How does China m-CBDC Bridge Project Promote the Internationalization of RMB?
Empirical experiences from other Major Currencies

Lianqian Yin[1] and Yueqing Lu[1*]

Abstract

The People's Bank of China's participation in the m-CBDC Bridge Project is regarded as a step for China to further promote the internationalization of RMB. This paper will verify whether the project can promote the internationalization of RMB through theoretical analysis and empirical analysis methods. Firstly, this paper uses existing theories and conclusions to analyze the economic response brought by the project, and concludes that the project will bring three major effects: network externality, currency stability and financial market development. Then, the quarterly data of four countries and regions from 2002 to 2023 in the United States, Europe and Japan are selected to verify whether the three effects brought by the project can promote currency internationalization by using the method of panel regression. The empirical results show that network externalities, currency value stability and the degree of financial market development are important factors to improve the degree of currency internationalization. Therefore, this paper believes that m-CBDC Bridge Project is expected to further improve the degree of RMB internationalization. China should seize the opportunity and take this project as a fulcrum to accelerate the construction of a macro-control system compatible with the circulation of the central bank's digital currency, and fully explore the value brought by the central bank's digital currency to the financial market.

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[1] International Business School of Jinan University, Zhuhai City, Guangdong Province, China.
*Corresponding author.

1. Introduction

On 24 February 2021, the Digital Currency Institute of the People's Bank of China announced its participation in the Multilateral Central Bank Digital Currency Bridge project, a significant step further to promote RMB internationalization in China. Since the RMB internationalization was launched in 2009, the RMB's position in the international monetary system has risen rapidly, as evidenced by the RMB Internationalisation Index published by the Institute of International Monetary Studies of Renmin University of China. However, in recent years the internationalization of the RMB has started to slow down. What are the factors hindering the internationalization of the RMB? This question has been widely debated. Carbaugh and Hedrick proposed that when the value of a product to consumers increases along with the number of other users (Carbaugh and Hedrick, 2009), the product has a network externality. Krugman argued that currency transaction cost is a decreasing function of transaction volume (Krugman, 1980), and the network externality of currency is the critical factor in promoting currency internationalization. Lee pointed out that network externality is the most fundamental reason for currency internationalization compared with macro factors such as exchange rate fluctuations (Lee, 2014). Meissner and Oomes argue that network externalities underpin the dominance of the US dollar in today's international monetary system (Meissner and Oomes, 2009), making it difficult to make a breakthrough in the current international monetary system. Wessels agrees, stating that solid network externalities underpin the hegemony of the US dollar, making it difficult for other currencies to become the clearing option for international trade (Wessels, 2011). In addition to network externalities, scholars have also explored other factors hindering RMB's internationalization. Rana and Pardo, Ly, Liao and McDowell, and others have found ways to promote the internationalization of the RMB through the Belt and Road project. Rana and Pardo pointed out that neighboring countries' currency and financial stability should be strengthened by building financial institutions (Rana and Pardo, 2018). The universality and security of the RMB should be improved, thus promoting the internationalization of the RMB. Ly believes that the political, economic, and legal conflicts in the "Belt and Road" region, the obstacles to RMB acceptance and popularity, and the low level of international organization system of domestic financial institutions hinder the process of RMB internationalization (Ly, 2020). Liao and McDowell found that the Belt and Road Initiative strengthened RMB investment in neighboring countries by signing bilateral agreements, which impacted RMB internationalization (Liao and McDowell, 2015). McNally and Gruin argue that there are at least two aspects of RMB internationalization that remain untapped (McNally and Gruin, 2017): first, the potential of the RMB to be used as an international currency, and second, the potential of the RMB to be used as an international currency. The first is the diversification and politicization of capital account and currency management controls; the second is how these unique currency management systems interact with international financial market concepts

and institutions. Keddad, Lai and Yuexamine the impact of financial market openness and currency stability on currency internationalization, respectively (Lai and Yu, 2015; Keddad, 2019). Tao et al., starting from the development experience of the US dollar and the euro, point out that a high level of economic integration and stable macro conditions are conducive to the internationalization of currencies (Liu et al., 2019).

Since Satoshi Nakamoto invented Bitcoin in 2008, there has been a surge of research into digital currencies. Bitcoin, through blockchain technology, can accomplish mutual trust transactions without the involvement of intermediaries, thus attracting many investors. However, its decentralization and value instability can significantly impact the existing financial system and is a challenge to the existing financial system. The anonymous nature of bitcoin transactions makes it difficult to monitor the process and provides an arena for illegal actors to engage in illicit behavior. Gorodnova pointed out that although Libra (now renamed Diem), the digital currency, avoids the huge energy waste of bitcoin mining, it still lacks effective anti-money laundering measures and is difficult to be widely accepted by the world (Gorodnova, 2021). The defects of private digital currency and its impact on the economy make the academic circle turn the research focus to the digital currency supported by the national credit, the central bank digital currency (CBDC). In 2014, the People's Bank of China officially began researching CBDC. In 2016, Broadbent explicitly introduced the concept of CBDC (Broadbent, 2016). "Research and Development of China's Digital RMB Progress" white paper (2021) states that the central bank digital currency is a substitute for circulating cash and should be attributed to M0.

Subsequently, Arauz and Qian have classified central bank digital currencies as account-based, wallet-based, and central bank digital accounts (CBDA) and central bank digital currencies (CBDC), respectively, in terms of whether they are based on central bank accounts (Qian, 2019; Arauz, 2021). The "Flower of Money" conceptual model defines a central bank digital currency in terms of digital form, accessibility, issuing entity, and technical architecture. In the same year, the BIS provided a clear definition of a "central bank digital currency": a digital currency is a digital form of central bank money. It is distinct from digital funds held by traditional financial institutions in central bank margin accounts and clearing accounts.

