# The Influence Pathways and Impacts of Retail and Wholesale Central Bank Digital Currencies on Financial Stability

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**Abstract.** In the face of global economic downturn risks and post-pandemic impacts, the effectiveness of continuous loose monetary policies by various governments has been diminishing. To prevent the potential collapse of the financial system due to prolonged negative interest rates, countries have accelerated the research and implementation of central bank digital currencies (CBDCs). The emergence of CBDC could take direct or indirect impacts on the financial system, including bank disintermediation, negative interest rate policies, legal systems, technological development including block-chain technology, etc. This article analyzes along four paths to prove how retail CBDC and wholesale CBDC affect financial stability: banking industry, monetary policy, payment systems, and financial regulation.

**Keywords:** CBDC; DLT; financial regulation; monetary policy; financial stability.

## 1 Introduction

The global trade environment remains uncertain, accompanied by persistent risks of economic downturn. Many countries have adopted relatively loose monetary policies, ushering in an era of negative interest rates worldwide. However, this policy has not only failed to achieve expected outcomes but has also heightened the fragility of the global financial system. According to the International Monetary Fund's Global Financial Stability Report released in October 2019, 80% of non-bank financial institutions in economies with systemically important financial sectors (measured by GDP) are highly vulnerable, approaching levels seen during the peak vulnerability of the global financial crisis. Moreover, with diminishing scope for conventional monetary policy measures, a recession in the era of negative interest rates could potentially destabilize the traditional monetary credit system, posing risks to financial stability. Hence, this paper investigates the impact pathways and consequences of central bank digital currencies (CBDCs) on the financial system, examining both retail and wholesale perspectives.


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## 2 Definition of Legal Digital Currency

CBDC refers to a digital currency issued by a country's central bank, backed by national credit and possessing the highest credit rating. It provides inherent stability in value and serves the three core functions of legal tender: as a medium of exchange, a unit of account, and a store of value.

Since 2015, the Committee on Payments and Market Infrastructures (CPMI) has classified legal digital currency as a type of crypt-currency [1]. From various countries' research and practices, it is evident that central banks are adopting a highly flexible approach to the technical development of CBDCs, without being confined to a single predetermined path. The technical models can vary, being centralized or distributed, account-based or token-based, and managed directly by the central bank or through a two-tier system [2, 3, 4]. In 2018, CPMI introduced the concept of the "money flower," which outlines four critical attributes of central bank digital currencies: the issuer (central bank or non-central bank), the form of money (digital or physical), accessibility (broad or restricted), and implementation technology (account-based or token-based)."

### 2.1 Definition of Retail and Wholesale Digital Currency

Mainstream research categorizes digital currencies into retail and wholesale types based on differences in their intended payment targets and accessibility. These distinctions are central to ongoing international discussions regarding the optimal paths for developing CBDCs.

#### 2.1.1 Retail-type CBDC .

Retail CBDCs are legal digital currencies accessible to the general public, primarily used for transactions in the retail market. Theoretically, the value of retail CBDCs can be stored locally on devices or mobile wallets, akin to universally accepted digital cash backed by the central bank. Similar to physical cash, retail CBDCs represent a liability of the monetary authority, supported by national credit, and possess legal tender status and enforceability. Typically, they are issued and redeemed through a model involving both central banks and commercial banks.

#### 2.1.2 Wholesale-type CBDC .

Wholesale CBDCs are not accessible to the public and are mainly used among financial institutions for transactions in the wholesale market. According to some theories, wholesale CBDCs operate on a distributed ledger system, allowing transaction senders to transfer value directly to recipients through digital tokens, which act as bearer assets. This approach contrasts with the current system where the central bank records account information for both lenders and borrowers without transferring actual value.

