

Deployment of Blockchain Technology on the Banking Industry in China: A Policy Review Study

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Abstract: This paper focuses on exploring the development of BC in the banking industry in China. Due to the Great Firewall and policy factors, the development of blockchain in China has not been synchronous with the rest of the world. However, China has been gradually researching the application of blockchain in the banking sector. To investigate the factors that have led to a faster pace of development in blockchain in the banking industry in the past five years, this paper employs the methods of policy review and case study. The analysis findings indicate that blockchain in the banking industry in China is currently primarily applied in six major modules: supply chain financing, cross-border financing, cross-border settlement, identity verification (KYC), fraud prevention and security, and digital currency. The driving factors behind the development of blockchain in the Chinese banking industry are mainly twofold: the encouragement and guidance of government policies and meeting the needs of the banking business model to enhance the quality of its assets and maintain social productivity.

Keywords: blockchain; China; the banking industry; policy review; application; finance; settlement; ICBC

1. Introduction

Blockchain (hereafter 'BC') was created as the underlying core technology for Bitcoin (Berentsen & Schär, 2018). In 2008, a self-proclaimed "Satoshi Nakamoto" published a paper "Bitcoin: a Peer-to-Peer Electronic Cash System", which for the first time made the concept of BC public, marking the birth of the BC 1.0 era (Hamdi, Fourati & Ayed, 2023); by 2013, ether realised digital assets and smart contracts, marking the arrival of the BC 2.0 era; by 2017, the public link system was born, marking the arrival of the 3.0 era of "BC +" (Hamdi, Fourati, & Ayed, 2023). In recent years, every country in the world has agreed that BC technology will be a new generation of cutting-edge information technology. Therefore, BC technology has been favoured by various international authorities, national governments, large financial institutions and technology companies. Among all blockchain entrepreneurial projects in China, financial projects have the highest proportion. (2018, Financial Blockchain Research Report) With the continuous development of BC technology in the banking industry, the underlying technology, infrastructure and business model of the banking industry will be completely changed. (2019, Blockchain + Supply Chain Emerges as the Mainstream Implementation Scene.)

2. Background

The Chinese government attaches great importance to the development and application of BC technology. Therefore, the development of BC technology has gradually entered a fast track. In the "The 13th Five-Year National Informatization Plan" issued by the State Council in 2016, BC technology was included in the national informatization strategic plan and included as one of the national strategic frontier technologies. BC is a distributed ledger technology, which uses cryptography to ensure the security of transmission access and is jointly maintained by multiple parties, and can realize the effective storage of data, prevent tampering, and non-repudiation of technology (2016, White Paper on the Development of Blockchain Technology and Applications in China). R3 BC alliance is an international alliance which contributes to the application of BC technology in the

banking industry (Natoli & Gramoli, 2016). With the increasing maturity and development of BC technology, more than 70 large international financial institutions have officially joined the "R3 BC alliance", including the China Foreign Exchange Center. In 2021, the State Council also clarified the overall goal of the BC key special work and included the BC key special work in the "14th Five-Year Plan" national key research and development plan. (2021, "14th Five-Year Plan" National Key Research and Development Plan "BC" key Project Declaration Guide)

3. Literature Review

3.1. Literature Review on Blockchain Technology

As defined by Crosby et al. (2016), BC technology is a distributed database or shared ledger, public or private, of all digital transactions executed and disseminated among participating entities within the BC network. BC technology distinguishes itself from most existing information system designs by encompassing several key characteristics: it employs multi-node collective maintenance, point-to-point transmission, encryption algorithms, and consensus mechanisms (Bai & Sarkis, 2020; Kwok et al., 2024a, 2024b).

3.1.1. Hash Function

BC technology relies on mathematical algorithm models, establishing a network among various nodes (Zheng et al., 2017). Trust is built through technical endorsement, eliminating the necessity for centralized credit institutions in information dissemination. A BC comprises blocks connected by a hash function, forming an immutable data chain (Winarski, 2022). The header of each block reflects the content of the subsequent one, forming a chain (Saber et al., 2019). Controlling the consensus of the majority of nodes is crucial, and practical applications involve deploying nodes to different business participants, preventing unilateral data tampering.