Scholars have also studied the impact of central banks' digital currencies. Cherian examines the relationship between legal digital currency and currency internationalization, suggesting that issuing a sovereign digital currency can promote RMB internationalization (Cherian, 2022). Yao makes some constructive suggestions for developing a legal digital currency, such as actively promoting the effective integration of legal digital currency with other financial infrastructures to promote cost-saving and efficiency in society (Qian, 2019). Allen et al. argue that the issuance of legal digital currency brings benefits and has a double impact on payments, monetary policy, financial system, international trade, etc (Allen et al., 2022). The study of Gorodnova shows that the issue of legal digital currency will

positively impact the economy in the short term (Gorodnova, 2021). However, this impact will disappear with the adjustment of people's future expectations. Meanwhile, the issue of central bank digital currency will have a specific impact on the stability of our banking system, but this impact is controllable. Nevertheless, Fegatelli points out that legal digital currency can provide new monetary policy tools, reduce the time lag of monetary policy, and thus improve the implementation effect of monetary policy (Fegatelli, 2021). Subsequently, Wang pointed out that the issuance of digital currency by the central bank could not only enhance the effectiveness of the monetary policy but also promote the internationalization of RMB through the network externality expansion mechanism, RMB value stability mechanism and financial development promotion mechanism (Wang, 2013).

Most of the existing studies on digital currencies have focused on the advantages of central bank digital currencies over private digital currencies and the benefits that central bank digital currencies can bring to the effectiveness of monetary policy and the upgrading of the financial system. Scholars at home and abroad have come up with many constructive results through empirical studies or theoretical analyses. However, only a few scholars have noted the relationship between CBDC and RMB internationalization, and the number of studies that have produced valid results could be more significant.

Using quarterly data from the US, Europe, Japan, and China from 2002 to 2023, this paper explores the impact of the Multilateral Central Bank Digital Currency Bridge Project(m-CBDC Bridge Project) on the internationalization of the RMB through a combination of theoretical analysis and empirical testing. The marginal contributions of this paper are: First, there are few kinds of research on whether the central bank's digital currency can promote the internationalization of RMB. Based on the vital move that the Digital Currency Research Institute of the People's Bank of China joined the m-CBDC Bridge Project, this paper focuses on the relationship between the CBDC and the internationalization of RMB, which can broaden the research field and provide more references. Second, it is still a short time since China's central bank joined the m-CBDC Bridge Project, and there are no studies on the economic benefits brought by the project. This paper focuses on the impact of this project on the internationalization of RMB. It indirectly measures the economic benefits brought by this project, which is the most significant innovation point of this paper. Since m-CBDC Bridge Project has just been launched, this paper's empirical analysis tests whether the theoretical analysis's effect can promote currency internationalization in the past to provide some reference. The economic benefits of this project still need to be further studied and verified.

2. The process of RMB internationalization and its constraints

2.1   RMB internationalization process

The RMB internationalization refers to the process whereby the RMB can cross national borders and circulate in the international market, becoming an internationally recognized currency for valuation, settlement, and even reserve. It includes three specific aspects: firstly, the RMB has a certain degree of circulation outside of China; secondly, RMB-denominated financial products become an essential investment tool in the international financial market; and thirdly, the proportion of international trade settled in RMB reaches a certain level. The RMB internationalization is of strategic importance, as it can promote the direct settlement of China's international trade in RMB, thereby reducing foreign exchange risks. It can also enhance China's international status and voice in the international financial market, which is one of the signs of China's rise.

It has been nearly 13 years since the RMB internationalization was launched in 2009. In April 2009, the State Council decided to launch cross-border trade RMB pilot projects with Hong Kong, Macao, and ASEAN regions in Shanghai, Guangzhou, and Shenzhen. In 2012, the People's Bank of China officially started constructing the cross-border RMB payment system "CIPS". On 1 October 2016, the RMB was officially included in the Special Drawing Rights basket (SDR), becoming the fifth currency to be included in the basket after the USD, EUR, GBP, and JPY. On 24 February 2021, the Institute of Digital Currency of the Central Bank of the People's Bank of China announced its participation in the m-CBDC Bridge Project to explore cross-border payments with CBDC. In addition, the increase in the scale of bilateral currency swaps with other countries, the launch of the Shanghai Stock Exchange and Hong Kong Stock Exchange, the adoption of RMB settlement for the "One Belt, One Road" project, and the construction of an offshore RMB financial center are all efforts made by China to promote the RMB internationalization. As a result of the importance attached by the State to the RMB internationalization, it has made good progress.

Table 1: Share of major world currencies in international foreign exchange reserves

Share of each currency in international foreign exchange reserves (%)							
Time	**USD**	**Euro**	**RMB**	**Time**	**USD**	**Euro**	**RMB**
2017Q1	64.69	19.29	1.08	2019Q3	61.61	20.26	1.96
2017Q2	63.84	19.96	1.08	2019Q4	60.75	20.59	1.94
2017Q3	63.53	20.07	1.12	2020Q1	61.85	20.08	2.01
2017Q4	62.73	20.17	1.23	2020Q2	61.31	20.19	2.08
2018Q1	62.79	20.36	1.40	2020Q3	60.45	20.59	2.16
2018Q2	62.41	20.26	1.83	2020Q4	58.92	21.29	2.29
2018Q3	61.95	20.48	1.80	2021Q1	59.43	20.50	2.50
2018Q4	61.76	20.67	1.89	2021Q2	59.18	20.58	2.64
2019Q1	61.79	20.28	1.95	2021Q3	59.21	20.57	2.67
2019Q2	61.31	20.56	1.93	2021Q4	58.81	20.64	2.79

(Source: compiled by the author)

As shown in Table 1, the share of the RMB in the foreign exchange reserves of the world's central banks has been on a significant upward trend in recent years. It reached 1.89% in the fourth quarter of 2018, overtaking the Canadian dollar as the fifth-largest foreign exchange reserve currency. It exceeded 2% for the first time in the first quarter of 2020 and reached 2.79% by the fourth quarter of 2021, a strong progression reflecting the growing recognition of the RMB by central banks worldwide.

In addition, according to a report by the Society for Worldwide Interbank Financial Telecommunication (SWIFT), as of February 2021, the RMB ranked fifth with 2.20% of payments transacted through the SWIFT system globally, and sixth with 1.53% after excluding payments within the Eurozone. It is clear from the above data that the RMB has become increasingly internationalized in recent years, playing an increasingly important role in the international monetary system and becoming more and more popular with central banks and investors. However, its absolute level is still at a relatively low position, which is seriously inconsistent with China's economic status, political status, and military power in the international arena. The RMB internationalization process still has a long way to go.

