Development Status of Digital RMB Under the Background of Blockchain Technology: Theoretical Practice and Policy Suggestions

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Abstract. In the burgeoning digital economy, the explosion of interest in digital currencies, sparked by blockchain technology, has captivated stakeholders across the spectrum. At the forefront, China's central bank's digital yuan is rapidly advancing, setting it apart from private digital currencies with its legal status, anonymity, and convenience, thus heralding significant shifts in market transactions and necessitating enhancements in the national financial infrastructure. This paper, through a comprehensive review of literature and current trends, delves into the digital yuan's theoretical foundations, its application, impacts, and the risks it poses. Findings suggest that the digital yuan, leveraging its unique features, has made inroads in consumer services, aiding the broader acceptance of digital payments in China. Yet, its integration into supply chains and retail sectors lags, trailing behind third-party payment systems in adoption and development. Amidst efforts to refine policy regulation, bolster financial oversight, and encourage innovation, the digital yuan also introduces financial and cybersecurity challenges. This analysis aims to map out the digital yuan's trajectory under blockchain's umbrella, offering policy insights to underpin further research.

Keywords: Blockchain, Digital RMB, Application prospect, financial innovation, Policy regulation.

1. Introduction

The advent of the Digital Currency Electronic Payment (DC/EP) system heralds a significant evolution in China's financial technology landscape, positioning it as the globe's pioneering large-scale Central Bank Digital Currency (CBDC) initiative. Aimed at overhauling the country's monetary framework, the digital yuan endeavors to enhance the efficiency of currency operations, bolster supervisory mechanisms, and fortify anti-money laundering efforts. Utilizing blockchain as its foundational technology, the digital yuan distinguishes itself through the employment of "electronic wallets" for conducting an array of payment transactions across retail and selected wholesale domains. Its attributes – legal status, anonymity, user convenience, and the extensive traceability of transactions – bestow upon the digital yuan a pivotal role in market exchanges, enabling it to potentially supplant traditional currency forms.

Blockchain technology's integration into the digital yuan's fabric underscores its significance in the contemporary "great wisdom moving cloud area" epoch, demonstrating vast applicability across diverse sectors. This central bank-managed, legally sanctioned digital currency leverages blockchain to ensure governmental oversight over monetary issuance and regulatory practices, setting it apart from decentralized counterparts like Bitcoin and Ethereum. The digital yuan's emergence has captivated global attention, propelling several nations to explore their own CBDC ventures. As a trailblazing project under the aegis of China's central bank, it marries blockchain's revolutionary capabilities with conventional monetary issuance methodologies, instigating unparalleled shifts within the financial ecosystem. Transactions executed in digital RMB are immutably chronicled on the blockchain, ushering in new vistas for transactional transparency, security, and efficiency, whilst concurrently presenting novel challenges for financial innovation and management.

Existing scholarly discourse predominantly focuses on digital currency's ramifications on the payment systems across various industries, with limited attention paid to the digital yuan's developmental trajectory and its broader impacts. This paper endeavors to bridge this gap by

meticulously compiling digital RMB literature and hot topics, conducting comprehensive analyses on its theory, application, impact, and associated risks. Furthermore, it proposes actionable policy recommendations to address these identified risks, thereby furnishing a valuable framework for subsequent scholarly inquiries into the digital RMB domain.

2. Theoretical analysis of blockchain and digital currency

2.1. Blockchain

Introduced by Satoshi Nakamoto in 2008, blockchain technology represents a sequential linkage of data blocks, as outlined in "Bitcoin: A Peer-to-Peer Electronic Cash System" [1]. This structure organizes information packets in blocks according to their time of creation, incorporating timestamps to ensure chronological integrity. It operates on computer servers that provide essential storage and computational power. The ISO22739:2020 standard precisely defines blockchain as a technology that leverages cryptographic methods to secure a consensus on data blocks, forming a distributed ledger with distinct technical, financial, and societal implications [2]. Scholars like Zhang Huan et al., in 2023, describe blockchain as a sophisticated synthesis of various core technologies, including cryptographic algorithms, consensus mechanisms, peer-to-peer transmission, and distributed storage, positioning it as a pivotal distributed network data management technology [3]. Further analysis by Lu Yu in 2020 identifies its fundamental components as distributed ledgers, asymmetric encryption, smart contracts, and consensus mechanisms [4]. Highlighting its transformative capacity, Yao Zhongzheng and Ge Jingguo in 2017 noted that blockchain enables transactions to circumvent traditional third-party financial intermediaries securely, providing a level of decentralization, transparency, security, and anonymity through digital signatures not found in electronic signatures, signifying a significant evolution in digital transactional methodologies.

