Progress of Research & Development of E-CNY in China

Working Group on E-CNY Research and Development of the People's Bank of China

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Introduction

The robust development of network technology and digital economy call for retail payment services that are more convenient, safe, inclusive and privacy-friendly. In many countries and regions, central banks or monetary authorities have kept a close eye on Fintech development and sought to digitalize fiat currency, putting theory into practice.

The People's Bank of China (PBOC) attaches great importance to the research and development of digital fiat currency. In 2014, it set up a task force to study digital fiat currency, and its scope of research covered the issuance framework, key technologies, issuance and circulation environment, and international experience. In 2016, the PBOC established its Digital Currency Institute, which developed the first-generation prototype of digital fiat currency. At end-2017, upon the approval of the State Council, the PBOC began to work with commercial institutions in developing and testing digital fiat currency (hereinafter referred to as e-CNY, a provisional abbreviation following international practices). So far, as the top-level design, function development, and system testing has been basically completed, the PBOC has initiated pilot programs in some representative regions, while making sure the pilots run in a steady, safe, managed, innovative and practical manner.

The PBOC working group on e-CNY research and development hereby releases this white paper to clarify the PBOC's position, to explain the background, objectives and visions, design framework and policy considerations for the e-CNY system, to seek public comments, as well as to deepen communication with all those concerned and join hands with them in building an open, inclusive, inter-operable and innovative currency service system for the era of digital economy.

1. Background of research and development

1.1 The development of digital economy calls for new retail payment infrastructures that are safe, inclusive and adaptive to the digital era.

Currently, as the Chinese economy is shifting from high-speed growth to high-quality development, technological innovation represented by the digital economy has become an important driver of development. With the rapid development of digital technologies such as big data, cloud computing, artificial intelligence, blockchain and the Internet of Things, the digital economy has witnessed various new models and new businesses. Covid-19 has sped up digital transformation of people's work and life, and online shopping, remote working and e-learning have become more active. The digital economy has expanded in its geographic coverage, and the less developed and remote areas have witnessed a rising demand for online financial services.

In recent years, the rapid development of electronic payment, especially mobile

payment in China has provided the public with convenient and efficient retail payment services, which boosted development of the digital economy, helped the public get used to digital payment, and created higher demand for technology and new services. Meanwhile, a safer, more inter-operable and more inclusive retail payment infrastructure which meets diversified payment needs is an important public good for higher quality growth. Such infrastructure will deliver better and more efficient basic financial services, ensure smooth domestic circulations, and support the building of a new development paradigm.

1.2 The functions of cash and the environment of using cash are changing profoundly.

As the digital economy develops, the share of transactions using cash is declining in China. According to a survey conducted by the PBOC in 2019, the number and value of transactions via mobile payment accounted for 66 percent and 59 percent of the total, while those paid in cash accounted for 23 percent and 16 percent, and those paid by card 7 percent and 23 percent, respectively. Among those surveyed, 46 percent used no cash in any transaction during the survey period. It should be noted, however, from end-2016 to end-2020, cash in circulation (M0) registered RMB6.83 trillion, RMB7.06 trillion, RMB7.32 trillion, RMB7.72 trillion and RMB8.43 trillion, respectively, representing a small rise. In the areas where financial services are less available, in particular, cash usage is still quite common. Meanwhile, the cost of cash management is quite high. Every element in the cash cycle consumes much human, physical and financial resource. Such elements include banknote design, minting and printing, transportation, deposit and withdrawal, identification, processing, reflow, destruction, counterfeit prevention and etc.

1.3 Cryptocurrencies, especially global stablecoins (GSC), have developed rapidly.

Since the creation of Bitcoin, the private sector has launched a variety of so-called cryptocurrencies. According to incomplete statistics, there are over 10,000 kinds of cryptocurrencies which have gained some influence, whose total value exceeds USD1.3 trillion.[1] Adopting blockchain and encryption technology, cryptocurrencies such as Bitcoin are claimed to be decentralized and entirely anonymous. However, given their lack of intrinsic value, acute price fluctuations, low trading efficiencies and huge energy consumption, they can hardly serve as currencies used in daily economic activities. In addition, cryptocurrencies are mostly speculative instruments, and therefore pose potential risks to financial security and social stability. Moreover, they have been employed as payment instruments for money-laundering and other illegal economic activities. To tackle the relatively big price fluctuation concern of cryptocurrencies, some commercial institutions launched so-called “stablecoins”, and tried to stabilize their values by pegging them to sovereign currencies or related assets. Some commercial institutions even plan to launch global stablecoins, which will bring

[1] Source: the website of CoinMarketCap, as of July 15th, 2021.

risks and challenges to the international monetary system, payment and clearing system, monetary policies, cross-border capital flow management and etc.