2.2   Constraints to RMB internationalization

There are many factors affecting the internationalization of sovereign currencies. Based on the studies of Lee (Lee, 2014), Lai and Yu (Lai and Yu, 2015), and Keddad (Keddad, 2019), this paper categorizes the factors restricting the internationalization process of RMB into the following three types: network externality, currency stability, and financial market development

Network externalities occur when the utility a product brings to users increases with the number of people using the same product. One of the many goods in life that have network externalities is money. As a currency has more users and is used on a larger scale, it becomes more liquid and easier to communicate within the network,

thus attracting more users to use the currency, further increasing the size of the user, and so on. For example, suppose the number of Chinese-speaking countries increases in the world. In that case, Chinese nationals will gain many conveniences in terms of travel, trade, etc., and this convenience will increase with the number of Chinese-speaking countries. Similarly, the network externality of a currency is that the more people who use it, the lower the transaction costs of using it, thus attracting more countries and regions to use it for valuation and settlement. The network externality of a currency can be divided into two aspects: direct and indirect. On the direct side, as more countries and regions use a currency, the liquidity of that currency increases, and the risk of holding that currency decreases, therefore attracting more countries to use that currency. On the indirect side, the expansion of currency use will push the corresponding infrastructure and systems to reform and upgrade, making it faster and cheaper to pay, leading to more people using the currency. Krugman and Lee both argue that the network externality is the key to promoting currency internationalization (Krugman, 1980; Lee, 2014).

The hegemony of the US dollar is an important reason why the network externality has become a constraint factor for RMB internationalization. As shown in Table 1, the overwhelming dominance of the US dollar in global foreign exchange transactions has suppressed the development of RMB internationalization. Meissner and Oomes indicated that in addition to the comprehensive strength of the United States, network externalities also supported the dominant position of the US dollar in the international monetary system, making it difficult for the current reform of the international monetary system to achieve a breakthrough (Meissner and Oomes, 2009). Although the RMB internationalization process has been launched, the renminbi's status in the international monetary system has been increasing. However, there is still a considerable gap between RMB and the US dollar, and it is difficult to change the current payment clearing system alone.

Currency stability means that prices do not fluctuate significantly within a short period; even if they do, they are within reach of society and the population. Currency stability includes domestic and external currency stability. Internal currency stability refers to the stability of domestic prices, while external currency stability refers to the stability of the exchange rate of the sovereign currency. According to Keddad, currency stability is essential to internationalization (Keddad, 2019). After the "811" exchange rate reform in 2015, the quotation mechanism of RMB central parity has become more transparent, and the RMB exchange rate has been further market-oriented. Nevertheless, as a result, against the backdrop of slowing economic growth in China and intensifying trade frictions between the US and China, the RMB exchange rate fell significantly, once below 1 to 7, reaching its lowest level in a decade, and harmed the RMB internationalization.

However, it should not be overlooked that when the new crown epidemic hit, China achieved economic recovery in the shortest possible time and became the only major economy in the world with positive growth in 2020. In addition, to stimulate economic growth during this period, the United States carried out a significant quantitative easing policy and put a large amount of liquidity into the market, which

significantly increased the depreciation pressure of the dollar. Therefore, China's sound fundamentals and prudent economic policies eventually led to the appreciation of the RMB exchange rate and enhanced the stability of the currency value compared with before.

The degree of development of a country's financial markets is also an essential factor affecting the internationalization of its currency. Only when a country has a highly developed and liquid financial market will foreign entities enter the market to purchase financial assets identified by the country's currency. Thus, the country's currency will be accepted as a world currency. Lai and Yu argue that well-developed financial markets, regulated financial market order, complete financial market operation rules, and great local currency-denominated financial products can provide sufficient liquidity and complete information, making the market more effective (Lai and Yu, 2015). The higher the level of financial market development is, the more reasonable the pricing of local currency and the lower the transaction cost will be. Therefore, by improving the level of financial market development, more investors can be attracted to hold financial assets denominated in local currency, thus promoting currency internationalization.

Historically, the pound was once at the center of the international monetary system, coinciding with the UK having the most developed financial markets in the world. Furthermore, today, the same is true of the US dollar. China's financial markets started late, need to be better developed, and have many unreasonable structures, such as the predominance of indirect financing and the over-representation of retail investors in the composition of investors. These problems make our capital markets ineffective, the pricing of assets not reasonable enough, and investment risks high. In addition, China's capital account could be more open, and the conversion between currencies is restricted, making it too costly for foreign investors to invest in RMB assets, all of which restrict the internationalization of the RMB.

3. Theoretical foundations and transmission mechanisms

3.1   Digital currency development process

[1]Throughout the development of money, the form of money has undergone many evolutions, from physical money, metal money, to paper money, and then to electronic money. With the development of cryptography and blockchain technology, the development of electronic money has also deepened, coming out with electronic money, which is out of the virtual state, i.e., digital money. In fact, the concept of digital currency has not yet been clearly defined. However, there have been several central banks that have discussed it. The Bank of England defines it as a generally accepted interest-bearing central bank liability recorded through a distributed ledger. The Bank for International Settlements, on the other hand, classifies digital currencies in its report: according to the issuer, there are private digital currencies (PDCs) and central bank digital currencies (CBDCs). Private digital currency is a limited legal payment instrument issued and controlled by developers that are free from the constraints of the virtual space of the network,

while legal digital currency refers to legal digital currency issued by the central bank with specific value support and national credit endorsement. In this paper, we will briefly review and summarize the development of digital currencies, tracing its evolution from early conceptual discussions to recent advancements in central bank digital currencies (CBDCs).