2.2. Private digital currency and legal digital currency

As the inaugural application of blockchain technology, digital currency has revolutionized the financial landscape. Unlike traditional payment systems characterized by centralization, blockchain-enabled digital currencies operate on an entirely decentralized basis, facilitating direct transactions between parties without the need for intermediaries. Their transaction records are transparently maintained in a continuous blockchain ledger accessible to all users [5]. According to Zhou Yonglin (2018) [6], digital currencies can be broadly categorized into private digital currencies and government-issued legal digital currencies, each leveraging their unique advantages to fulfill various monetary functions and potentially substitute traditional currencies in specific domains.

Private digital currencies, such as Bitcoin and Ethereum, are distinguished by their security and anonymity, attributes afforded by their decentralized nature and the computational limits imposed on them. This decentralization, supported by blockchain's distributed ledger technology, liberates private digital currencies from the constraints of third-party payment systems, enabling direct, peer-to-peer settlements and significantly enhancing payment efficiency. Consensus algorithms ensure the authenticity and reliability of digital currency transactions, while asymmetric encryption safeguards the security and privacy of transactions. However, the anonymity of private digital currencies and their propensity for significant value fluctuations render them highly speculative. The definitional and accounting treatment of these currencies remain contentious across jurisdictions, and unregulated circulation could destabilize the financial system, potentially heightening the risk of illicit activities such as underground market transactions, money laundering, and other criminal endeavors.

Conversely, legal digital currencies are issued by central banks and underpinned by national credit, representing a digital form of fiat money. Unlike their private counterparts, fiat digital currencies are centralized and backed by the full faith and credit of issuing nations. Transaction details are fully transparent to the central bank, with anonymity provisions specifically designed to protect individuals, enterprises, and non-authorized banking institutions [8].

2.3. Digital RMB

Amidst the burgeoning digital economy, the advent of international digital currencies has captivated global interest, propelling research and development efforts towards Central Bank Digital Currencies (CBDCs). In this dynamic landscape, the People's Bank of China's Digital RMB Research and Development working group [9] elucidated the concept of China's legal digital currency in the "White Paper on the Research and Development Progress of China's digital RMB," published in July 2021. Defined as a digital manifestation of legal tender issued by the People's Bank of China, the digital RMB operates under designated institutions. It is anchored in a broad account system, supports the loose coupling of bank accounts, and maintains parity with physical RMB, embodying both value and legal tender status.

The genesis of China's legal digital currency initiative traces back to 2014, with the establishment of a dedicated research group by the central bank. This initiative aimed at the public issuance of a digital renminbi was further advanced in 2016, leading to the inauguration of a digital currency research institute in Shenzhen. This endeavor facilitated the creation of the first-generation legal digital currency prototype system and initiated research and development tests with commercial entities towards the end of 2017. By April 2020, pilot testing of China's digital RMB commenced, progressively expanding its reach. The digital RMB app's official release on platforms like the Huawei application market and Apple App Store in early 2022 marked a significant milestone, enhancing user accessibility and fostering widespread standardization.