## 2.2 Practices of Various Countries in the Field of CBDC

**Table 1.** National Practices of Retail CBDC and Wholesale CBDC

| | Practice State | Project Name | Project Content |
|---|---|---|---|
| Retail type | Central Bank of Uruguay | Digital peso "Thee-Peso Project" | In 2017, the Central Bank of Uruguay (BCU) launched the world's first legal digital currency project by issuing an initial batch of digital notes worth 20 million Uruguayan pesos (approximately 4.775 million RMB) on a limited scale. |
| | Central Bank of the Bahamas | Sha Yuan "Sand Dollar" | The project aimed to enhance financial inclusion through the use of a digital version of the Bahamian dollar as a payment method, facilitating access to the digital payment system via electronic wallets. |
| | Swedish Central Bank | E-Krona Project | The Swedish central bank introduced the e-krona to combat the ongoing decline in cash usage, offering the public a digital alternative supported by state-guaranteed currency value. |
| Retail/Wholesale type | The People's Bank of China | DC/EP Multilateral Digital Currency Bridge | China's Digital Currency Electronic Payment (DCEP) initiative focuses primarily on small-scale retail scenarios. It operates on a two-tier issuance structure involving both the central bank and commercial banks. Commercial banks are required to maintain 100% reserves with the central bank. The project also explores the application of central bank digital currencies in cross-border payments through a multilateral digital currency bridge. |
| Wholesale type | Monetary Authority of Singapore and the Bank of Canada | Jasper Project | In 2019, collaborative efforts between the two countries involved in the DCEP project leveraged DLT. Notably, the Monetary Authority of Singapore completed a direct remittance to the Bank of Canada (BoC) without the need for intermediaries. |
| | Bank of Thailand | Inthanon Project | Thailand's financial infrastructure has seen significant enhancements through the exploration of DLT's potential. Initially focusing on domestic wholesale fund transfers, the project expanded to support cross-border transactions. Participants included Bangkok Bank and the country's seven largest commercial banks. |
| | European Central Bank and55 Bank of Japan | Stella Project | The experimental results of the European Central Bank and the Bank of Japan's interbank digital currency payment scheme, based on DLT, demonstrate its capability to replicate key functions of traditional RTGS. These functions include queue management, transaction privacy, settlement finality, and mechanisms for saving liquidity. |
| | Monetary Authority of Singapore | Project Ubin | The project tested a central bank digital currency payment scheme based on DLT, achieving the main functions of traditional RTGS; the second phase explored the interaction and coordination between the DLT solution and RTGS. |

Data Source: BIS and author's compilation.

Recent surveys by the Bank for International Settlements (BIS) indicate a significant shift in global attitudes towards CBDCs, evolving from cautious and conservative stances to active exploration. By early 2023, 93% of central banks worldwide were involved in CBDC research, with more than half conducting experiments and pilot projects [5]. Retail CBDCs, initially conceived as digital-age replacements for cash, have been launched in at least 88 countries and regions. Before 2019, central banks primarily focused on applying Distributed Ledger Technology (DLT) to Real-Time Gross Settlement (RTGS) systems within the wholesale funds market [6].

Theoretical concepts of CBDCs across different countries generally align on the idea that CBDC represent the future of monetary systems. However, varied national conditions have led to diverse perspectives on issuance purposes, usage scenarios, and implementation methods. Most CBDC are based on block-chain technology with distributed ledger technology, thus giving CBDC the characteristics of being tamper-resistant, efficient, and traceable.(Table 1).

## 3 The Role and Effects of CBDC on Financial Stability

In response to the current economic downturn, there have been international proposals for negative interest rate policies and higher inflation rate targets. However, both approaches face practical limitations. Existing payment systems also encounter challenges such as interruptions and limited coverage, especially in cross-border payment clearing, where infrastructure is often inadequate and presents numerous inconveniences. Retail CBDCs and wholesale CBDCs are designed to tackle these issues, each employing distinct mechanisms.

As revealed by the research, the emergence of CBDC could take direct or indirect impacts on the financial system, including bank disintermediation, compression of intermediary services, negative interest rate policies, credit creation, monetary policy transmission, legal systems, technological development including block-chain technology and smart contracts, etc. Scholars generalized all those factors might significantly affecting CBDC into four path: banking industry, monetary policy, payment systems, and financial regulation [3] [19](Fig. 1).