In 1982, cryptographer David Chaum first proposed an untraceable cryptographic network payment system. Later in 1990, Chaum further developed this idea into a cryptology anonymous cash system. He used blind signature technology to invent electronic cash that can completely protect user privacy, which is known as E-cash. This anonymous cash received much attention when it was introduced, but it was always a central system run by only one centralized company, which could only carry a very limited number of users and transactions. The system could not be maintained if the central company or server collapsed. Ultimately, the project ended in failure. With the further development of monetary finance and cryptography, the technology of digital currencies was gradually refined, and digital currencies such as E-gold, which emerged in 1996, and Liberty Reserve, which emerged in 2006, overcame the problems of the E-cash system and became more widely used. However, due to their anonymity, these platforms became a gathering place for criminals. It triggered a large number of illegal money laundering transactions, all of which were eventually explicitly banned from use by various countries.

2008 was a significant turning point in the development of private digital currencies. In the paper entitled "Bitcoin: A Point-to-Point E-Cash System", Nakamoto describes the e-cash system of Bitcoin, which is the first distributed anonymous digital currency. On 3 January 2009, Nakamoto has released the first version of Bitcoin client and 50 Bitcoins, marking the birth of the first Bitcoin blockchain. Compared to previous digital currencies, Bitcoin differs in that it protects the privacy of its users while allowing network nodes to manage the transfer of money rather than relying on a central control center. Bitcoin is now an investment product favored by investors. At the beginning of 2021, it ushered in a sharp appreciation, hitting the $60,000 mark for the first time. However, while Bitcoin has its technical value, is easy to keep, and represents the future of money, it is not guaranteed by the production and trading of goods across society, so its value is highly volatile and does not have a basis of value as a currency, and is currently far from being universally accepted by the public. Moreover, bitcoin has been banned by many central banks without the backing of national credit, so it is not a real currency.

Although Bitcoin is difficult to use as a payment instrument for commodity transactions by market players, its emergence has led to a renewed focus on the development of digital currencies in academia. The highly speculative nature of Bitcoin has made scholars realize that in order to advance the further development of digital currencies, they must be backed by value, and in this context, a digital currency called USTD was created. This currency was issued by the US company Tether, which pledged to deposit $1 in its exclusive account for every unit of USTD issued, which pegged the US dollar to the USTD at a ratio of 1:1, i.e., the US dollar became the value backing for the USTD. This value-backed digital currency is

known as a digital stablecoin. The creation of digital stablecoins quickly attracted a large number of scholars. In September 2018, the US government approved two stablecoins, Gemini Dollar and Paxos Standard, and they can be converted to the US dollar at a 1:1 ratio. In June 2019, Facebook officially launched its digital stablecoin Libra (later renamed Diem Coin) program, declaring that Libra will anchor a basket of currencies to guarantee its value, including the US dollar (50%), the Euro (18%), the British pound (11%) and the Singapore dollar (7%), and that Libra will take a 1:1 ratio for value conversion, meaning that for every unit of Libra purchased by a user, an equivalent value of the mainstream currency will enter the asset pool to guarantee the value of Libra.

The development of digital stablecoins on the one hand demonstrates the future direction of cryptocurrency development, but on the other hand poses a huge challenge to the regulatory system and the ability to regulate of each country. In response to this challenge, Germany and France have joined forces to resist Libra's entry into the European market, and the resistance of various countries has delayed the launch of Libra time and time again. Under the impact of digital stablecoins, the call for developing a central bank legal digital currency and establishing a CBDC system has risen. According to the Bank for International Settlements (BIS) "The Third Research Report on Central Bank Digital Currencies" in 2021, nearly 90% of central banks worldwide participating in the survey have undertaken work related to CBDS, of which 60% have moved from conceptual research to the pilot stage, and 14% are advancing the development or conducting pilot work. However, few countries have yet to launch the issuance of CBDC formally. As of December 2021, more than 110 countries and territories have undertaken work related to CBDC to varying degrees.

3.2   Digital RMB Development Process

China is also one of the economies in the world actively researching legal digital currencies and has established the Central Bank Digital Currency Institute for this purpose. China's central bank digital currency, known as the digital RMB (e-CNY), is a sovereign currency issued by the central bank and has all the attributes of a fiat currency. This article will analyze the information disclosed about the central bank's digital currency and the statements made by the person in charge, in an attempt to summarise the mechanism of issuance and circulation of the e-CNY.

The issuance of e-CNY will adopt a two-tier structure model. As shown in Figure 1, the so-called two-tier structure means that the issuance will be divided into two tiers: the first tier is the central bank to commercial banks, and the second tier is commercial banks to the public. As summarized in a statement by Wang Yongli, former deputy governor of the People's Bank of China, under the two-tier structure, the central bank designates a commercial bank with strong capital and technology as the operator, and the operator cooperates with other commercial banks to jointly provide e-CNY circulation services. At the same time, the operator establishes different types of e-CNY accounts for its customers based on their information to provide redemption services.
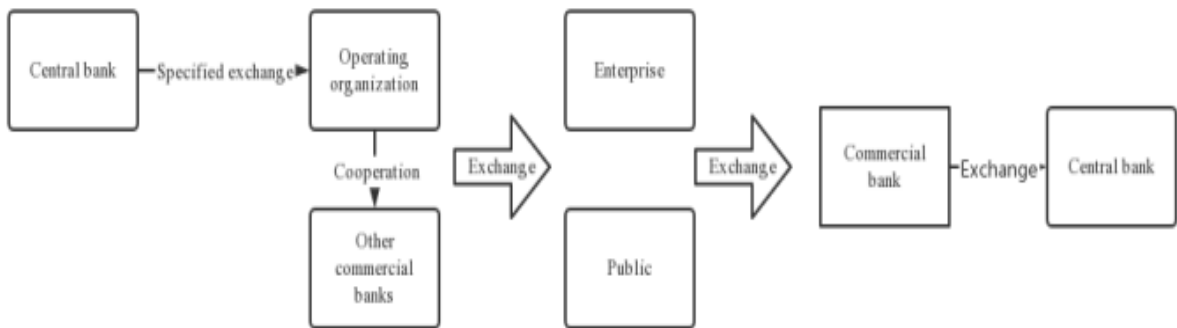
Figure 1: Two-tier structure of e-CNY

(Source: compiled by the author)

Moreover, the e-CNY is non-interest-bearing; it is only used for collection and payment, not for lending. The People's Bank of China will establish a value transfer system and financial infrastructure for e-CNY. It will not charge any fees for circulation or issuance, and commercial banks will not charge individuals for e-CNY payment and transfer services. According to the pilot project of e-CNY in Shenzhen, the two-tier structure is as follows: the public needs to download the App for e-CNY on their mobile phones and then open an e-CNY Wallet at a designated bank (designated banks include Industrial and Commercial Bank of China, Agricultural Bank of China, China Construction Bank and Bank of China, from which the public can access the e-CNY Wallet). The main means of payment is scanning a QR code (offline payments are supported).