3. Application analysis of digital RMB

3.1. Application advantages of digital RMB

The digital renminbi, delineated by its defining attributes, technical specifications, and operational functionalities, can be characterized by six distinct features. Firstly, it possesses legal tender status, equating its legal standing with that of traditional banknotes and coins, enabling its use across all transactions involving the renminbi, underpinned by national credit. Secondly, the digital RMB is engineered to support smart contracts, which necessitate the fulfillment of specific transaction conditions before automatic execution, thereby enhancing transaction security and equity. Thirdly, as Wang Weixuan (2023) [10] highlights, unlike private cryptocurrencies, the digital RMB benefits from national credit endorsement, securing capital flow and personal privacy through a centralized management approach. Fourthly, it operates on a dual-tier system, as elucidated in the White Paper, segregating into issuance and usage layers. The central bank predominates the issuance layer, allocating or withdrawing digital RMB to qualified commercial banks, loosely linked to bank accounts and subjected to the same zero-interest policy as circulating RMB. The usage layer facilitates daily transactions for users via commercial banks. Fifthly, the digital RMB enables dual offline payments, allowing transactions in the absence of network connectivity. Users can execute payments by simply utilizing NFC technology for near-field communication via the "touch" function within the "Digital RMB" app, achieving the "settlement upon payment" convenience without network dependency. Lastly, it adheres to the principle of "anonymity for small amounts, traceability for large transactions," with the central bank's data center capable of real-time monitoring of digital RMB circulation through its unique value certificates to avert illegal activities and mitigate financial risks.

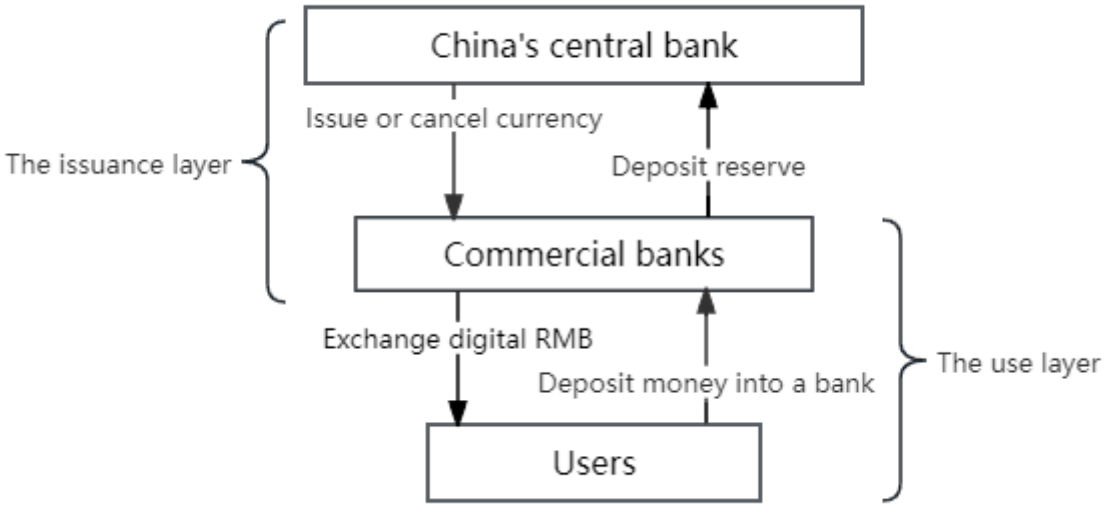

Figure 1. Two-tier operation system

3.2. Comparison between digital RMB and third-party payment

(1) Issuing Authority: According to Zheng Fan and Ni Dehui (2022) [11], the digital RMB is underpinned by national credit and managed by the People's Bank of China, distinguishing it from third-party payment platforms developed by private entities or financial institutions with profitability in mind. While digital RMB represents the digitalization of the physical yuan and falls within the category of M0, merely replacing cash in circulation, third-party payments are facilitated by market-driven enterprises, essentially acting as pre-collected monetary funds by payment institutions, classified under M1. Furthermore, monetary tools like Yu 'e Bao and Changtong, which serve as risk diversification mechanisms stemming from the growing user base and transaction volume of third-party payments, are categorized under M2. Therefore, the monetary attributes of third-party payments span M1 and M2 levels.

(2) Payment Methods: The core advantage of third-party payment platforms presently lies in mobile payments, with digital RMB payment services overlapping in functionalities, especially in retail and small-value, frequent consumer payment scenarios. The primary limitation of third-party platforms is their dependency on network connectivity for transaction processing and data transmission, requiring users to access payment services through mobile apps or websites. On the other hand, the digital RMB enables "payment upon settlement," enriching payment scenarios and fulfilling public demand for safe, efficient, and convenient transactions. While digital yuan primarily facilitates domestic transactions and is in its pilot phase without extensive cross-border application, some third-party services, like the international version of Alipay, support global payments. Additionally, unlike third-party platforms that may charge withdrawal fees for profitability, leading to public debate, digital RMB operates non-profitably, exempting circulation or redemption fees, thus benefiting both issuing commercial banks and individual users through cost savings.