3.1.2. Consensus Mechanism

BC's consensus mechanism dictates rules for nodes when adding transactions (Rozario & Vasarhelyi, 2018). Proof of Work (PoW), the common algorithm, uses specific cryptocurrencies as rewards, incentivizing nodes for mining. In a PoW scenario, tampering with records is practically improbable unless a single node controls over half the computing power (Luo & Yang, 2023). This mechanism ensures BC's tamper resistance.

3.1.3. Smart Contract

Smart contract, programs running on the BC, are a key reason why BC is referred to as "decentralized." They record the behaviour of transaction parties, ensuring immutable and traceability for transaction security (Lai & Chuen, 2018). Smart contracts can run automatically without human intervention based on code design. A contract can be transformed into a smart contract based on a specific programming language, and once preset conditions are met, the contract will be enforced automatically (Moll & Yigitbasioglu, 2019). Each block in the distributed ledger has verifiable, timestamped transaction records, making the entire process transparent and traceable, increasing mutual trust among project participants and providing auditable data (Moll & Yigitbasioglu, 2019).

3.1.4. Decentralization and Trust

BC's decentralization, a key trait fostering trust, enhances transaction efficiency and reduces costs by eliminating third-party involvement (Raval, 2016). This feature, including tamper-resistant timestamps and the consensus mechanism, ensures transparent transactions between counterparties (English & Domingue, 2016). Trust is inherent in BC; its distributed ledger guarantees integrity, traceability, and tamper resistance, eliminating the need for participants to establish trust. BC operates objectively, preventing entities, whether large companies

or individual users, from violating algorithmic rules (Crosby et al., 2016). The use of asymmetric public-key encryption mechanisms in BC further ensures information validity and prevents fraud (Sabeti et al., 2019).

3.2. Literature Review on the Classification of Blockchain

Currently, BC systems can be broadly categorized into three types: public chains, private chains, and consortium chains.

Public BC allows anyone to join, creating a decentralized network (Zheng et al., 2017). However, due to the large number of unconfirmed individuals involved, extensive protection and verification measures are required, presenting challenges and lag in network development. Private BC, on the other hand, is a centralized network entirely controlled by an organization, requiring entity identification (Zheng et al., 2017). Transactions in a private BC are controlled by a few main nodes, resulting in faster transaction processing and higher operational efficiency (Kour, 2023).

Sitting between public and private BCs, consortium BC operates in an intermediate zone (Vinoth et al., 2022). Consortium chains are partially centralized, with pre-selected nodes holding power (Hamdi, Fourati & Ayed, 2023). As such, consortium BC addresses the issues of slow transaction speeds in the public chain and limited network scalability in the private chain, while maintaining a distributed structure and enhancing security by restricting participation (Kour, 2023).

3.3. Literature Review on Obstacle of Blockchain Development in China

3.3.1. Great Firewall

China's BC development is impeded by the Great Firewall, restricting access to international forums and hindering the timely import of foreign technologies (Heggie, 2022). This isolation limits the public's understanding, hindering the widespread recognition, exploration, learning, and application of blockchain technologies (Taneja & Wu, 2014).

3.3.2. Policy Measures Against Mining

China has implemented stringent policies curbing blockchain network mining, focusing on supervision and regulation. The government, as per the 2021 Notice from the National Development and Reform Commission, prohibits new mining projects, expedites the phased withdrawal of existing ones, and restricts virtual currency mining projects from participating in the electricity market. These activities are categorized for elimination. In 2021, China declared virtual currency-related businesses, including Bitcoin and Ethereum, as illegal financial activities through a Notice addressing the need for additional risk mitigation measures, prohibiting their circulation as currency and voiding legal protection.

4. Research Aim and Objectives

- Research Aim: Why is Blockchain Growing Rapidly in the Banking Industry in China?
- Objective 1. What Factors Make Blockchain Suitable for the Banking Industry?
- Objective 2. How Blockchain Can Improve the Performance of Banks?