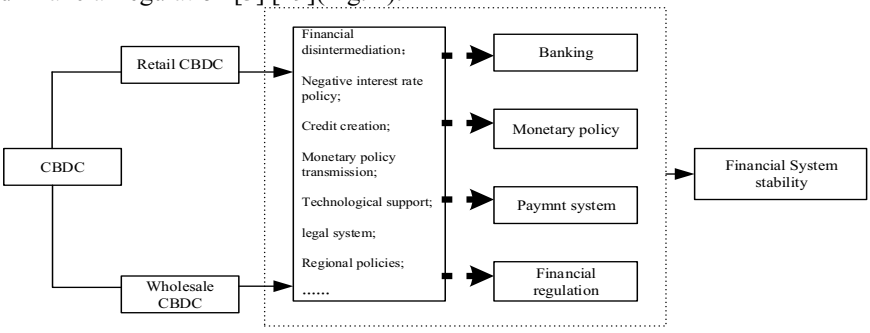


**Fig. 1.** The Path of CBDC' Impact on Financial Stability

### 3.1 Retail CBDCs: Banking Financial Disintermediation, Enhanced Effectiveness of Monetary policy, Efficiency of the Payment System Improvement and Impacting Financial Regulation

#### 3.1.1 Lead to "Crowding out Effect" on Bank Deposits and Financial Disintermediation.

Research has shown that interest-bearing CBDCs can squeeze out bank deposits. Although "dual-tier" issuance and management structure adopted by China and most country can reduce the risk of disintermediation, the full reserve system and the nature of the central bank's liabilities can still exacerbate the squeeze on bank deposits.[10](Formula derivation as Table 2,(1-4))

**Table 2.** Monetary Aggregates

| Currency hierarchy | traditional currency hierarchy | currency hierarchy of CBDC |
|---|---|---|
| $M0$ | $M0 = C;$ | $M0 = C_1 + CBDC$ |
| $M1$ | $M1 = C + \mathrm{D};$ | $M1 = C_1 + CBDC + \mathrm{D}$ |
| $M2$ | $M2 = C + \mathrm{D} + \mathrm{T}$ | $M2 = C_1 + CBDC + \mathrm{D} + \mathrm{T}$ |

$C$ :cash; $\mathrm{D}$ :demand deposits; $\mathrm{T}$ :time deposits; $C_1$ :CBDC cash ; $m_1$ :the money multiplier of $M1$ ; $m_2$ : the money multiplier of $M2$ ; $E$ : bank excess reserves; $R_d$ :demand deposit reserve requirement ratio; $R_t$ :statutory reserve requirement ratio for time deposits.

The money multipliers in the traditional monetary policy framework:

$$m_1 = \frac{D + C}{D \times R_{\mathrm{d}} + T \times R_t + E + C} = \frac{1 + \frac{C}{D}}{R_d + \frac{T}{D} \times R_t + \frac{E}{D} + \frac{C}{D}} \tag{1}$$

$$m_2 = \frac{D + C + T}{D \times R_{\mathrm{d}} + T \times R_t + E + C} = \frac{1 + \frac{C}{D} + \frac{T}{D}}{R_d + \frac{T}{D} \times R_t + \frac{E}{D} + \frac{C}{D}} \tag{2}$$

In the CBDC traditional monetary policy framework, the money multipliers will transformed as follow forms:

$$m_1 = \frac{D + C_1 + CBDC}{D \times R_{\mathrm{d}} + T \times R_t + E + C_1 + CBDC} = \frac{1 + \frac{C_1 + CBDC}{D}}{R_d + \frac{T}{D} \times R_t + \frac{E}{D} + \frac{C_1 + CBDC}{D}} \tag{3}$$

$$m_2 = \frac{D + C_1 + CBDC + T}{D \times R_{\mathrm{d}} + T \times R_t + E + C_1 + CBDC} = \frac{1 + \frac{C_1 + CBDC}{D} + \frac{T}{D}}{R_d + \frac{T}{D} \times R_t + \frac{E}{D} + \frac{C_1 + CBDC}{D}} \tag{4}$$

The ultimate impact of CBDC on the money multiplier depends on the currency ratio, the ratio of excess reserves to demand deposits, and the changes in the ratio of time deposits to demand deposits. Besides, these issues also affects the deposit creation capability.