(3) Legal Status: Digital RMB enjoys the same legal currency status as paper RMB, unlike third-party payment methods, which represent a novel payment form without legal tender status. Under the dual-tier operational system, digital yuan usage necessitates a Chinese bank account, with the central bank exerting primary control, whereas third-party services require users to link bank cards or accounts, utilizing various legal funding sources. From a privacy and regulatory standpoint, Huang Zhigang, Huang Shuangshuang, Tang Yong (2023) [12] note that consumer information disclosure is higher under competitive than monopolistic operations. Third-party platforms demand user agreement to personal information disclosure, placing the onus of security management on users. Conversely, digital RMB transactions are only visible to the central bank, reducing privacy and profit

theft risks, and are subject to stringent supervision, including more extensive KYC requirements, thus offering superior security and legal safeguards compared to third-party payments.

In essence, digital RMB affords enhanced protection for users' privacy and financial security over third-party payment methods.

3.3. Application scenarios and prospects of digital RMB

Leveraging Near Field Communication (NFC) and other Internet of Things (IoT) technologies, the digital RMB's electronic payment functionality demonstrates robust utility in offline transactions characterized by frequent small amounts, spatial constraints, and unstable network conditions. Since its pilot inception in 2020, various regions have progressively honed and expanded the deployment of digital RMB, broadening its use cases to encompass e-commerce, daily services, public transit, salary disbursements, and cross-border transactions. To date, over 126 merchant platforms including giants like Meituan, iQiyi, Taobao, Sinopec, and Didi Chuxing have integrated the digital RMB APP, with WeChat and Alipay among the two payment platforms adopting it. In the realm of public transportation, cities such as Hangzhou and Shaoxing now facilitate digital RMB for ride-code services. Moreover, Jiangsu Province has witnessed the adoption of digital RMB in salary payments, transitioning from specific transportation subsidies to comprehensive wage payments. This initiative has spurred the activation of digital RMB wallets for businesses and individuals alike, thereby enhancing its visibility and acceptance. The 2022 Beijing Winter Olympics marked the advent of cross-border payment capabilities for digital RMB, further propelled by pilot projects in Hong Kong, fostering currency interoperability between the mainland and Hong Kong.

The ongoing pilot projects indicate a positive trajectory for digital RMB in consumer services, promoting the wider acceptance of digital payments in China. Nonetheless, there's an observed shortfall in supply-side engagement and widespread adoption among retail merchants. When juxtaposed with third-party payment platforms, the digital RMB's outreach and refinement necessitate further advancement. On the financial front, digital RMB is poised to catalyze financial innovation through the integration of smart contracts and blockchain technology, potentially unveiling new financial products and services to forge a more efficient financial ecosystem. With vast potential within the Chinese market, the digital yuan aims to enhance payment efficiency, foster financial inclusion, and facilitate internationalization. However, it remains imperative to vigilantly address regulatory, privacy, and security considerations to ensure the digital yuan's sustainable progress.

4. Impact analysis of digital RMB

Huang Guoping and colleagues (2022) [17] posit that the digital RMB not only pioneers' advancements in payment and settlement mechanisms but also inherently broadens the spectrum of financial supervision while elevating both its complexity and associated costs. This innovation aims at augmenting the controllability and regulatory efficacy of China's monetary policy, thereby bolstering currency risk management. This discussion unfolds along two pivotal axes: the refinement of policy regulation and the identification and mitigation of currency risks.

The comprehensive adoption of the digital RMB has catalyzed an in-depth exploration into the synergy between monetary policy adjustments and currency risk management. Monetary policy adjustments involve the central bank's strategic maneuvers concerning the aggregate money supply, interest rates, and other macroeconomic indicators to meet predefined macroeconomic goals. Conversely, currency risk management encompasses regulatory measures designed to diminish or circumvent the myriads of risks and perils within financial markets, thus safeguarding financial system stability and integrity. The digital RMB emerges as a formidable instrument for the central bank, furnishing granular insights into monetary usage and flow dynamics. This development ushers in a novel and exhaustive data repository for monetary policy crafting and adjustment, thereby enhancing policy precision and effectiveness. The interplay between monetary policy adjustments

and currency risk management is both intricate and synergistic, with the digital RMB forging a more intimate bond between these domains, manifesting in several key dimensions.