In China, the internet is subject to a firewall, making it challenging for BC to synchronize with the rapid pace of global development. Additionally, the government prohibits mining activities, contributing to the relatively slow pace of BC development in China compared to the rest of the world.

However, despite these challenges, BC technology has gained recognition in various industries in China, including banking, charity, education, food processing, and more. This article primarily aims to investigate why the development of BC in the banking industry on the Chinese mainland is progressing rapidly. To achieve this

research objective, the paper first explores the factors that make BC suitable for the banking sector, followed by an examination of the impact of BC on banking performance. Subsequently, the study seeks to identify the reasons behind the popularity of BC in the banking sector.

5. Research Method

5.1. Policy Review for Objective 1

In the process of searching related documents, the keywords used to search the related documents are "BC/BC application", "BC + bank", and "BC policy", the time range is 2016-2023, after the screening, a total of 121 effective related documents have been collected, downloaded and exported, contributing to the systematic policy review. The database is the government and financial regulatory authorities. (See Table 1)

Table 1. The content of government units and documents accompanied by the respective year.

Government Units	Documents
Central People's Government of the People's Republic of China	<p>"13th Five-Year Plan" National Information Plan. (2016)</p> <p>Blockchain: Building a Trustworthy World. (2016)</p> <p>Zhejiang Merchants Bank Completes First Real Transaction Using "Blockchain" Technology. (2017)</p> <p>Trial Operation of Digital Currency Issued by the Central Bank. (2017)</p> <p>"14th Five-Year Plan" National Information Plan. (2021)</p> <p>State Council Notice on Issuing a Package of Policy Measures to Solidly Stabilize the Economy. (2022)</p> <p>Over the Past Decade, Small and Medium-sized Enterprises Have Developed Fast and Well. (2022)</p> <p>People's Bank of China Issues "Financial Technology Development Plan (2022-2025)". (2022)</p> <p>State Council Opinions on Carrying out Innovative Pilot Work on Business Environment. (2021)</p> <p>Gansu Delegates Speak to the Central Committee: Promoting the Integration and Innovative Development of Big Data, Blockchain, and the Economy and Society. (2021)</p> <p>Industrial and Commercial Bank of China Successfully Connects to the Financial Blockchain Service Platform. (2020)</p>
Ministry of Industry and Information Technology	White Paper on the Development of Blockchain Technology and Applications in China (2016)
China Academy of Information and Communications Technology	Financial Blockchain Research Report(2018)
Anhui Provincial Department of Commerce	Blockchain Development Welcomes New Opportunities. (2021)
Anhui Provincial Department of Justice	Jing County Issues the First Intellectual Property Notarized Electronic Data Certification. (2022)
Beijing Municipal Bureau of Economy and Information Technology	Beijing Digital Economy Full Industrial Chain Open Development Action Plan. (2022)
State-owned Assets Supervision and Administration Commission of the People's Government of Beijing	<p>Huaxia Bank's First Blockchain Resale Transaction Lands, Adding a New Wing to Serving the Real Economy. (2020)</p> <p>Beijing Bank's Blockchain 2.0 Platform is Launched, Upgraded to the Most Advanced BaaS Platform in the Industry. (2019)</p> <p>Huaxia Bank Actively Develops Blockchain Technology to Serve Tianjin Pilot Free Trade Zone. (2019)</p>

(continued table 1)