2020 is called "the first year of digital RMB". On 19 April 2020, the head of the Central Bank's Digital Currency Research Institute said that the research work on digital RMB is steadily progressing and will be carried out in several places for pilot implementation. On 8 October 2020, the Shenzhen People's Government selected 50000 people to experience e-CNY red packets in the local area. The lottery winners can pay and consume with 3389 merchants that have realized digital transformation in Shenzhen by scanning the code with a mobile APP. In December, Suzhou issued 20 million yuan of e-CNY wallets to eligible citizens, each with 200 yuan. On 29 December, the Daxing Airport of the Beijing Metro launched RMB "touch and go" payments. In this mode of payment, consumers can simply place their mobile phones close to the "touch a tag," and the payment interface will pop up on their phones, enter the amount and click "confirm" to complete the payment. On 5 January 2021, in Shanghai, the e-CNY was made available as a "Hard Wallet" payment method. The "Hard Wallet" is a bank card-sized card with an ink screen that displays information such as balance, payment amount and the number of payments. To pay with the Hard Wallet, users swipe the card over the payment terminal, without the need for a mobile phone. These payment methods are "single

offline", meaning that the payer can go offline, but the recipient needs to be online to receive the payment. Researchers at e-CNY are working towards "double offline", where neither the recipient nor the payer needs to be online to receive or pay. With "double offline" technology, transactions can be completed by "touching" mobile phones, even if both recipients and payers are offline.

3.3   Multilateral Central Bank Digital Currency Bridge Project (m-CBDC Bridge Project)

Although at present, e-CNY adheres to the M0 positioning and is mainly used in domestic retail-type transaction scenarios, cross-border applications are its development direction and ultimate goal. Cross-border circulation of digital currencies can reduce many intermediate links for currency crossings, save time and money costs, improve cross-border circulation efficiency and reduce exchange rate risks. However, the cross-border circulation of private digital stablecoins such as Diem can impact monetary sovereignty. In order to reap the benefits of cross-border circulation of digital currencies while protecting monetary sovereignty and maintaining the stability of national financial markets, on 24 February 2021, the Hong Kong Monetary Authority, the Bank of Thailand, the Central Bank of the United Arab Emirates and the Institute of Digital Currency of the People's Bank of China jointly launched the "Multilateral Central Bank Digital Currency Bridge" project, which aims to explore how to use central bank digital currencies in cross-border payments. The project is supported by the BIS Hong Kong Innovation Centre and has received much attention at the BIS Innovation Summit on 22-25 March 2021.

What is the "Multilateral Central Bank Digital Currency Bridge"? According to the Institute of Digital Currency of the People's Bank of China, the m-CBDC Bridge will further investigate distributed ledger technology by developing an experimental prototype to enable round-the-clock simultaneous settlement (PvP) of cross-border transactions of CBDC. The concept of the m-CBDC Bridge comes from the HKMA's Inthanon-LionRock project with the Bank of Thailand, which was launched in September 2019 to enable cross-border payments of digital currencies and further promote economic cooperation between the two countries. The Inthanon-LionRock project attempts to build a corridor network between the two countries' wholesale central bank digital currency networks. It enables the same distributed ledger to support multiple central bank digital currencies by issuing depositary receipts on the corridor network, enabling real-time transfer and redemption of cross-border funds. The launch of the m-CBDC Bridge Project will further build a favorable environment for international trade and help solve the problems of low efficiency, low transparency, and high costs in cross-border payments. It is now widely believed that China's participation in the project is essential for the implementation of cross-border payments with central bank digital currencies, as China is at the forefront of research in the world in this area. On the other hand, the implementation of the m-CBDC Bridge will facilitate the cross-

border circulation of e-CNY and increase the settlement of RMB in international trade, thus promoting the internationalization of RMB.
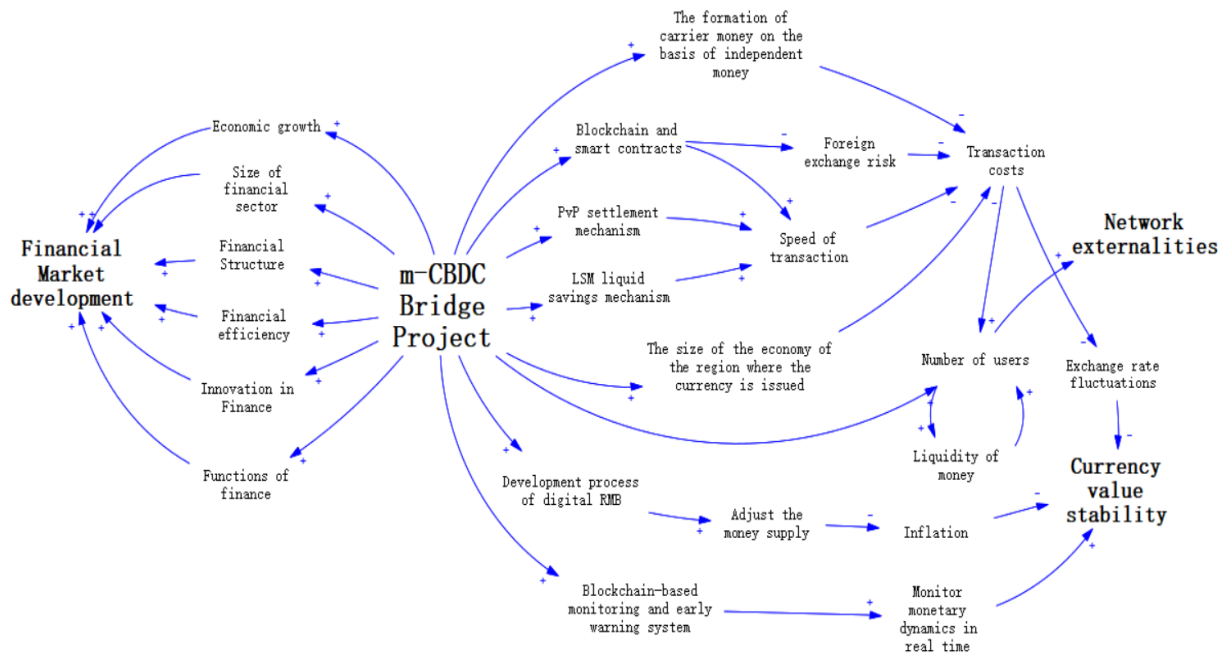
Figure 2: Causal feedback diagram

