



Research on the Impact of Digital Currency on the Money Multiplier: Insights from the Money Multiplier Formula

Fengqi Xie

Tomsk State University, Russia

Abstract

This study examines the impact of digital currencies on the money multiplier. Through a comprehensive analysis of various factors, including cash leakage rate, deposit reserve ratio, time deposit ratio, and the proportion of digital currencies in circulation, the study reveals important insights into the relationship between digital currencies and the money multiplier. The findings indicate that the adoption of digital currencies reduces cash leakage rate by providing an alternative to traditional cash, thereby expanding the money multiplier. Digital currencies also influence deposit reserve requirements, either decreasing or increasing the need for reserves, depending on regulatory responses. Furthermore, digital currencies affect the proportion of time deposits, as they lower transaction costs and make long-term deposits more attractive, contributing to the expansion of the money multiplier. Importantly, the study uncovers a positive relationship between the proportion of digital currencies and the magnitude of the money multiplier. As digital currencies gain prominence and their share in the currency system increases, their impact on the money multiplier becomes more pronounced. The study highlights the implications for policymakers, central banks, and financial institutions, emphasizing the need for adaptive strategies in response to the changing landscape of digital currencies. Further research is encouraged to deepen our understanding of the broader implications of digital currencies on the economy and financial system.

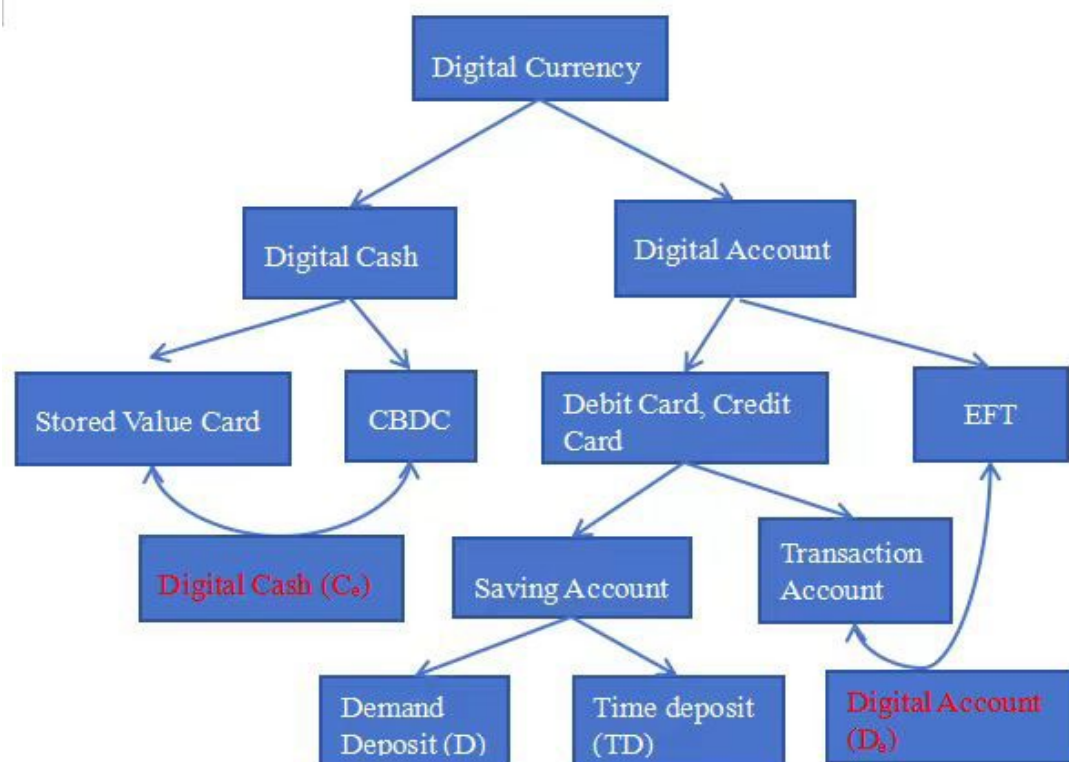
Keywords: digital currency, money multiplier, cash leakage rate, deposit reserve ratio, time deposit ratio, the proportion of digital currencies in circulation