Compared to zero-interest cash, interest-bearing legal digital currency better preserves value and enhances public trust in the monetary system. Legal digital currency offers substantial transaction convenience and profitability compared to cash, potentially displacing cash over time, although the decision on whether retail central bank digital currency should bear interest remains undecided [11]. Due to their equivalent liquidity to demand deposits, legal digital currencies may prompt the public to shift deposits to digital forms, potentially limiting the money creation ability of commercial banks if full reserves are required. This impact varies based on the profitability and convenience of digital currency payments. However, if primarily used as a payment method to complement cash (M0), retail legal digital currency could coexist alongside cash for an extended period, gradually replacing it in the long term [12, 13]. However, completely replacing cash in the short term is currently impractical. Furthermore, as demand deposits and digital currency are classified differently, commercial banks must adjust their balance sheets according to central bank regulations and establish appropriate information systems, which introduces adjustment pressures [14].

### 3.1.2 Enhance Effectiveness of Monetary Policy Transmission.

Retail CBDCs hold significant potential for enhancing the transmission of monetary policy. Firstly, interest-bearing retail CBDCs can eliminate the effective lower bound of interest rates, thus expanding the scope of monetary policy. Traditional theory indicates that the rigidity of deposit interest rates limits the effectiveness of negative interest rate policies. However, widespread adoption of central bank digital currency and reduced availability of large-denomination cash reduce arbitrage opportunities between cash and digital currency. Consequently, funds would predominantly reside in specialized digital currency accounts, enabling the central bank to influence commercial bank deposit rates through negative interest rates on CBDCs or moderate wallet custody fees. This approach can stimulate consumption and investment without solely relying on changes in depositor risk preferences, thereby avoiding a liquidity trap and eliminating the effective lower bound of interest rates [7] [10].

Secondly, issuing CBDC allows the central bank to bypass constraints posed by the effective lower bound of interest rates and the necessity of using inflation as a primary monetary policy tool. This flexibility means that commercial banks are not compelled to pass on changes in interest rates directly to the real economy [8].

Lastly, from a theoretical standpoint, legal digital currency can serve multiple functions beyond recording transactions and tracing data by using block-chain technology and smart contracts. It can be programmable for monetary purposes, enabling central banks to monitor circulation post-issuance and gather comprehensive monetary information. This capability, coupled with a forward-looking condition-triggered design, can effectively address traditional monetary policy challenges such as the negative interest rate lower bound, ineffective transmission mechanisms, and the potential drawbacks of traditional quantitative tools leading to excessive liquidity [9].

### 3.1.3 Improve the Efficiency of Payment System.

CBDC Based on block-chain technology can enhance the resilience of payment system.

As a payment tool, digital currency improves payment efficiency and stability, empowering financial institutions and users to diversify risks, thereby strengthening the resilience of the national payment system. In contrast to the traditional model where each commercial bank operates its own clearing system, serving as both an intermediary and central authority, CBDC adopts a distributed architecture. This decentralization reduces payment times and costs, while its decentralized nature lowers the risk of data tampering or attacks.

The issuance and use of digital currency not only enhance existing payment tools but also ensure continuous digital payments during interruptions in private institutions' payment systems due to technical or network issues. Retail CBDC also simplifies access to central bank funds for electronic payments, expanding financial inclusion by enabling a broader demographic to utilize these services [15].

### 3.1.4 Impact on Financial Stability and Financial Regulation.

On one hand, the issuance of CBDC could potentially increase financial fragility, raising the risks of speculative attacks and bank runs within the financial system.

CBDC is confronted with two primary underlying technical vulnerabilities: Firstly, the distributed ledger technology might not sustain the stable operation of CBDC transactions. Secondly, the frequent occurrence of hacker attacks poses a grave potential danger of significant losses for those holding CBDCs.