<p>Beijing Municipal Local Financial Supervision and Administration Bureau</p>	<p>Financial Technology "Brightens" the First Batch of Listed Banks, with a Double-digit Increase in Financial Technology Investment in the 2021 Annual Report. (2022)</p> <p>Safeguarding Global Industrial Chain Coordination: Construction Bank's "Combined Punch" Safeguards Cross-border Financial Business. (2020)</p> <p>Technological Innovation Assists in "Epidemic" Services, Bank of China Beijing Branch Lands the First Blockchain Loan to Support Small and Medium-sized Enterprises. (2020)</p> <p>Postal Savings Bank Completes the First Cross-chain Transaction in Forfaiting, Making a Breakthrough in Blockchain Application Innovation. (2020)</p> <p>Haidian Small and Medium-sized Enterprise Financial Service Platform Achieves the First Loan. (2020)</p> <p>The Enterprise Electronic Identity Authentication Information System (eKYC) Based on Blockchain Goes Online and Completes the First Account Opening. (2020)</p> <p>Safeguarding Financial Science and Innovation: Commercial Banks Launch a Network Security "Offensive-Defensive Combination". (2018)</p> <p>Three Questions about Blockchain. (2018)</p> <p>A Long Article Reveals the Eight Pain Points of Hexing Blockchain. (2018)</p>
<p>People's Government of Haidian District, Beijing</p>	<p>Haidian Small and Medium-sized Enterprise Financial Service Platform Achieves the First Loan. (2020)</p>
<p>Shenzhen Municipal Local Financial Supervision and Administration Bureau</p>	<p>Shenzhen Supply Chain Finance Encourages Banks to Research Exclusive Credit Products for Key Industrial Chains. (2023)</p> <p>Proposal on Using Big Data and Blockchain Technology to Restructure the Financial Credit System and Solve the Financing Difficulties of Small and Medium-sized Enterprises. (2022)</p> <p>Letter from the Municipal Local Financial Supervision and Administration Bureau Regarding the Hosting Opinions on the Handling of Proposal No. 20220307. (2022)</p> <p>Blockchain Gambling, Games? These fundraising schemes under the guise of blockchain are all routines. (2020)</p> <p>National Blockchain Exhibition and Service Network Launched. (2019)</p> <p>Guarding against fraudulent fundraising activities conducted under the names of "virtual currency" and "blockchain". (2019)</p>

(continued table 1)

China Financial News Network	<p>Export-Import Bank's digital letter of credit business goes smoothly and completes its first reply. (2023)</p> <p>People's Bank of China Chongqing Branch: "Five Strengthenings" to attract financial vitality and assist in the development of small and micro enterprises in distress. (2022)</p> <p>Digital technology boosts the innovation of the supply chain finance model. (2021)</p> <p>Empowering the supply chain with finance to "revitalize" and "transform". (2021)</p>
Shandong Provincial Local Financial Management Supervision Bureau	<p>Yantai Free Trade Zone completes its first cross-border financial blockchain service platform transaction. (2020)</p> <p>Bank of China Shandong Branch successfully handles the province's first cross-border financial blockchain service platform export financing business. (2020)</p> <p>Bank of China Shandong Branch successfully completes the province's first "Blockchain Forfaiting Trading Platform" secondary market cross-bank buying and selling business. (2019)</p> <p>Qilu Bank's new supply chain finance business solves the problem of labor capital turnover</p> <p>The application scenario of "Export Credit Insurance Policy Financing" on the cross-border financial blockchain service platform successfully lands in the Guangdong-Hong Kong-Macao Greater Bay Area. (2021)</p> <p>Hengfeng Bank leverages technology to create credit products and promote the revitalization of rural industries. (2021)</p>
People's Government of Shandong Province	Regulations to promote the development of big data. (2021)
Sichuan Provincial Local Financial Management Bureau	<p>The world's first blockchain loan lands in Chengdu. (2019)</p> <p>Cross-border cooperation between trade finance blockchain platforms and Hong Kong TradeLink platforms kicks off trial operation. (2020)</p> <p>How small and medium-sized banks can catch the financial technology express. (2020)</p> <p>From the first launch of "Tianfu Zhilai Loan" to the first establishment of the Sichuan blockchain technology platform</p> <p>Promoting the science and innovation of warehouse financial services with the "Starry Plan". (2023)</p>

(continued table 1)