1. Introduction

The rapid advancement of digital technologies has revolutionized various aspects of our lives, fundamentally transforming the way we conduct financial transactions. One notable development in this realm is the emergence of digital currencies (Lü et al., 2020). The concept of digital currency can be traced back to 1993, when Joel Kurtzman reviewed the evolution of currency and proposed that currency has transitioned from a stage of general equivalence to an abstract symbolic existence, where computer systems would replace tangible assets (Kurtzman, 1993). In 2015, the Bank for International Settlements (BIS) defined digital currencies as assets represented in digital form for the settlement of debts and claims (BIS, 2015). Digital currencies are categorized into two types: account-based and wallet-based (Yao, 2017). Hence, within the context of this paper, digital currency primarily refers to digital cash and digital accounts.

Digital cash refers to cash in digital form, specifically wallet-based payment tools, which include various forms of prepaid stored-value cards. On the other hand, a digital account refers to an account based on digital technology, utilized for storing and managing funds and financial information of individuals or organizations, specifically account-based methods encompassing transaction accounts in credit cards and debit cards, and electronic funds transfer systems (Wang et al., 2020).

Figure 1: type of digital currency



Source: The author's own summary.

These currencies have emerged as a disruptive force in the global financial landscape, challenging traditional systems of money exchange and payment. As the use and adoption of digital currencies continue to grow, it becomes increasingly essential to analyze their impact on various aspects of the financial system, including the money multiplier.

The money multiplier is a fundamental concept in monetary economics that quantifies the relationship between the monetary base and the broader money supply within an economy. It represents the potential expansion or contraction of money through the banking system, reflecting the process by which central bank reserves are transformed into loans and deposits (Dong, 2022). Understanding the factors that influence the money multiplier is crucial for policymakers, economists, and financial institutions, as it helps shape monetary policy decisions, assess financial stability, and monitor the overall health of the economy.

With the rise of digital currencies, there is a need to examine their implications for the money multiplier. The unique characteristics of digital currencies, such as their decentralized nature, cryptographic security, and peer-to-peer transactions (Belke & Beretta, 2020), introduce new dynamics that may have an impact on the traditional money creation process. Factors such as cash leakage rate, deposit reserve ratio, time deposit ratio, and the proportion of digital currencies in circulation are potential variables that could influence the money multiplier in the presence of digital currencies (Zhang & Wang, 2019).

This research aims to analyze the impact of digital currencies on the money multiplier and explore the factors that shape this relationship. To achieve the research objectives, a comprehensive review of the existing literature on the money multiplier and digital currencies will be conducted. This will provide a foundation for identifying gaps in knowledge and areas that require further investigation. Theory analysis will be conducted using money multiplier formula, examine the implications of digital currencies on the money multiplier.

The results of this research will have implications for policymakers, central banks, financial institutions, and researchers interested in understanding the changing dynamics of money and the potential effects of digital currencies on the economy. By shedding light on the impact of digital currencies on the money multiplier, this study aims to contribute to the ongoing discussion surrounding the future of money and the financial system in the digital age.

2. Literature review

The money multiplier theory was initially developed by Brunner and Meltzer between 1961 and 1964, building upon the money and credit expansion theory they jointly established (Brunner, 1961). They derived the money multiplier formula, based on the balance equations in the balance sheets of three key entities: monetary authorities, commercial banks, and the public.

According to their formulation, the money multiplier (m) can be calculated using the following equation:

$$m = \frac{1+c}{c+r(1+t)} \quad (1)$$

In the formula, c represents the cash coefficient, t represents the time deposit coefficient, and r represents the average reserve rate, which can be further divided into the average minimum reserve rate and the average excess reserve rate.

In the mid-to-late 1960s, Andersen and Jordan made a significant contribution to the understanding of the monetary base and its analytical use in their seminal work titled "The monetary base-explanation and analytical use" (Andersen & Jordan, 1968). Jordan (1969) further developed a model that expressed the money multiplier as follows:

$$m = \frac{1 + \frac{CP}{DP}}{\left[\left(\frac{R}{DP+T+DP}\right) + \left(1 + \frac{T}{DP} + \frac{DG}{DP}\right) + \frac{CP}{DP}\right]} \quad (2)$$

In the formula, CP represents the currency held by the public, DP represents demand deposits, R represents commercial banks' deposit reserves, T represents time deposits, and DG represents commercial banks' deposit liabilities to the government.