4.1. Made policy regulation more precise

The adoption of the digital yuan empowers the central bank to meticulously track and scrutinize currency circulation, thereby refining the craft and application of monetary policies. Through the lens of real-time digital yuan analytics, the central bank gains the capacity to swiftly identify and mitigate potential risks within the currency market, rendering monetary policy interventions more precise and impactful. Bao Jianyuan (2020) [18] highlights China's pioneering and advantageous position in the realms of high-speed internet, big data, cloud computing, and artificial intelligence technologies. These cutting-edge technological advancements underpin the digital RMB, equipping macroeconomic regulators with the sophisticated tools necessary for making more accurate and informed regulatory decisions.

4.2. Raised the level of financial regulation

The rollout of the digital yuan stands to significantly enhance the central bank's financial supervisory capabilities. By overseeing digital yuan transactions, the central bank can achieve a more nuanced understanding of financial market dynamics, thereby bolstering its defenses against potential currency risks. Additionally, the digital RMB's integration fosters improved risk management practices among financial institutions and contributes to the overall stability of the financial sector. This advancement notably mitigates the issue of information asymmetry, as the widespread adoption of the digital yuan streamlines the central bank's ability to monitor and preempt currency risks effectively. Real-time analysis of digital yuan transactions enables the central bank to swiftly identify and address market risks, ensuring financial market stability.

The traceable nature of digital yuan transactions heralds' significant advancements in anti-money laundering efforts. The development of a joint risk management model, which leverages privacy-preserving computation in the digital yuan's anti-money laundering initiatives, marks a significant stride in this direction. Zhu Wei (2022) [19] underscores the digital yuan's inherent technical prowess in combating financial crimes and augmenting financial oversight. This progress is further supported by concurrent advances in information technology, providing a robust foundation for anti-money laundering activities.

4.3. Promoting financial innovation

In recent years, while the innovation in financial instruments has predominantly orbited around private digital currencies, the inherent instability of these instruments is ill-suited to China's financial innovation landscape. Huang Guoping (2022) [17] argues that the introduction of the digital RMB is poised to mitigate the negative repercussions stemming from the unregulated expansion of private digital currency markets, thereby bolstering the stability of the financial ecosystem. The digital RMB's rollout carves out expansive avenues for financial ingenuity among banks, payment processors, and other fiscal entities. This digital medium, underpinned by the national credit endorsement of the digital RMB, empowers financial institutions to craft more inventive financial products and services, thereby sharpening their competitive edge. Concurrently, it necessitates the fortification of risk management and preventive frameworks to safeguard the integrity and stability of these financial offerings.

The advent of the digital RMB marks a significant evolution in the dynamics between monetary policy adjustments and currency risk management. It has refined the granularity of policy regulations, augmented financial oversight capabilities, and bolstered efforts in monitoring and mitigating currency risks, while also steering the course of financial innovation. Nevertheless, the deployment of the digital RMB must proceed hand in hand with the continuous enhancement of relevant legal and regulatory infrastructures to ensure the financial system's safety and stability. This dual pursuit represents a crucial area for future academic inquiry and policymaking endeavors.

5. Risk identification and policy suggestions of digital RMB

5.1. Risk classification

(1) Financial Risks: The integration of digital RMB into the financial ecosystem encapsulates several risk dimensions, including financial instability, banking system vulnerabilities, the propensity for financial crimes, and challenges in financial oversight. The risk of financial instability primarily manifests through exchange rate fluctuations, given the digital RMB's peg to the traditional RMB, potentially impacting its valuation. Banking system risks arise from the digital RMB's widespread adoption altering the conventional dual-tier banking mechanism. Its decentralized nature significantly reduces reliance on financial intermediaries, simplifying payment and settlement processes without the need for complex intermediation, thereby posing substantial challenges to commercial banks. Such disintermediation may precipitate a decline in bank deposits, thereby straining liquidity. Financial crime risks are largely concentrated around money laundering and illicit fund flows, with the digital RMB's semi-anonymous transactions potentially facilitating such activities due to low transaction and storage costs. It is imperative for governments to intensify scrutiny of atypical transaction patterns. Lastly, the advent of digital RMB presents a pivotal test for regulatory frameworks and legislative bodies, necessitating adjustments to cope with the swift evolution of digital currencies and preempt market turmoil due to regulatory lag.