1.4 The international community pays close attention to central bank digital currency (CBDC) and is exploring CBDC options.

At the moment, many major economies are actively considering or advancing research and development of CBDC. According to the latest survey conducted by the Bank for International Settlements (BIS) on central banks in 65 countries or economies, about 86 percent have carried out researches on digital currencies. Meanwhile, the proportion of central banks that were performing experiments or developing a proof-of-concept prototype increased from 42 percent in 2019 to 60 percent in 2020. Publicly available information shows that, in recent years, central banks of the US, the UK, France, Canada, Sweden, Japan, Russia, Korea and Singapore as well as the European Central Bank have all disclosed their considerations and plans regarding CBDC in various ways. Some central banks have initiated or even completed preliminary trials.

2. Definition, objectives and visions

2.1 Definition of e-CNY

E-CNY is the digital version of fiat currency issued by the PBOC and operated by authorized operators. It is a value-based, quasi-account-based and account-based hybrid payment instrument, with legal tender status and loosely-coupled account linkage. It has the following connotations:

First, e-CNY is the fiat currency issued by the central bank. Firstly, e-CNY has all the basic functions of money, i.e., unit of account, medium of exchange and store of value. Same as the physical form of RMB, e-CNY is China's legal tender. Secondly, e-CNY is the digital version of China's fiat currency. Throughout history, the form of currency has evolved from objects, metal coins to banknotes. Such evolution of currency is a result of progress made in science and technology as well as evolution of economic activities. The issuance and circulation of e-CNY is identical with physical RMB, while the value of the former is transferred in a digital form. Thirdly, e-CNY is the central bank's liabilities to the public. Backed by sovereign credit, e-CNY has the status of legal tender.

Second, e-CNY adopts a centralized management model and a two-tier operational system. The right to issue e-CNY belongs to the state. The PBOC lies at the center of the e-CNY operational system. It issues e-CNY to authorized operators which are commercial banks, and manages e-CNY through its whole life cycle. Meanwhile, it is the authorized operators and other commercial institutions that exchange and circulate e-CNY to the public.

Third, e-CNY is mainly a substitute for cash in circulation (M0), and will coexist with physical RMB. Both e-CNY and physical RMB are the PBOC's liabilities to the

public, with the same legal status and economic value. The PBOC will issue e-CNY and physical RMB in parallel, and will take account of both during daily data collection, analysis and management. International experience shows that, as an economy matures, there naturally arises the need for more diversified means of payment. China is a large country with vast territory, large population, multiple ethnic groups and wide differences in regional development. In such a society, people's payment habits, age and security needs vary. Therefore, physical RMB enjoys advantages that could not be replaced by other means of payment. As long as there is demand for the physical RMB, the PBOC will neither stop supplying it, nor replace it via administrative order.

Fourth, as retail CBDC, e-CNY mainly serves domestic retail payment demands. Categorized by user and purpose, there are two kinds of CBDC, wholesale and retail. Wholesale CBDC is mainly issued to institutions such as commercial banks and mostly serve large-value settlement. Retail CBDC is issued to the public for daily transactions. Major countries and economies vary in their priorities of developing CBDC, with some focusing on wholesale transactions and some dedicated to improving the efficiency of the retail system. E-CNY is a retail CBDC issued to the public. With a modern domestic payment system in China, the issuance of e-CNY will fully meet the public's daily payment needs, further improve the efficiency of the retail payment system and reduce the cost of retail payment.