Burger (1972) derived the narrow money multiplier and the broad money multiplier based on the model developed by Jordan. The formulas for the narrow money multiplier (m_1) and the broad money multiplier (m_2) are as follows:

$$m_1 = \frac{1+k}{(r-b)(1+t+g)+k} \quad (3)$$

$$m_2 = \frac{1+k+t}{(r-b)(1+t+g)+k} \quad (4)$$

In these equations, k represents the ratio of currency to demand deposits, r represents the reserve ratio, b represents the ratio of commercial banks' discounted borrowings from the central bank to their total deposits, t represents the ratio of fixed deposits to current deposits, and d represents the ratio of government deposits to public demand deposits.

Numerous theoretical studies have been conducted on money multipliers, and although the formulas may differ, they can be generalized as expressing "the money supply is equal to a certain base money quantity multiplied by a multiplier." The variations in these theories lie in the different factors emphasized in determining the money multiplier.

The factors influencing the money multiplier can be categorized into four main categories: cash leakage ratio, time deposit ratio, statutory deposit reserve ratio, and excess reserve ratio. Additionally, the credit scale control ratio and central bank deposit ratio are two special factors that directly impact the fluctuation of the money multiplier (Ba, 1998). The presence of various financial instruments used as payment methods collectively influences the money multiplier, introducing volatility and unpredictability (Xia & Liao, 2001). The introduction of

legal digital currency is expected to replace physical cash, thereby affecting the currency multiplier (Xie & Feng, 2019). Apart from deposit reserves, the money multiplier is significantly influenced by market entities' demand and bank credit (Zhang et al., 2021). The monetary expansion effect resulting from local government borrowing also impacts the money multiplier (Liu & Li, 2022).

The advent of legal digital currency optimizes the existing digital payment system, but it also introduces challenges in theoretically deriving changes in the currency multiplier (Lin, 2019). The introduction of legal digital currency complicates the delineation of the intermediate target of quantitative monetary policy, enhances uncertainty in the currency multiplier, and hampers monitoring and regulation (Fang & Huang, 2020). However, some scholars argue that while the money multiplier may experience short-term fluctuations with the implementation of legal digital currency, it is expected to stabilize in the long run for both narrow and broad money multipliers (Jiang et al., 2020). The advantages of legal digital currency in transforming circulating currency into narrower currency forms contribute to expanding the multiplier (Yang, 2022).

While existing literature has made significant contributions to the understanding of money multipliers and the impact of digital currency, it primarily relies on traditional money multiplier models, neglecting the comprehensive incorporation of the scale of digital currency. To address this gap, this article proposes an enhanced theoretical framework by introducing digital currency into the traditional money multiplier formula.

3. Methodology and data propositions

3.1 Theoretical framework

Money supply theory posits that the money supply in the modern banking system is determined by the base currency and the money multiplier. Let M represents the total amount of money, B denotes the quantity of base currency, and m represent the money multiplier. Thus, the relationship can be expressed as follows:

$$m = \frac{M}{B} \quad (5)$$

In the absence of digital currency, the total amount of money comprises cash in circulation (C), demand deposits (D), and time deposits (TD). The base currency includes cash in circulation (C) and deposit reserves (R). Consequently, the general formula for the money multiplier is given by:

$$m = \frac{C + D + TD}{C + R} = \frac{c + 1 + d}{c + r} \quad (6)$$

Here, c represents the cash leakage rate, $c = \frac{C}{D}$, d denotes the fixed deposit ratio, $d = \frac{TD}{D}$, and r

signifies the deposit reserve ratio, $r = \frac{R}{D}$.