(Source: compiled by the author)

4. Study design

4.1 Sample selection

As the m-CBDC Bridge Project has launched not for long, there needs to be more data to verify directly whether the project has contributed to the RMB internationalization. Therefore, this paper will use past data to analyze whether the effect brought by the project has promoted the internationalization of currency to provide a reference for whether the project can promote RMB internationalization in the future. As the euro was officially launched on 1 January 2002 and taking into account the availability of data, quarterly data from 2002 to 2023 for four countries and regions, namely the US, Europe, Japan, and China, were finally selected for this paper. Data published in the annual form will be converted into quarterly data using the Quadratic-match average method.

4.2 Variable definition

(1) Explanatory variable: degree of currency internationalization. There are many factors affecting the degree of internationalization of a currency, taking into account the definition of the functions of money in Western economics - medium of exchange, unit of account, and store of value. This paper selects four indicators: the

share of global foreign exchange transactions, the share of international direct investment, the share of international bonds, and the share of international foreign exchange reserves, and uses principal component analysis regarding Tung's research to determine their weights (Tung et al., 2012). Finally, the index to measure the internationalization degree of each significant currency is calculated. This index will be selected as an indicator to measure the internationalization degree of various currencies, which is denoted as IID.

(2) Explanatory variables: For network externalities, this paper follows Wang and Liu, and measures them with a one-period lag of the currency internationalization index, denoted as NE (Wang and Liu, 2012). The lagged term of the currency internationalization index shows the consideration of the degree of acceptance of the currency in the market by national agents when choosing a currency in the future. This consideration can be seen as the pursuit of currency network externalities. For currency stability, two indicators are needed to measure internal and external stability, respectively. Internal stability refers to the stability of the domestic price level. In this paper, the year-on-year growth rate of the consumer price index, denoted as CPI, will be chosen as an indicator; the higher the indicator, the higher the inflation rate, and the less stable the currency is internal. External stability refers to the stability of the exchange rate. In this paper, the exchange ratio of each currency against SDR (expressed by the direct quotation method) will be selected to measure it, denoted as ESDR. Currently, there is no accurate indicator to measure this effect in the academic circle. Most scholars use the ratio of financial assets to GDP to represent the depth of the financial market. The reason is that a well-developed financial system must have a well-developed stock market, and the depth of the stock market can, to a certain extent, reflect the degree of development of the financial market, and the higher the indicator, the higher the degree of development of the financial market.

In conjunction with analyzing the constraints to RMB internationalization in Part II of the article, this paper proposes the following four hypotheses.

Hypothesis H1: NE, an indicator of network externalities of currencies, positively contributes to currency internationalization.

Hypothesis H2: The CPI, an indicator of the currency's internal stability, negatively affects currency internationalization.

Hypothesis H3: The ESDR, an indicator of the external stability of the currency, negatively affects currency internationalization.

Hypothesis H4: FM, an indicator of the degree of financial market development, positively contributes to the degree of currency internationalization.

According to scholars Hecox (Hecox, 2002),Carbaugh and Hedrick (Carbaugh and Hedrick, 2009), and other essential factors that influence currency internationalization are economic development, military power, and political stability. Therefore, in this paper, the GDP growth rate, the currency value of the military expenditure to GDP, and the political stability coefficient of each country will be selected as the control variables of the model. All variables and their meanings are shown in Table 2.

Table 2: Summary of variables

Variable type	Variable name	Specific meaning	Data sources
Explained variables	Degree of currency internationalisation (IID)	Currency Internationalisation Index	People's Bank of China, International Monetary Fund, Bank for International Settlements, World Bank, United Nations Trade and Development Organization
Explanatory variables	Network Externalities (NE)	Currency internationalisation index lags by one period	People's Bank of China, International Monetary Fund, Bank for International Settlements, World Bank, United Nations Trade and Development Organization
	Currency to SDR conversion ratio (ESDR)	Exchange rates expressed as direct mark-ups	IMF
	Price stability (CPI)	CPI year-on-year growth rate	National Research Network Database
	Financial Market Development (FM)	Ratio of stock market turnover to GDP	World Bank GFDD
Control variables	Political Stability (PST)	Political stability factor	World Bank WGI
	Military strength (MI)	Ratio of military expenditure to GDP	World Bank WDI
	Economic Development (GDP)	GDP growth rate	National Research Network Database

Note. 1EU FM and PST will be replaced by German data in view of data availability. (Source: compiled by the author)

4.3 Model construction

Based on the above analysis, the following multiple regression model is developed in this paper:

$$IID_{i,t} = \beta_0 + \beta_1 NE_{i,t} + \beta_2 ESDR_{i,t} + \beta_3 CPI_{i,t} + \beta_4 FM_{i,t} + \beta_5 PST_{i,t} + \beta_6 MI_{i,t} + \beta_7 GDP_{i,t} + \varepsilon_{i,t}$$

Where i represents currency, t represents the quarter, and ε is a random disturbance term.

5. Empirical Results and Analysis

5.1 Descriptive statistics and correlation coefficient analysis

The results of the descriptive statistical analysis are shown in Table 3. The minimum and maximum values of IID, NE, ESDR, and FM have significant differences and large standard deviations, so it is essential to focus on the smoothness of these indicators in the empirical process.