Fifth, in the future digital retail payment system, e-CNY and funds in the electronic account of authorized operators are inter-operable, and both constitute cash in circulation. Commercial banks and licensed non-bank payment institutions that meet compliance requirements (including anti-money laundering and countering terrorist financing requirements) and regulatory requirements regarding risk management on a comprehensive and on-going basis may participate in the e-CNY payment system as per recognition and support of the central bank. They can also fully tap existing payment and other infrastructures while providing digital retail payment services for customers.

2.2 Objectives and visions

The development of China's e-CNY system aims to create a new form of RMB that meets the public's demand for cash in the era of digital economy. Supported by a retail payment infrastructure that is reliable, efficient, adaptive and open, the e-CNY system will bolster China's digital economy, enhance financial inclusion, and make the monetary and payment systems more efficient.

The first objective is to diversify the forms of cash provided to the public by the central bank, satisfy the public's demand for digital cash and support financial inclusion. As digital technology and electronic payment develop, the use of cash in retail payments has been on a decline. However, it's the mandate of the central bank to ensure the public's direct access to cash, and make sure the unit of account is

consistent in the era of digital economy by digitalizing cash. An e-CNY system will make financial services more accessible, providing fiat money for a large population in various scenarios. Those without bank accounts can enjoy basic financial services provided via e-CNY wallet, and foreign residents temporarily travelling in China can open an e-CNY wallet to meet daily payment needs without opening a domestic bank account. In addition, as e-CNY is settled upon payment, businesses and related parties can improve cash flow while enjoying more convenient payment services.

The second objective is to support fair competition, efficiency and safety of retail payment services. E-CNY will provide the public with a new interoperable way of payment, which will further diversify payment instruments and make the payment system more efficient and safer. The Chinese authorities support coordinated development of various payment methods. E-CNY and existing electronic payment tools are on different dimensions. They complement each other, and also differ. Defined as a substitute for M0, e-CNY mainly serves retail payment. Its issuance aims at enhancing financial inclusion. It draws on existing electronic payment technologies and supplements the existing system. While sharing similar payment functions, e-CNY and existing electronic payment instruments differ in many aspects. First, e-CNY is China's legal tender, which is the safest asset in China. Second, it has intrinsic value, and can be transferred without relying on bank accounts. In addition, it supports off-line transactions and is settled upon payment. Third, e-CNY supports managed anonymity, which helps protect privacy and user information.

The third objective is to echo the international initiative and explore the improvement of cross-border payments. Whether e-CNY will be used in cross-border payments, and to promote RMB internationalization draws much attention. First of all, cross-border payment involves various complicated issues such as monetary sovereignty, foreign exchange policies and arrangements, as well as regulatory and compliance requirements. It is also a challenge that the international community is committed to address. The internationalization of a currency is a natural result of market selection. The international status of a country's currency depends on its economic fundamentals and the depth, efficiency and openness of its financial markets. Therefore, though technically ready for cross-border use, e-CNY is still designed mainly for domestic retail payments at present. Looking ahead, the PBOC will actively respond to initiatives of G20 and other international organizations on improving cross-border payments, and explore the applicability of CBDC in cross-border scenarios. Based on experiences of domestic trials and international demand, and preconditioned on mutual respect to monetary sovereignty and compliance, the PBOC will explore pilot cross-border payment programs and will work with relevant central banks and monetary authorities to set up exchange arrangements and regulatory cooperation mechanisms on digital fiat currency in line with the principle of "no detriment," "compliance," and "interconnectivity."[2]

[2] First, no disruption. CBDC supplied by one central bank should continue to support the healthy evolution of the

Meanwhile, the PBOC will uphold the principle of having a two-tier and risk-free system in order to meet regulatory and compliance requirements of various countries.

3. Framework of design

The design of e-CNY system follows the concept of "safe and inclusive, innovative and user-friendly, and time-evolving." The principles for design are based on a holistic consideration of monetary functions, market demand, supply model, technological support, and cost-benefit. Studies are conducted and revised on currency properties, operating model, digital wallet ecosystem building, compliance and responsibilities, selection of technology roadmap, and regulatory system. This aims to deliver an open, inclusive, sound, and reliable e-CNY system design plan that suits China.

3.1 Principles for design

Compliance with laws and regulations. The institutional design of e-CNY system strictly complies with regulations on the administration of RMB, anti-money laundering and countering the financing of terrorism (AML/CFT), the administration of foreign exchange, and data and privacy protection. The operation of e-CNY should be included in the regulatory framework.