This article introduces the following currency forms: Cash in circulation (C), demand deposits (D), time deposits (TD), digital cash (Ce), and digital accounts (De). Among these, cash in circulation, demand deposits, and time deposits constitute traditional currency, while digital cash and digital accounts represent digital currency. The base currency encompasses cash in circulation, central bank legal digital currency, and bank deposit reserves (R). Consequently, in a currency system incorporating digital currency, the expression for the money multiplier (m) is modified as follows:

$$m = \frac{C + D + TD + Ce + De}{C + R + Ce} \quad (7)$$

Furthermore, we define τ as the ratio of digital currency to traditional currency:

$$\tau = \frac{Ce + De}{C + D + TD} \quad (8)$$

The revised expression for the money multiplier can be written as:

$$m = \frac{C + D + TD + Ce + De}{C + R + Ce} = \frac{(C + D + TD)(1 + \tau)}{C + R + Ce} = \frac{(1 + \tau)(c + 1 + d)}{c + r + \rho} \quad (9)$$

In this equation, c represents the cash leakage rate, d represents the fixed deposit ratio, r denotes the deposit reserve ratio, τ signifies the ratio of digital currency to traditional currency, and ρ represents the ratio of the central bank's legal digital currency to bank demand deposits.

3.2 Theoretical analysis

(1) The impact of cash leakage rates on the money multiplier.

The first-order partial derivative of the cash leakage rate, calculated using the money multiplier expression in the presence of digital currency, is given as

$$\frac{\partial m}{\partial c} = \frac{(1 + \tau)(r + \rho - 1 - d)}{(c + r + \rho)^2} \quad (10)$$

Because $r + \rho < 1$, therefore $\frac{\partial m}{\partial c} < 0$. Consequently, an increase in the cash leakage rate leads to a decrease in the money multiplier.

Since cash in circulation does not actively participate in the money creation process within the banking system, the cash leakage rate demonstrates an inverse relationship with the money

multiplier. With the introduction of digital currency, such as digital cash or digital accounts, there is a partial replacement of cash in circulation. As a result, the cash leakage rate is reduced to a certain extent. Consequently, digital currency has the potential to expand the currency multiplier by lowering the cash leakage rate.

Table 1: Changes in china's cash leakage rate from 2010 to 2021

Year	cash leakage rate	Year	cash leakage rate
2010	0.201033905	2016	0.163307459
2011	0.212248724	2017	0.149310834
2012	0.215192251	2018	0.153002806
2013	0.210157558	2019	0.154744289
2014	0.209382033	2020	0.155772618
2015	0.187177060	2021	0.163173249

Source: National Bureau of Statistics of China. (2022). China Statistical Yearbook 2022. <https://www.stats.gov.cn/sj/ndsj/2022/indexch.htm>

Based on Table 1, it is evident that China's cash leakage rate has displayed a consistent downward trend since 2010. Notably, around 2014, the cash leakage rate experienced a significant decline. This can be attributed to the rapid development of third-party payment systems during that period. The introduction of digital payment platforms and increased adoption of mobile payment services reduced the reliance on physical cash, thereby lowering the cash leakage rate. Subsequently, from 2014 onwards, the cash leakage rate remained relatively stable at lower levels, indicating a sustained reduction in cash leakage in the Chinese economy.

(2) The impact of deposit reserve ratio on the money multiplier.

The first-order partial derivative of the deposit reserve ratio, calculated using the money multiplier expression in the presence of digital currency, is given as:

$$\frac{\partial m}{\partial r} = \frac{-(1+\tau)(c+1+d)}{(c+r+\rho)^2} \quad (11)$$

Because $\frac{\partial m}{\partial r} < 0$, an increase in the reserve requirement ratio leads to a decrease in the money multiplier. When the deposit reserve ratio is higher, commercial banks retain a larger portion of deposit reserves. Consequently, a smaller proportion of money will be available for currency creation within the banking system, resulting in a reduced amplification of base money. As a result, the money multiplier decreases.

In the context of increasing digital monetization and the rapid growth of non-bank payment institutions, maintaining a high statutory deposit reserve ratio can impede the competitiveness of the banking system in the payment market due to excessive capital costs. Therefore, as digital currencies continue to develop, the average deposit reserve level within the banking system is expected to exhibit a long-term downward trend. Consequently, the central bank

considers the market's reasonable deposit reserve level when determining the statutory deposit reserve level, and this consideration will likely contribute to an overall decline in the statutory deposit reserve level.