The correlation coefficient matrix for each variable is shown in Table 4. Since the empirical model in this paper is a dynamic panel model with the introduction of lagged terms of the explanatory variables, it is normal for the first two rows of the matrix to show a strong correlation. In addition, the degree of correlation and direction of influence between the main indicators chosen in this paper, ESDR, FM, and the control variables, PST and MI, are generally consistent with the economic logic. However, the direction of influence of CPI and GDP with other variables is different from the economic logic and needs to be further tested in more scientific detail.

Table 3: Descriptive statistics of variables

Variables	Sample size	Average value	Standard deviation	Minimum value	Maximum value
IID	288	16.10097	13.30076	0.125844	40.06688
NE	284	16.06925	13.28327	0.125844	40.06688
ESDR	288	40.65893	64.17513	1.04	186.76
CPI	288	0.015056	0.015311	-0.016388	0.066906
FM	288	114.5689	78.22926	11.12691	372.1267
PST	288	0.431645	0.595954	-0.677103	1.248033
MI	288	0.020806	0.011823	0.008209	0.049596
GDP	288	0.033218	0.038517	-0.064715	0.146162

(Source: compiled by the author)

Table 4: Correlation coefficient matrix

	IID	NE	ESDR	CPI	FM	PST	MI	GDP
IID	1	0.998936	-0.51579	0.076748	0.280475	0.292058	0.660853	-0.46825
NE	0.998936	1	-0.51501	0.079615	0.280905	0.290852	0.661781	-0.46855
ESDR	-0.51579	-0.51501	1	-0.47174	-0.14607	0.522221	-0.56245	-0.32686
CPI	0.076748	0.079615	-0.47174	1	0.198757	-0.46543	0.27026	0.433928
FM	0.280475	0.280905	-0.14607	0.198757	1	-0.13425	0.677472	-0.0552
PST	0.292058	0.290852	0.522221	-0.46543	-0.13425	1	-0.2366	-0.83529
MI	0.660853	0.661781	-0.56245	0.27026	0.677472	-0.2366	1	-0.02384
GDP	-0.469	-0.475	-0.297	0.507	-0.211	-0.745	0.019	1.000

(Source: compiled by the author)

5.2 Return to baseline

5.2.1 Stability check

As the sample selected in this paper is long panel data, a smoothness test is required to prevent pseudo-regression. This paper uses the LLC method to conduct the test, as shown in Table 5, and only CPI and GDP are smooth series among the selected variables. After the test, IID, NE, ESDR, and PST are all first-order single integers, and FM and MI are second-order single integers. Since the condition that the number of variables corresponding to the highest order of a single integer is greater than or equal to 2 is satisfied, the three methods of the Kao test, Pedroni test, and Westerlund test for panel data cointegration (the test results are not shown due to the limitation of space) all prove that there is cointegration relationship between the selected variables and there is no pseudo-regression problem.

Table 5: Stability test results

Variables	Adjusted t-value	Sequence smoothness
IID	1.9682	Unstable
NE	1.2356	Unstable
ESDR	2.0223	Unstable
CPI	-3.0156	Stable
FM	-0.1789	Unstable
PST	1.3963	Unstable
MI	-2.3650	Unstable
GDP	-4.2356	Stable

(Source: compiled by the author)

5.2.2 Panel model selection and benchmark model results

In this paper, the panel model selection is carried out by F-test and Hausman test. The results found that: the F-test results reject the original hypothesis at the 5% significance level, and the mixed-effects model should not be used; the Hausman test results do not reject the original hypothesis at the 10% significance level, so the

random-effects model should be selected. The panel regression of the random effects model was conducted according to the setting of a model (1), and the regression results are shown in Table 6. The results show that in terms of network externalities, NE is significant at the 1% level and positively affects the current level of currency internationalization. It shows that a positive currency network externality causes subjects in each country to give more consideration to that currency when choosing a currency. The empirical results suggest that network externalities of currencies are critical factors affecting currency internationalization and positively contribute to currency internationalization. Hypothesis H1 holds, which is consistent with the results of the prevailing research.

Regarding the external stability of currencies, the empirical results show that the exchange ratio of national currencies to SDRs hurts the degree of internationalization of currencies and passes the significance test. The higher the exchange rate, the lower the currency's value, the less external stability of the currency, and the lower the degree of internationalization of the currency, the hypothesis H3 holds.

In terms of the internal stability of the currency, the empirical results suggest that the year-on-year CPI growth rate harms the currency's internationalization, which is in line with the intuition that the higher the CPI growth rate is. The more significant the price increase, the less stable the currency is internal, which is not conducive to internationalization. However, this indicator does not pass the significance test, so hypothesis H2 is not yet valid and needs further investigation. Regarding the degree of financial market development, the FM index positively affects the currency internationalization index. It passes the significance test at the 10% level, suggesting that the depth of financial market development catalyzes the degree of currency internationalization, and hypothesis H4 is valid.

Regarding control variables, the coefficient on political stability passes the significance test at the 5% level. It positively contributes to the degree of currency internationalization, which is also in line with mainstream research findings.

Table 6: Random effects model regression results

Explained variables	IID	
Explanatory variables	Coefficient	P-value
NE	0.9776	0.000
ESDR	-0.0028	0.008
CPI	-2.7892	0.216
FM	0.0019	0.076
GDP	2.2443	0.287
MI	-3.1597	0.553
PST	0.3894	0.007

(Source: compiled by the author)

5.3   Robustness tests

The baseline regression above did not consider serial correlation, heteroskedasticity, and cross-sectional correlation. Through the test, it was found that: the selected sample data have serial correlation, heteroskedasticity, and cross-sectional correlation problems, which will affect the significance level of the parameters, and therefore this paper corrects them in the robustness test stage. In order to check the robustness of the regression results, this paper will use methodological and data-based approaches for robustness testing.

The reliability and limitations of the benchmark model are explored in terms of the methodology, i.e., using multiple regression methods and observing whether the results remain significant under different regression methods. The random effects model (RE) has been chosen for the benchmark regressions supported by various tests above to ensure that the regression results are robust. The paper will rerun the regressions using the panel-corrected standard error method (PCSE) and the entirely feasible generalized least squares method (full FGLS).