Safety and Convenience. The e-CNY system is based on broad accounts, loosely coupled with bank accounts and has its system of value. This makes it adaptive to various on-line and off-line payments. Difficulties resulting from limited technological literacy and telecommunications coverage are minimized to meet people's demand for safe and convenient payment instruments. The e-CNY operational system is highly secure, highly usable, and highly expandable and concurrent, which can ensure business continuity.

Openness and Compatibility. The PBOC leverages on the advantage and professional experience of authorized operators and aspires to keep technology up-to-date by promoting technological competition and upgrading in line with the principle of evolving with the time so as to avoid the excessive concentration of system operational risk. The e-CNY system supports interoperability with traditional electronic payment systems. It makes full use of existing financial infrastructures to

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international monetary system. CBDC supplied by one central bank should not disrupt other central bank's currency sovereignty and their ability to fulfill its mandate for monetary and financial stability, and meanwhile should protect the legitimate rights of consumers and boost fair competition.

Second, compliance. Cross-border payments arrangements with CBDC should have a sound legal system and a stable operational system, comply with the regulations and laws of the jurisdictions concerned, such as capital management and foreign exchange mechanism. Information flow and fund flow could be synchronized, so as to facilitate the advancement of cross-border trade, bolster the development of real economy and meet the regulatory requirements for anti-money laundering and countering terrorist financing.

Third, interoperability. The development of CBDC should fully tap the role of the existing infrastructures and leverage Fintech so as to enable interoperability between CBDC systems of different jurisdictions as well as between CBDC systems and incumbent payment systems. In the meanwhile, its development should contribute to the orderly development of the payment system and guard against market fragmentation.

connect digital wallets of different operators as well as connect e-CNY wallet with bank accounts, thus improving the interoperability of payment instruments.

3.2 Features of e-CNY design

The design of e-CNY takes account of the advantages of both physical RMB and electronic payment instruments. Therefore it shares both the features of physical RMB, such as settlement upon payment and anonymity, and the features of electronic payment instruments, which are less costly, highly portable, highly efficient and hard-to-counterfeit. The design of e-CNY mainly considers the following features:

3.2.1 Identifiable both as an account-based and a value-based system

E-CNY is an account-based, quasi-account-based and value-based hybrid payment instrument. It has a variable face value and its value transfer takes the form of cryptocurrency strings.

3.2.2 Non-interest accrual

The e-CNY is a substitute for M0. Thus, it is treated the same as the physical RMB under M0, which carries and pays no interest.

3.2.3 Low costs

Consistent with the management of physical RMB, the PBOC does not charge authorized operators for exchange and circulation services, and the operators do not charge individual clients for the exchange of e-CNY either.

3.2.4 Settlement upon payment

According to settlement finality, the e-CNY is loosely coupled with bank accounts, and thus payments through e-CNY wallets are settled upon payment.

3.2.5 Anonymity (managed anonymity)

E-CNY follows the principle of "anonymity for small value and traceable for high value," and attaches great importance to protecting personal information and privacy. It aims to meet the public demand for anonymous small value payment services based on the risk features and information processing logic of current electronic payment system. Meanwhile, it is necessary to guard against the misuse of e-CNY in illegal and criminal activities, such as tele-fraud, Internet gambling, money laundering, and tax evasion by making sure that transactions comply with AML/CFT requirements. The e-CNY system collects less transaction information than traditional electronic payment and does not provide information to third parties or other government agencies unless stipulated otherwise in laws and regulations. Internally, the PBOC sets up a firewall for e-CNY-related information, and strictly implements information security and privacy protocols, such as designating special personnel to manage information, separating e-CNY from other businesses, applying a tiered authorization system, putting in place checks and balances, and conducting internal audits. Any arbitrary information requests or use are prohibited.

3.2.6 Safety

E-CNY adopts a variety of technologies, including digital certificate system, digital signature, and encrypted storage to make double-spending, illegal duplication and counterfeit, transaction falsification, and repudiation unfeasible. A multi-layer security system has been initially established to guarantee that e-CNY has a safe life cycle and risks are manageable.