<p>People's Government of Jilin Province</p>	<p>"Blockchain + Finance": Accelerating landing for the real economy. (2019)</p> <p>Deepening the interaction of blockchain technology with banking and taxation, Shenzhen tax support helps stabilize the development of banks. (2020)</p> <p>Tracking the forefront of technology, focusing on the trend of the times, using blockchain technology to innovate and develop, activate new energy, and cultivate new business formats. (2020)</p> <p>Tonghua City promotes live cattle collateralized loans. (2020)</p> <p>Riding the wave of "digital" and leading the development with "intelligence". (2023)</p> <p>Giving "Jiniu" a "digital makeover". (2023)</p>
<p>Jiangxi Provincial Local Financial Management Bureau</p>	<p>Diverse scenarios emerge as blockchain financial applications gradually become popular. (2020)</p> <p>On the wind of blockchain, what obstacles still need to be overcome. (2020)</p> <p>China National Aviation Trust actively lays out blockchain financial applications. (2017)</p> <p>The first financing of export credit insurance policy in the province landed in the revolutionary old area of Southern Teng. (2021)</p> <p>Jiangxi Joint Equity Trading Center: "Blockchain Pilot + Credit Information" dual-wheel drive serves the real economy. (2022)</p>
<p>Fujian Provincial Local Financial Management Bureau</p>	<p>Reply to Proposal No. 20201324 of the 12th Session of the Provincial CPPCC. (2020)</p> <p>Xiamen approved for the pilot of the cross-border financial blockchain service platform. (2019)</p> <p>Using "Blockchain + Big Data" Technology to Promote the Development of Forest Rights Mortgage Loans. (2022)</p> <p>Technology and Finance Integration, Supporting Industrial Innovation and Upgrading. (2017)</p> <p>Xiamen International Bank launches the "Data Broker" application scenario for Fujian Big Data Exchange. (2023)</p> <p>Putian: Financial institutions grant online credit of 185 million yuan to foreign trade companies. (2023)</p> <p>Pingtang Comprehensive Experimental Zone introduces a new model of "all-process online intelligent approval and paperless handling" for real estate registration and transactions. (2021)</p> <p>Significant Achievements in Financial Support for High-Quality Development of the Real Economy. (2021)</p>

(continued table 1)

People's Government of Fujian Province	Announcement of the "14th Five-Year Plan" Digital Special Plan for Fujian Province. (2021)
People's Government of Hebei Province	<p>Hebei Equity Exchange launches the Shenzhen Tong blockchain platform. (2022)</p> <p>Baoding City Blockchain Financial Comprehensive Service Platform goes online and launches. (2021)</p> <p>The Foreign Exchange Administration assists foreign trade enterprises in cross-border trade financing to achieve "double-chain integration". (2020)</p> <p>"2018 Financial Technology Summit Forum" held in Mancheng District. (2018)</p> <p>New Era, New Journey, New Great Cause Blockchain New Track "Xin" Runs Fast. (2023)</p> <p>Anyang High-tech Zone approved to create a leading area for blockchain development in Henan Province. (2023)</p> <p>A group of blockchain troops are coming. (2023)</p> <p>Henan plans blockchain construction with a forward-looking vision. (2023)</p> <p>Zhengzhou clarifies: By 2025, the "Zhengzhou Chain Service System" will be fully established. (2023)</p>
Shanghai Municipal Commission of Economy and Informatization	Shanghai promotes the implementation plan for the urban blockchain digital infrastructure system (2023-2025). (2023)
Shanghai Municipal Local Financial Supervision and Administration Bureau	<p>Foreign banks actively participate in the Import Expo, confident in China's opening-up opportunities. (2022)</p> <p>Financial technology talents remain the favorite of banks. (2022)</p> <p>Making finance better for the relief and resolution of difficulties for small and micro enterprises. (2022)</p> <p>During the epidemic, banks can still provide loans, and stocks can still be traded, thanks to the efforts of Shanghai's financial state-owned enterprises. (2022)</p> <p>Boosting the Quality and Efficiency of the Real Economy - The Financial Technology Power Behind the "Wave Acid" and "Shenzhen Speed". (2022)</p> <p>China Merchants Bank Shanghai Branch Ingeniously Uses Small Bills to Solve the Financing Difficulties of Small and Medium-sized Enterprises. (2022)</p> <p>Industrial Consumer Finance of Industrial Bank Applies Blockchain to Explore Solutions to Financial Litigation Challenges. (2022)</p> <p>Industrial and Commercial Bank of China's various digital financial service scenarios will be showcased at the 2022 Service Trade Fair Financial Services Special Exhibition. (2022)</p>

