While CBDCs can offer a regulated alternative to private cryptocurrencies, they may also need to address technological and design challenges to compete effectively. The present study has highlighted several challenges and considerations that must be addressed before implementing CBDC. One critical issue is the potential impact on commercial banks and the overall financial system. Specifically, CBDC could disrupt the traditional banking sector by reducing the deposit base and altering the role of banks as intermediaries. It should be noted that the specific impact on banks will depend on the design and implementation of CBDCs. Different models, such as a two-tier system, can mitigate potential risks and maintain the role of commercial banks as intermediaries. Another key finding of this study is that CBDC can potentially address the issues related to financial inclusion. By providing a digital payment system that is accessible to all (regardless of socioeconomic background or geographical location), CBDC can promote greater financial

inclusivity and reduce the reliance on traditional banking services. While CBDCs have the potential to enhance financial inclusivity, the access to digital infrastructure and financial literacy are critical factors that need to be addressed to achieve meaningful financial inclusion. In addition, CBDC can change the monetary policy framework in a way that liquidity provision and the negative interest rate policy (ZLB) is facilitated, which, in turn, can help prevent a fragmented monetary system in which different types of currency become imperfect substitutes. Also, it is noteworthy to mention that the effectiveness of CBDCs in implementing specific monetary policies will depend on the central bank's chosen design and operational framework. Finally, this study found that CBDC can strengthen the interest rate channel of monetary transmission by promoting financial inclusion. The credit channel can also be strengthened, since it has an impact on bank balance sheets, reserves, and funding policies. However, the exchange rate and expectations channels are unlikely to be affected. While CBDCs may have an impact on these channels, comprehensive empirical evidence is still limited, and the extent of their influence will depend on various factors, including the design, adoption, and integration of CBDCs within the existing financial system.

Although this study focused on current literature and the main aspects of how transmission mechanisms function with and without CBDC, it skipped an empirical investigation because of the relatively low number of CBDC in countries where it has already been launched or piloted. Hence, future studies should conduct robust empirical research on how CBDC can impact different channels of monetary policy transmission mechanisms. Another part of digital currency that must be further explored is the use of UADs. Currently, the application of CBDC is through the Internet on mobile phones, while offline use has yet to be considered. Moreover, issues related to privacy, cybersecurity, and data protection must be thoroughly examined. In this regard, the implementation of CBDC involves the collection and storage of vast amounts of personal and financial data, which raises concerns about privacy and the potential for data breaches. Therefore, addressing these concerns is crucial for gaining public trust and acceptance of CBDC on a wider scale. In this regard, future research should create a prototype of a CBDC physical wallet that can explain its available functions and their respective reasons.

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