3.2.7 Programmability

E-CNY obtains programmability from deploying smart contracts that don't impair its monetary functions. Under the premise of security and compliance, this feature enables self-executing payments according to predefined conditions or terms agreed between two sides, so as to facilitate business model innovation.

3.3 Design of e-CNY operational system

In line with the central bank's mandates, there are two options to operate digital fiat currency. One is single-tier operation under which the central bank directly provides issuance, circulation, and maintenance services for the general public. The other is two-tier operation under which central bank issues digital fiat currency to authorized operators and then these operators take charge of exchange and circulation.

E-CNY adopts two-tier operation whereby the PBOC is responsible for issuance and disposal, inter-institution connect and wallet ecosystem management. Additionally, it prudently selects commercial banks with certain strengths in capital and technology as authorized operators to take the lead in providing e-CNY exchange services. Other commercial banks and institutions, under the PBOC's centralized management, give full play to their creativity, and collectively provide services for e-CNY circulation. Specifically, under the quota management of the PBOC, the authorized operators open different types of digital wallets for customers based on the strength of customer personal information identification, and provide e-CNY exchange services. In the meantime, to enable secure and effective operation, authorized operators and related commercial institutions jointly provide e-CNY circulation services and retail management, including innovation on payment product design, system development, scenario expansion, marketing, business processing as well as operation and maintenance. The PBOC will try to keep a level-playing field and ensure that the market plays a decisive role in resource allocation. This will incentivize all participants and unleash their creativity, and maintain financial stability. The two-tier system can fully tap authorized operators' advantage in resources, talents, and technology to build a market-driven system that promotes innovation and competition. On top of that, since the public is used to accessing financial services via commercial banks, the two-tier system can increase the public acceptance of e-CNY.

3.4 Design of e-CNY wallet

Digital wallets are the medium of e-CNY that reaches out to users. Based on

centralized management, unified cognition and anti-counterfeiting, the PBOC makes the rules, while authorized operators jointly develop and share apps on mobile devices. They manage wallets, authenticate e-CNY, and develop wallet ecological platforms to enable operator-specific visual system and special features as well as online and offline applications in all scenarios. This aims to satisfy the different types of demands of different users at different levels. Digital wallets must be inclusive and obstacles arising from "digital divide" should be avoided.

3.4.1 There are different types of wallets, depending on the strength of customer personal information identification.

Authorized operators assign different types of digital wallets to customers based on the strength of their personal information identification, and set per-transaction and daily limits as well as maximum balance according to the strength of real-name information. The least-privileged wallets can be opened without providing identities to reflect the principle of anonymity. Users can open least-privileged anonymous wallets by default and upgrade them to higher-level real-name ones as needed.

3.4.2 There are personal and corporate wallets, depending on the type of holder.

Natural persons and self-employed individuals can open individual wallets, on which classification of transaction and balance limits are placed according to the strength of customer personal information identification; legal persons and unincorporated institutions can open corporate wallets. Transaction and balance limits are determined depending on whether the wallet is opened remotely. The functions of wallets can be customized to suit the needs of users.

3.4.3 There are software and hardware wallets, depending on the carrier.

A software wallet provides services through mobile payment apps, software development kit (SDK), and application programming interface (API). A hardware wallet uses security chips and other technologies to enable the functions of e-CNY. It is supported by IC card, mobile phones, wearable objects, and the Internet of Things devices. Combining these two types of wallets can enrich the wallet ecosystem and meet the needs of different groups of people.

3.4.4 There are parent wallets and sub-wallets, depending on the authorization.

The wallet holder can set the main wallet as parent wallet and open several sub-wallets under it. Individuals are able to set payment caps, payment conditions, personal privacy protection and other functions through sub-wallets; enterprises and institutions are able to pool and distribute funds and manage finance through sub-wallets.

3.4.5 The PBOC together with authorized operators and relevant organizations jointly build, own, and share the e-CNY wallet ecological platform.

A matrix of e-CNY wallet will be developed from the above dimensions. Based on this, the PBOC makes the rules, while authorized operators provide the basic

functions and cooperate with relevant market players to further develop various payment and financial products. This will help build a wallet ecological platform that can meet the needs in multiple scenarios and enable their respective special functions.