(continued table 1)

<p>Shanghai Municipal Local Financial Supervision and Administration Bureau</p>	<p>Industrial Consumer Finance Industry targets new urban residents' financial needs and provides lifecycle services. (2023) The trend of improvement in the financial technology industry remains unchanged. (2023) Shanghai has made significant progress in building a globally competitive fintech center. (2023) Commercial banks issued 240 billion yuan in green financial bonds within the year, a year-on-year increase of over 88%. (2023)</p>
<p>Shaanxi Provincial People's Government</p>	<p>The first landing of export credit insurance policy financing business in Shaanxi. (2023) Shaanxi's social financing scale exceeded 680 billion yuan in 2022. (2023) Qinchuang Innovation Voucher is about to debut. (2021) The scale of cross-border fund flow in Shaanxi increased by 11.67% year-on-year in the first half of the year. (2020) 13 financial measures in Shaanxi support the construction of the Central and European (Xi'an) Assembly Center for China-Europe freight trains. (2020)</p>
<p>Heilongjiang Provincial Financial Supervision and Administration Bureau</p>	<p>2022 Annual Report on the Construction of the Rule of Law Government of the Provincial Local Financial Supervision and Administration Bureau. (2023) Bai Rong Yun Cang focuses on the financial scene to relieve the pressure of small and micro loans. (2020) The financial industry's application of blockchain technology has a "security token". (2020) The pilot of the cross-border financial blockchain service platform is launched. (2020) Everbright Bank: Actively serving the real economy, comprehensively promoting the construction of wealth management banks. (2020)</p>
<p>Heilongjiang Provincial People's Government</p>	<p>Heilongjiang Provincial Government Notice on Printing and Issuing the Industrial Revitalization Action Plan of Heilongjiang Province (2022-2026). (2022) Notice on Printing and Issuing Several Policy Measures to Support the Development of Ice and Snow Economy in Heilongjiang Province. (2022) State Council Office Opinion on Further Releasing Consumption Potential to Promote Sustainable Consumption Recovery. (2022) Full Text of the "Regulations of Heilongjiang Province on Promoting the Development of Small and Medium-sized Enterprises". (2022)</p>

(continued table 1)

Shanxi Provincial People's Government	Comprehensive Promotion of High-Quality Development - Seeking Blockchain Strengths (Part 1). (2022) Comprehensive Promotion of High-Quality Development - Seeking Blockchain Strengths (Part 2). (2022)
Hubei Provincial Local Financial Supervision and Administration Bureau	Hubei introduces fifteen financing support measures to promote the development of foreign trade industries. (2022) Continuous release of policy benefits, the financial industry supports small and micro enterprises more intensively. (2022) Give full play to the driving role of Jin Cang District. (2022) Hubei Private Banks enter the national team. (2021) Recognize the true face of fraudulent fundraising and secure the people's money bags. (2021) "Six Specializations" service rapidly responds to the financial needs of enterprises. (2020) The Foreign Exchange Bureau Hubei Branch promotes effective landing of foreign exchange policies benefiting people and enterprises in the current account. (2022)
Hainan Provincial Local Financial Supervision and Administration Bureau	Hainan Province's "14th Five-Year Plan" for the development of the financial industry. (2021)
Jiangsu Provincial Local Financial Supervision and Administration Bureau	"14th Five-Year Plan" for financial development clarifies the roadmap - Jiangsu prepares to build a financially strong province. (2021) Regarding the Suggestion to Address the Financing Difficulties of Small and Micro Enterprises in Our Province). (2021) Concerning the Proposal for the Technical Support of "Blockchain + Supply Chain Finance" to Facilitate the High-Quality Development of Small and Micro Enterprises. (2020)
People's Government of Guangdong Province	Blockchain + Supply Chain Emerges as the Mainstream Implementation Scene (2019)