Table 2: Changes in china's statutory deposit reserve ratio from 2010 to 2023

Date	deposit reserve ratio	Date	deposit reserve ratio
2010.02.25	16.5%	2016.03.01	17%
2010.05.10	17%	2018.04.25	16%
2010.11.16	18%	2018.07.05	15.5%
2010.12.20	18.5%	2018.10.15	14.5%
2011.01.20	19%	2019.01.15	14%
2011.02.24	19.5%	2019.01.25	13.5%
2011.04.21	20.5%	2019.09.16	13%
2011.05.18	21%	2020.01.06	12.5%
2011.06.20	21.5%	2020.04.15	12.5%
2011.12.05	21%	2020.05.15	12.5%
2012.02.24	20.5%	2021.07.15	12%
2012.05.18	20%	2021.12.15	11.5%
2015.02.05	19.5%	2022.04.25	11.25%
2015.04.20	18.5%	2022.12.05	11%
2015.09.06	18%	2023.03.27	10.75%
2015.10.24	17.5%	2023.09.15	10.5%

Source: eastmoney. (2023). data center. <https://data.eastmoney.com/cjsj/ckzbj.html>

Table 2 displays the changes in China's statutory deposit reserve ratio in recent years, which align with the implications of this article. Since 2012, when currency digitization witnessed vigorous development, the statutory deposit reserve ratio has consistently exhibited a downward trend. This trend is in line with the argument that the development of digital currencies contributes to a reduction in bank reserve requirements, thereby expanding the money multiplier.

Furthermore, considering excess reserves, the efficiency of inter-bank transfers, clearing, and settlement has significantly improved with the advancement of currency digitization and electronic payments. Consequently, the likelihood of commercial banks encountering liquidity crises has decreased. As a result, commercial banks hold substantial excess reserves. With reduced demand for reserves, there is an overall trend of decreasing excess reserves in the banking system.

(3) The impact of time deposit ratio on the money multiplier

The first-order partial derivative of the time deposit ratio, calculated using the money multiplier expression in the presence of digital currency, is given as

$$\frac{\partial m}{\partial d} = \frac{1 + \tau}{c + r + \rho} \quad (12)$$

Because $\frac{\partial m}{\partial d} > 0$, an increase in the proportion of time deposits results in an expansion of the money multiplier.

The continuous development of digital currency and electronic payments has contributed to a reduction in the cost of converting between different financial assets. Additionally, due to the higher interest rates associated with time deposits, there is an increasing trend in the proportion of time deposits. Consequently, the development of digital currencies impacts the proportion of time deposits, thereby expanding the money multiplier.

As digital currencies and electronic payment systems advance, individuals and businesses find it more convenient to engage in financial activities, including the allocation of funds into time deposits. The attractiveness of time deposits, driven by their higher interest rates, leads to a higher proportion of funds being allocated to such accounts. This increase in the proportion of time deposits contributes to the expansion of the money multiplier.

Table 3: Changes in china's time deposit ratio from 2010 to 2021

Year	time deposit ratio	Year	time deposit ratio
2010	0.476855168	2016	0.736370822
2011	0.696848839	2017	0.676740827
2012	0.771404050	2018	0.710961121
2013	0.834886046	2019	0.728692151
2014	0.917507103	2020	0.709146603
2015	0.853447462	2021	0.741893815

Source: National Bureau of Statistics of China. (2022). China Statistical Yearbook 2022. <https://www.stats.gov.cn/sj/ndsj/2022/indexch.htm>

Table 3 illustrates the changes in the proportion of time deposits in China from 2010 to 2021. The data reveals an overall increasing trend in the proportion of time deposits.

From 2010 to 2021, the share of total deposits allocated to time deposit accounts steadily rose. This trend aligns with the argument made in this article that the development of digital currencies and electronic payments reduces the cost of conversion between different financial assets and influences the allocation of funds. Additionally, the higher interest rates associated with time deposits contribute to their attractiveness, further driving the increase in the proportion of time deposits.

These findings suggest that the continuous development of digital currencies and electronic payment systems has had a significant impact on the allocation of funds, leading to a higher proportion of deposits being directed towards time deposit accounts. Thus, the increasing trend in the proportion of time deposits contributes to the expansion of the money multiplier in my

country's financial landscape.

(4) The impact of digital currency proportion on currency multiplier

The first-order partial derivative of the ratio between digital currency and traditional currency, calculated using the money multiplier expression in the presence of digital currency, is given as

$$\frac{\partial m}{\partial \tau} = \frac{c+1+d}{c+r+\rho} \quad (13)$$

Because $\frac{\partial m}{\partial \tau} > 0$, an increase in the proportion of digital currency leads to a greater currency multiplier.