The regression results are shown in Table 7. By comparing the results derived from different regression methods, it is found that the direction of influence of each variable on the degree of currency internationalization under different regression methods is consistent with the random effects regression results. Network externality indicator NE and financial market development indicator FM passed the significance test under all three regression methods. They confirm the positive contribution of network externality and financial market development to currency internationalization. The external currency stability indicator ESDR is significant at the 10% level, except for the generalized least squares method, which is not significant. The internal currency stability indicator CPI is significant at the generalized least squares method, confirming the negative relationship between ESDR, CPI and currency internationalization. This demonstrates the robustness of the regression results of the random effects model developed above.

Table 7: Regression results

Explained variables	IID		
Regression methods	RE	PC	Full FGLS
NE	0.9654***	0.8216***	0.9325***
	(105.23)	(17.33)	(46.53)
ESDR	-0.0031*	-0.0063*	0.0031
	(-2.66)	(-1.98)	(-0.98)
CPI	-2.3321	-2.4512	-2.3216**
	(-0.55)	(-0.71)	(-2.59)
FM	0.0012*	0.0028*	0.0013**
	(1.41)	(1.88)	(2.56)
PST	0.4116*	-0.0413	-0.4236***
	(2.44)	(0.07)	(-2.94)
MI	-2.1356	-71.3356**	-49.5362***
	(-0.22)	(-2.77)	(-4.09)
GDP	1.8679	0.0346	0.7589
	(0.76)	(0.03)	(1.01)

Note: Z-values in brackets, *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

This paper regroups the sample data according to the international status of each country and the role of each sovereign currency in the international monetary system: the US dollar, the euro, and the Japanese yen are classified as core world currencies, and the Chinese yuan is classified as a virtual world currency. The grouped samples were regressed again, and the regression results are shown in Table 8. The results show that the influence direction of core explanatory variables such as network externality, currency stability, and financial market development degree on currency internationalization degree is consistent with the original panel regression results. Further confirming that the enhancement of network externalities, currency stability, and degree of financial market development has a facilitating effect on the level of currency internationalization. However, in the core world currency group, the year-on-year CPI growth rate is insignificant. The reason may be that the United States and the European Union have a solid economic development foundation, sizeable economic scale, and high national income and are, to some extent, "immune" to price fluctuations. However, the impact of the ratio of currency to SDR in the critical world currency groups on currency internationalization is contrary to the hypothesis, which may be because our country has been in a period of rapid development for an extended period. This rapid development is not strongly dependent on exports, so if the value of the RMB rises, it will hurt our export sector and, thus, our economic development, which in turn will affect the confidence of foreign principal's confidence in the RMB. The regression results after the grouping is consistent with the original random effects regression, despite minor differences. However, these differences are explainable and acceptable, indicating that the results of the original panel regression have some robustness.

Table 8: Regression results by group

Variables	Core world currencies	Important world currencies
NE	0.9386***	0.8814***
	(45.22)	(22.02)
ESDR	-0.0073***	0.0703*
	(-2.54)	(1.86)
CPI	-3.8965	-1.8756*
	(-1.33)	(-1.96)
FM	0.0039**	0.0011**
	(2.44)	(2.77)
PST	0.1698	-0.6174***
	(0.33)	(-3.22)
MI	-14.2389	-62.3218**
	(-1.21)	(-2.08)
GDP	6.9635	-5.4123***
	(0.094)	(-1.64)

Note: Z-values or t-values in brackets, *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

6. Research findings and policy recommendations

6.1   Research findings

This paper shows that the m-CBDC Bridge Project can bring about network externality, currency stability, and financial market development effects. These effects promote RMB internationalization.

Therefore, ensuring that the project can enhance the network externalities of RMB, maintain the stability of RMB currency value, and promote the development of China's financial market will be the key to enabling the m-CBDC Bridge Project to help the RMB internationalization.

6.2   Policy recommendations

This paper makes three specific recommendations in response to the study's findings. Firstly, we will take advantage of our current strengths in CBDC research and use the m-CBDC Bridge Project as a fulcrum to work with our project partners on the innovation and development of the international payment clearing system. Theoretically, the cross-border circulation of central bank digital currencies is bound to be more efficient than the existing international payment clearing system. According to a report by PwC, China ranks third in the world regarding CBDC maturity and leads major economies, giving it a first-mover advantage in CBDC. In the course of the project cooperation, China should vigorously play this advantage and rely on this project to develop cross-border trade settlement of e-CNY and increase the scale of RMB usage. At the same time, it should also actively cooperate with all parties to establish an international payment clearing system based on the CBDC.

Secondly, to build a macro-control system that can give full play to the advantages of CBDC. Implementing the m-CBDC Bridge Project allows four countries and regions to learn from each other's experience in the development of CBDC, which will speed up the development of e-CNY and bring forward the time for the full implementation of the e-CNY. Therefore, macro-control policies should adapt to the circulation of CBDC as soon as possible to improve the effect of macro-control. On the one hand, fiscal policy should be combined with CBDC, which can not only improve the efficiency and convenience of tax payment but also help the government to timely implement differentiated tax subsidy policies for different regions and different groups and improve the stability of fiscal policy. On the other hand, monetary policy should also adapt to the CBDC. Government should grasp the capital flow and timely adjust the credit policy to correctly solve the "financing difficulties" of the small, medium, and micro enterprises and improve the efficiency of capital allocation. The combination of macro-control policies and the CBDC will be conducive to the healthy development of China's economy, thus supporting the stability of the RMB currency.

Thirdly, to promote the reform of our financial system and create a favorable financial market environment. The m-CBDC Bridge Project aims to explore cross-border payments with the CBDC. If the project is successful, digital RMB will be

used in large quantities for cross-border payments. The amount of RMB outside the country will increase, and so will some related financial derivatives and innovations in the financial market, which is an opportunity and a great challenge for China's financial regulatory system. On the one hand, China can use this opportunity to promote further the opening of the capital account and interest rate market reform to increase the openness of the financial market in order to attract more foreign investors. On the other hand, competition in the financial market will become fierce, forcing China's financial institutions to implement reforms and hopefully create more liquid financial products based on the CBDC, fully exploiting the value brought by the CBDC to the financial market.

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