3.5 Defining obligations and entities of compliance

3.5.1 Obligations in AML/CFT compliance

As e-CNY is China's fiat currency, existing international standards and Chinese laws on AML/CFT apply. Authorized operators and other commercial institutions providing e-CNY exchange and circulation services are entities to perform AML duties and thus undertake AML obligations accordingly, including customer due diligence, keeping customers' identity data and records of transactions, and reporting large-value and suspicious transactions. While performing AML duties, authorized operators and other commercial institutions should protect business secrets, individual privacy and personal information in line with laws, and should not divulge customers' identity data or records of transactions. The PBOC, as the competent administrative authority for AML, conducts AML regulation by urging all parties concerned to fulfill their AML obligations and supervising the fulfillment accordingly.

3.5.2 Protection of consumers' rights and interests

The division of responsibilities for and the job of protecting consumers' rights and interests in the e-CNY system are the same as that of cash. The PBOC and authorized operators are responsible for authenticating e-CNY via its certificate and serial number. Authorized operators properly handle possible disputes and customer's loss according to relevant dispute settlement mechanisms. The PBOC protects the rights and interests of consumers in e-CNY exchange and circulation through regulatory evaluation.

3.6 Selection of technology roadmap

The selection of technology roadmap of e-CNY features long-term evolution, constant iteration and dynamic upgrading. Regular evaluations based on market needs are carried out for continuous improvements. Authorized operators may select their own technology roadmaps based on their actual demands and technological advantages, so as to maintain the insight and foresight into future technology.

The e-CNY system adopts a distributed and platform-based design, which enhances the resilience and expansibility of the system and supports the rapid growth in the volume of e-CNY transactions. To ensure the reliability and soundness of the system, the PBOC uses a mix of technologies such as trusted computing and special encryption based on hardware and software integration. The PBOC also builds up multi-layer security systems and design a data center solution featuring multisite high availability and 24/7 non-stop services, thus guaranteeing city-level disaster tolerance and business continuity.

The e-CNY system combines centralized architecture with distributed architecture,

forming a hybrid technical framework featuring the co-existence of dual states, namely, steady state and agile state, as well as the integrated development of centralized and distributed architectures.

3.7 Regulatory framework

The research and development of e-CNY is in line with the legal framework of China. Authorized by the *Law of the People's Bank of China*, the PBOC performs the responsibility of issuing RMB and supervising its circulation. The right to issue RMB is held exclusively by the PBOC. The newly released *Law of the People's Bank of China (Revised Draft for Comments)* further clarifies that "RMB includes both physical and digital forms."

However, regulatory measures and requirements for e-CNY need to be tailor-made. Regulation of e-CNY should be based on the principle of ensuring its property as a fiat currency, holding up to the bottom line of risk prevention and supporting innovative developments. The regulatory goals are to establish the management system for e-CNY business, make clear regulatory requirements for authorized operators, implement laws and rules on AML/CFT, strengthen the protection of user's personal information, and create a safe, enabling and regulated environment for the use of e-CNY.

4. Implications of CBDC and risk mitigation strategy of the e-CNY system

There is a divergent view about the implications of retail CBDC. Debates mainly focus on whether it could trigger financial disintermediation, weaken monetary policy and exacerbate bank runs. As the research and design schemes of retail CBDC may have different implications for monetary policy and financial stability, the PBOC attaches great importance to reducing risks and preventing potential impact of retail CBDC through top-level designs.

4.1 International opinions on the implications of retail CBDC

4.1.1 Implications for monetary policy

Essentially, time will tell

Some believe that retail CBDC is more attractive than deposits and may lead to financial disintermediation, narrow banking, and credit squeeze, while others argue that easy availability of CBDC can enhance the transmission of policy rates to the money and credit markets. If CBDC bears interest at a relatively attractive level, institutional investors might move from low-risk assets such as short-term government securities to CBDC, which will have an impact on the price of these assets. Therefore, in designing CBDC, central banks should take into account the formulation and implementation of monetary policy. However, some also argue that if CBDC bears no interest at all, the risk of CBDC competing with low-risk assets such as commercial bank deposits will be lower, and the potential impact on monetary policy will be mitigated.