Digital currencies, such as digital cash and digital accounts, offer lower transfer costs compared to traditional currencies. Additionally, transactions conducted through digital accounts ensure that funds continuously flow within the banking system. These characteristics enable digital currency to maximize its participation in the process of deposit currency creation, thereby expanding the currency multiplier.

As monetary forms transition towards digitalization, changes in the base currency can result in more significant fluctuations in the total money supply. The increased proportion of digital currency amplifies the impact of changes in the base currency, presenting the central bank with more complex challenges in monetary regulation.

The lower transfer costs and the seamless flow of funds within the banking system provided by digital currencies enhance their effectiveness in the deposit currency creation process. Consequently, an increased proportion of digital currency contributes to a greater currency multiplier, allowing for more substantial changes in the total money supply.

4. Results and discussion

The findings of this study provide insights into the impact of digital currencies on the money multiplier. Through a comprehensive analysis of various factors, the study reveals the following key results:

Digital currency will reduce the cash leakage rate and expand the currency multiplier by replacing cash in circulation.

Digital currencies will expand the money multiplier by affecting legal deposit reserves and excess deposit reserves.

Digital currency reduces the conversion cost of financial assets, thereby increasing the proportion of bank time deposits and expanding the money multiplier.

Among all currencies, the greater the proportion of digital currencies, the greater the currency multiplier.

The results of this study contribute to the ongoing discourse surrounding digital currencies and their implications for the money multiplier. By elucidating the specific mechanisms through which digital currencies affect the money multiplier, this research offers valuable insights for policymakers, central banks, and financial institutions.

The reduction in cash leakage rate resulting from the adoption of digital currencies has significant implications for monetary policy. As the money multiplier expands, central banks must consider the potential impact on money supply and inflationary pressures. Additionally, regulatory authorities need to adapt their policies to account for the changing dynamics of cash circulation and the role of digital currencies.

The influence of digital currencies on deposit reserve requirements highlights the need for regulatory frameworks that address the evolving nature of digital currencies. Policymakers should carefully assess the risks and benefits associated with digital currencies and develop appropriate strategies to safeguard financial stability while maintaining the effectiveness of the money multiplier.

The impact of digital currencies on the proportion of time deposits raises questions about the stability of the banking system. A higher reliance on time deposits may introduce liquidity risks, as banks depend on a smaller pool of liquid funds for immediate obligations. This aspect warrants further research and consideration of potential regulatory measures to mitigate any associated risks.

Lastly, the positive relationship between the proportion of digital currencies and the money multiplier underscores the transformative potential of digital currencies in reshaping the monetary landscape. As digital currencies continue to gain prominence, policymakers and financial institutions should anticipate and proactively address the implications for monetary policy, financial stability, and the overall functioning of the economy.

Overall, this study highlights the multifaceted impact of digital currencies on the money multiplier and emphasizes the need for further research and adaptive policy frameworks to navigate the evolving landscape of digital currencies.

5. Conclusion

The study provides valuable insights into the impact of digital currencies on the money multiplier. The findings indicate that digital currencies have significant implications for various factors that influence the money multiplier, including cash leakage rate, deposit reserve ratio, time deposit ratio, and the proportion of digital currencies in circulation.

The adoption of digital currencies reduces cash leakage rate by providing an alternative to traditional cash. This, in turn, expands the money multiplier as more currency is available for banks to create loans and increase the money supply. Additionally, digital currencies can influence deposit reserve requirements, either decreasing or increasing the need for reserves, depending on regulatory responses.

Furthermore, digital currencies affect the proportion of time deposits, as they lower transaction costs and make long-term deposits more attractive. This increases the funds available for lending and contributes to the expansion of the money multiplier.

Importantly, the study reveals a positive relationship between the proportion of digital currencies and the magnitude of the money multiplier. As digital currencies gain prominence and their share in the overall currency system increases, their impact on the money multiplier becomes more pronounced.

These findings have significant implications for policymakers, central banks, and financial institutions. Policymakers need to carefully consider the impact of digital currencies on monetary policy, inflation, and financial stability. Regulatory frameworks must adapt to the changing dynamics of digital currencies and address associated risks. Financial institutions should assess the implications of a higher reliance on time deposits and manage potential liquidity risks accordingly.