The distributed ledger technology is subject to "Impossible Trinity" where it is challenging to simultaneously attain decentralization, security, and high performance. Leaks of information from digital currency operational entities can result in the misuse of user data for illegal activities such as fraud and money laundering, directly violating users' rights to privacy, property, and reputation. Furthermore, there are currently no pertinent regulations to address these issues.

On the other hand, the block-chain technology underlying legal digital currency ensures controllable anonymity and resistance to tampering, which can lower the costs of customer identification and anti-money laundering, thus improve regulatory efficiency [16].

## 3.2 Wholesale Digital Currency: Efficiency Gains and Policy Implications

### 3.2.1 Squeeze the Intermediate Business of Banks.

According to the policies on CBDC in China, the central bank will manage the payment, settlement, and data analysis services of the CBDC, centrally, and delegate these tasks to independent certification centers, registration centers, and big data analysis centers.

As a result, the payment and settlement services, which originally belonged to the intermediate business of banks, will be squeezed as the pilot and comprehensive pro-

motion of the CBDC are carried out. This includes the loss of service fees, loss of control over user information, and the commercial opportunities contained in this information.

### 3.2.2 Optimize Payment Functionality and Drive Societal Cost-Savings and Efficiency.

DLT based on block-chain technology applied by financial asset (even digital asset) payment and settlement arrangements could use in more Transactions such as non-standardized equities, debts, derivatives, syndicated loans, and trade financing have a low degree of centralization and involve long settlement times and low efficiency. If these asset transactions are integrated through a unified DLT solution and settled directly using CBDC, economies of scale can be achieved, promoting cost savings and efficiency in society [20].

Current wholesale payment systems (traditional cross-border trading tables) are technologically outdated. Central Bank Digital Currencies (CBDCs) can enhance payment systems while incorporating the benefits of traditional payment instruments. Firstly, by enabling digital record-keeping and tracking, CBDCs can improve the enforcement of Anti-Money Laundering and Combating the Financing of Terrorism (AML/CFT) regulations, potentially reducing activities in the informal economy. Secondly, the digital nature of "minting," circulation, and storage of CBDCs results in lower issuance and transaction costs. Thirdly, leveraging existing advanced mobile payment technologies, CBDCs can facilitate payments across various mediums and channels, offering the same universality and omnipresence as other mobile payment solutions [6]. Experiments in Singapore, as well as joint efforts by the European Central Bank and the Bank of Japan, validate these benefits. When non-bank financial institutions engage in settlements using CBDC, it enhances socio-economic benefits by optimizing fund transfers, enhancing transaction security, improving data management, and bolstering risk control. The Bank of Canada's Jasper project, which explores a DLT-based CBDC large-value payment system, illustrates how such systems can integrate financial assets onto the block-chain, reduce collateral management and reconciliation cost [9].

### 3.2.3 Finance Regulation Need of Refinement.

The Bank of Canada's Jasper project illustrated facilitate financial asset transactions settled using central bank money, thereby strengthening market transaction oversight [17].

However, there is a counter viewpoint suggesting that payment systems based on distributed ledger technology may not significantly differ from current systems in terms of legal, operational, and security requirements. Moreover, they could potentially introduce new counterparties with direct or indirect access to central bank accounts, posing regulatory challenges [18].

In the realm of regulatory compliance, decentralized asset transactions necessitate the incorporation of regulatory technology concepts through technological innovation.

It is essential to set up a technical regulatory access point to strengthen active and intrusive regulatory capabilities for decentralized asset transactions, providing specialized services such as KYC (Know Your Customer), AML (Anti-Money Laundering), project due diligence, risk grading, information disclosure, and risk monitoring. The concrete implementation forms can vary based on different technical solutions; some may demand extensive restructuring, while others might only require minor amendments and adjustments [19].

## 4 Conclusion

As revealed by the research above, distinctions arise between retail and wholesale CBDC in their pathways and effects. And the suggestion should be as follows: establish the most optimal monetary policy based on CBDC, drive the transformation of commercial banking services, Increase investment in research and development of key technologies such as block-chain to improve the technical maturity and security of CBDC, refine legal and regulatory frameworks about CBDC.

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