4.1.2 Implications for financial stability

Some point out that CBDC, as the safest asset, could exacerbate bank runs in times of crisis. Residents and companies can easily convert bank deposits into CBDC, causing financial disintermediation and amplifying financial volatility. In particular, when systemic risks emerge, CBDC will serve as a channel for the public to quickly switch to safe assets. However, there are voices that CBDC will not have significant impact because quick interbank transfers have already been made possible under the current e-payment systems. In times of bank crisis or even economic crisis, e.g. currency crisis or sovereign debt crisis, funds will be withdrawn from all domestic assets, including CBDC, instead of merely shifting from bank deposits to CBDC.

4.2 Design of the e-CNY system to mitigate negative impact

Since the start of research on e-CNY, the PBOC has been paying close attention to the implications of retail CBDC for monetary system, monetary policy, financial markets, and financial stability, among others. The PBOC leverages on operational, technological and policy designs to minimize the impact of e-CNY system on existing monetary system, financial system, and the real economy.

FED's paper talks about same key principles

To reduce competition with bank deposits, e-CNY is a substitute for M0 and pays no interest. It circulates in the same way as the physical RMB in a two-tier system under which commercial banks exchange e-CNY for the public. Meanwhile, the PBOC has put in place system frictions as appropriate to prevent the rapid spread of bank runs. To promote the use of e-CNY in retail payment scenarios, ease the crowding-out of bank deposits, and prevent arbitrage as well as procyclical effects under stressful conditions, the PBOC has come up with a tiered design of e-CNY wallet with different caps on transaction and balance for different types of e-CNY wallets. Additionally, the PBOC has set up a framework of big data analysis, risk monitoring and early warning for e-CNY to enhance the foresightedness, accuracy and effectiveness of e-CNY management.

Digital fiat currency is a new thing. Its impact on the economy and the financial sector can be assessed through pilot tests and practices. The PBOC is carrying out e-CNY pilot programs with the focus on the implications of e-CNY for monetary policy, financial markets and financial stability in the pilot regions. Based on the findings of the pilot programs, the PBOC will iterate and improve the e-CNY design accordingly.

5. Progress in work

The PBOC has made sustained efforts to explore, update and improve the relevant theories and technologies on digital fiat currency, which has brought into shape the current e-CNY model and business framework. Going forward, the PBOC will build upon test results and further improve technological, business and policy frameworks.

5.1 Previous work

From 2014 to 2016, the PBOC established the digital fiat currency research group, and kicked off research in this field. The research group conducted in-depth studies in

issuance and business operation framework, key technologies, circulation environment and international practices on digital fiat currency. As a result, the theory of digital fiat currency for the initial stage took shape. In 2016, the PBOC built the concept prototype of China's first-generation digital fiat currency, established the Digital Currency Institute (DCI), and proposed the top-level designs and fundamental features of e-CNY, including the two-tier operational system, substitute for M0, loosely coupled with bank accounts, and managed anonymity.

Under this framework and approved by the State Council, the PBOC started the e-CNY R&D project at the end of 2017. Large commercial banks, telecom operators and Internet companies with high rankings in asset size and market share and strengths in technology development were selected to participate in this project. With long-term and evolutionary vision embedded in the process of top-level designs and R&D, the PBOC and participating institutions developed and improved e-CNY apps through three phases, i.e., development and testing, internal verification, and managed external pilot. The PBOC has developed three main functions of e-CNY, which are exchange and circulation management, interoperability and wallet ecosystem. In the meantime, based on the e-CNY R&D framework, the PBOC has built a relatively complete standard system, covering general requirements, business operation, interoperability, wallet, security and regulation.

Following the principle of being steady, secure, managed, innovative and practical, the PBOC has launched e-CNY pilots in Shenzhen, Suzhou, Xiong'an, Chengdu and scenarios in the 2022 Beijing Winter Olympics since the end of 2019. The pilot runs were designed to test the reliability of theories, the stability of systems, the usability of functions, the convenience of processes, the applicability of scenarios and the controllability of risks. Starting from November 2020, Shanghai, Hainan, Changsha, Xi'an, Qingdao and Dalian joined in the pilot. The selection of pilot places for e-CNY R&D project takes into account factors such as major national development strategies, coordinated regional development strategies, as well as city-specific industrial and economic features. The pilot program now spans the Yangtze River Delta, the Pearl River Delta, the Beijing-Tianjin-Hebei region, and China's central, western, northeastern and northwestern regions. A wide range of pilot places is conducive to testing and assessing the application of e-CNY in different parts of China.