Overall, the study highlights the transformative potential of digital currencies in reshaping the monetary landscape. As digital currencies continue to evolve and gain acceptance, it is crucial for stakeholders to closely monitor and understand their impact on the money multiplier and develop adaptive strategies to navigate the changing financial landscape effectively. Further research in this area is warranted to deepen our understanding of the implications of digital currencies on the broader economy and financial system.

Acknowledgment

This paper is an output of the current grants of the supervisor (Behavior non-professional retail investors in the financial market and the threat of digital financial pyramids: grant of the Russian Science Foundation No. 22-28-00806 and Project No NU 2.3.1.22 of the IG "Institute of digital defender: design of a system of integrated human security in the digital environment" within the framework of the program "Priority - 2030" of TSU) as well as with work in the Laboratory of Psychological and Financial Security of a Person in the Digital World.

References

- Andersen, L. C., & Jordan, J. L. (1968). The monetary base-explanation and analytical use. *Canadian Parliamentary Review*, vol.50, pp. 7-11.
- Ba, S. S. (1998). Monetary multiplier fluctuation and monetary control in transition economy. *Studies of International Finance*, vol.01, pp. 37-41.
- Bank for International Settlements. (2015). *Digital Currencies*. pp. No. 137.
- Belke, A. H., & Beretta, E. (2020). From cash to private and public digital currencies. The risk of financial instability and modern monetary middle ages. *Economics and Business Letters*, vol.09, pp. 189-196.
- Brunner, K. M. (1961). A schema for the supply theory of money. *International Economic Review*, vol.02, pp. 79-109.

- Burger, A. E. (1972). The money supply process.
- Dong, H. (2022). Research on the influence of digital payment on currency multiplier. Master's Dissertation, Lanzhou University, Lanzhou.
- Fang, X. C., & Huang, S. Y. (2020). Digital currency and china's monetary policy transformation. *Academic Forum*, vol.02, pp. 93.
- Jiang, T. F., Chen, X. R., & Li, X. K. (2020). The potential impacts of central bank digital currency on monetary policy—theory and empirical evidence. *Finance Forum*, vol.12, pp. 22.
- Jordan, J. L. (1969). Elements of money stock determination. *Canadian Parliamentary Review*, vol. 51, pp. 10-19.
- Kurtzman, J. (1993). The death of money: How the electronic economy has destabilized the world's markets and created financial chaos.
- Lin, C. (2019). Issue of legal digital currency and effectiveness of china's monetary policy. *Journal of Shenzhen University (Humanities & Social Sciences)*, vol.05, pp. 81.
- Liu, R., & Li, N. (2022). The monetary expansion effect of local government debt and its policy coordination. *Finance & Trade Economics*, vol.01, pp. 27.
- Lü, J. L., Guo, J. Y., & Zhang, L. H. (2020). Macroeconomic and financial effects of central bank digital currency. *Financial Economics Research*, vol. 01, pp. 3-19.
- Wang, P., Bian, W. L., & Ji, Y. (2020). Conceptual framework and international progress of central bank digital currency. *Review of Industrial Economics*, vol.05, pp. 63-79.
- Xia, B., & Liao, Q. (2001). Money supply is no longer suitable as the intermediary target of china's current monetary policy. *Economic Research Journal*, vol.08, pp. 33-43.
- Xie, X., & Feng, S. X. (2019). Theoretical study on the influence of legal digital currency on china's monetary policy. *Economist*, vol.09, pp. 54-63.
- Yang, J. (2022). Research on the logic function evolution and development trend of legal digital currency based on digital economy. *Social Science Journal*, vol.02, pp. 105-113.
- Yao, Q. (2017). Digital currency and bank accounts. *Tsinghua Financial Review*, vol. 07, pp. 63-67.
- Zhang, J., & Wang, S. J. (2019). An empirical analysis of the factors affecting chinese money multiplier on the background of mobile payment. *Journal of Nanchang University (Humanities and Social Sciences)*, vol.04, pp. 82-90.
- Zhang, W., Jing, W. M., & Xu, N. (2021). An analysis of the time-varying causes of the deviation between money supply and inflation. *Journal of Central University of Finance & Economics*, vol.06, pp. 77-89.