(2) Information Security Risks: The ascent of the digital economy and the evolution of third-party electronic payment methods have spotlighted money laundering through online transaction loopholes as a predominant concern within China. The anonymity afforded by digital RMB could hinder judicial efforts to trace fund flows and identify involved parties. Furthermore, its operational and supervisory mechanisms, which currently mirror traditional banking systems, coupled with the nascent stage of international legal digital currency research, curtail the prospects for domestic and international information sharing and regulatory collaboration. This scenario amplifies the risks associated with money laundering and terrorism financing. Additionally, in the deployment of digital RMB, safeguarding consumer rights and personal privacy emerges as a paramount concern. While the central bank has instituted an authorization management system for digital RMB data, minimizing data circulation channels to protect privacy, this approach necessitates robust information security capabilities within the central bank's data systems. Prompt establishment and enhancement of a privacy data storage and management system for the digital RMB are essential to address these challenges effectively.

5.2. Policy suggestions

(1) Addressing financial risks necessitates the establishment of explicit regulations surrounding the digital RMB. A comprehensive regulatory framework is vital, encompassing the issuance, transactions, and usage of digital renminbi, along with stringent anti-money laundering and counter-terrorism financing measures. Concurrently, crafting a transparent user privacy policy and data protection guidelines is essential to safeguard against misuse of user information. Regulators should proactively monitor the digital RMB's evolution to maintain market integrity and preempt potential threats. On the cybersecurity front, prioritizing the cultivation of network security expertise ensures the digital RMB infrastructure remains impervious to cyber threats and data breaches. Moreover, international collaboration serves as a crucial strategy in mitigating financial risks, facilitating cooperation with global counterparts and international bodies to address cross-border digital RMB issues and harmonize regulatory standards. The digital yuan's successful advancement relies on a foundation of security and stability, urging policymakers and regulators to remain vigilant against financial risks to promote its seamless adoption and widespread acceptance.

(2) Regarding information security risks, although the Law of the People's Bank of China specifies the central bank as the issuing and regulatory authority, and operating institutions as the entities responsible for anti-money laundering, a detailed regulatory framework remains pending. The central bank should define operational requisites for due diligence, transaction logging, and suspicious

activity reporting in digital RMB dealings, establish a shared reporting system for all relevant entities, and delineate specific roles, auditing protocols, and reporting standards for digital RMB oversight. Rigorous measures must be taken to thwart the exploitation of digital RMB for illicit activities through technological and regulatory gaps. In terms of information technology and privacy safeguards, expanding the pilot scope and application breadth necessitates the acquisition of multi-dimensional data. Building upon existing security measures such as information firewalls, big data analytics, and a risk monitoring and alert system, it's imperative to continuously validate and enhance the risk monitoring framework to bolster early warning and risk detection capabilities.

6. Conclusion

In conclusion, the digital RMB represents a significant stride by the People's Bank of China within the realm of digital currencies, marking rapid progress in China and exerting notable influence on the global monetary framework. It heralds a new phase in China's journey towards a digital economic future, ushering in enhanced prospects for modern payment systems, transactional efficiency, and regulatory robustness. The digital RMB has gained traction on the consumer front by leveraging its unique benefits, fostering the expansion of digital payments across China. Nonetheless, it faces challenges in garnering supply-side engagement and widespread acceptance among retail merchants. In comparison to existing third-party payment solutions, the digital RMB's adoption and refinement require further enhancement. As it navigates the complexities of policy precision, financial supervision enhancement, and the fostering of financial innovation, the digital RMB also encounters associated financial and information security risks, necessitating the development of comprehensive national policies, systems, and legal frameworks. Through a detailed theoretical, application, and impact analysis, this paper not only identifies these risks but also proposes strategic policy recommendations, offering valuable insights for ongoing and future inquiries into the digital RMB's evolution.

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