As of June 30, 2021, e-CNY has been applied in over 1.32 million scenarios, covering utility payment, catering service, transportation, shopping, and government services. More than 20.87 million personal wallets and over 3.51 million corporate wallets had been opened, with transaction volume totaling 70.75 million and transaction value approximating RMB34.5 billion. Supported by local governments, some cities distributed red packets of e-CNY to consumers. While some pilot tests involved real users and were conducted under different scenarios, large-scale tests were also arranged in batches. The pilot program tested the business and technological designs as well as whether the e-CNY system is stable, the product is user-friendly and the

scenario is applicable. It also deepened people's understanding of the design philosophy of e-CNY.

During the pilot, the PBOC focused on exploring the innovation of e-CNY application models. Smart contracts were used to make the e-CNY programmable, more expandable, and better integrated into various scenarios. Through collaboration with selected mobile phone producers, the PBOC studied dual offline payment and other innovations on mobile devices. Smartphone-free hardware wallets based on smart visual cards were tested in an effort to bridge the "digital divide". To make Winter Games technology savvy, innovative scenarios were deployed on a trial basis in the premises of the Beijing Organizing Committee for the 2022 Olympic and Paralympic Winter Games, such as unmanned vending carts, automatic vending machines and unattended supermarkets. Wearable devices were developed, such as gloves, badges and Olympic uniforms with payment functions. Most users participating in the pilot tests agree that e-CNY can help improve payment efficiency and reduce costs. The general public, micro and small vendors and enterprises acknowledge the convenience and inclusiveness of e-CNY.

During the R&D and pilot, the PBOC extensively exchanged views with international organizations (IOs) such as the Financial Stability Board, the Bank for International Settlements (BIS), the International Monetary Fund and the World Bank. The PBOC discussed cutting-edge issues on digital fiat currency with monetary and fiscal authorities and regulators in various jurisdictions, multinational financial institutions, and top universities. It actively participated in setting standards for digital fiat currency and building an international standard system under the framework of IOs. The PBOC DCI has signed an MOU with the Hong Kong Monetary Authority. It has also joined the Multiple CBDC Bridge (m-CBDC Bridge) led by the BIS Innovation Hub (BISIH), where it explores CBDC options in joint efforts with BIS innovation hub centers in Hong Kong Special Administrative Region and Singapore, as well as relevant central banks.

5.2 Outlook

The PBOC will continue to prudently advance the pilot e-CNY R&D project in line with China's 14th Five-Year Plan, with no preset timetable for the final launch. Efforts will focus on the following areas.

First, the PBOC will forge ahead with the pilot R&D project in a prudent and orderly manner. Building on the experience from the previous pilot tests and taking into account the development plans and local circumstances of pilot places, the PBOC will further expand test scenarios to cover all possible scenarios in selected pilot regions. The PBOC will improve the e-CNY ecosystem, and continue to explore new application models in line with economic and social development. In the meantime, the PBOC will join hands with and tap the strengths of all relevant parties, including

authorized operators, to improve pilot schemes based on practices and continuously optimize the design of the e-CNY system.

Second, the PBOC will improve relevant institutional arrangements and rules. We will actively advance the revision of laws and regulations, such as the *Law on the People's Bank of China*, and explore to formulate administrative measures on e-CNY to enhance protection of personal information. The PBOC will improve the rulebook and technical codes. Additionally, we will improve security management for the e-CNY operational system throughout the entire lifecycle of e-CNY, covering password security, financial information security, data security and business continuity, so as to ensure safe and stable functioning of the system.

Third, the PBOC will strengthen research on major issues. We will deepen our analysis of e-CNY's deep impact on monetary policy, financial system and financial stability, in an effort to lay a solid theoretical and policy foundation for the R&D and potential application of e-CNY. Meanwhile, the PBOC is willing to participate actively in international exchanges of views on digital fiat currency and discuss standards setting in an open and inclusive manner, in order to jointly advance the development of the international monetary system.