2016-2018 is the start period of "BC + commercial bank". 2019-2021 belongs to the period of rapid development. After the 18th collective study on BC technology organized by the Political Bureau of the CPC Central Committee in 2019, various central ministries and local governments have responded to the call to support the development of the BC industry and relevant policy documents have been intensively released. (2020, the BC on the Blue Ocean, what are the obstacles to pass; Jiangxi Provincial Financial Supervision Administration) 2022-2023 has been a period of sustainable development (See Figure 1).

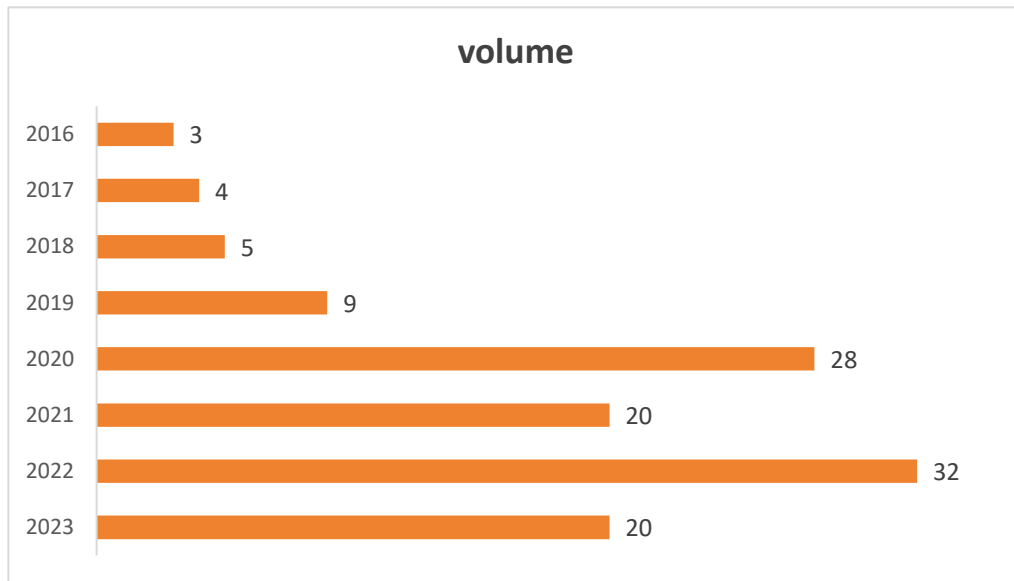


Figure 1. The distribution of data from 2016 to 2023.

5.2. Case Study for Objective 2

This paper also uses a case study to analyse objective 2, whether BC can reduce the non-performing loan ratio of banks, and introduces the Industrial and Commercial Bank of China (ICBC) as a case for analysis, to verify the effect of BC in practical application. At the same time, data analysis is used to study the analysed data from the annual report of ICBC from 2016 to 2023, and clearly and specifically analyse the impact of applying BC on the non-performing loan ratio, income, cost control, provision coverage ratio, comparing the corresponding data on an annual basis over ICBC itself. For the fields to which ICBC applies BC, relevant data are mainly obtained through the "White Paper on the Development of BC Financial Applications" release by ICBC.

6. Findings

6.1. Attribute to Implementing Blockchain for the Banking Industry

6.1.1. Macro Policies Encourage the Development of Blockchain

In recent years, the Chinese government has actively promoted the integration of blockchain (BC) technology in the banking sector. Initiatives include the establishment of shared credit information platforms, breaking down information silos [1]. Qualifying fintech companies are encouraged to access the People's Bank of China's credit reporting system, fostering credit data sharing [2]. To address emerging areas in digital finance, 17 financial industry standards, covering artificial intelligence, BC, big data, and cloud computing, are actively under development [3]. Promoting safety and compliance, there is guidance for strategic collaboration between banking and insurance institutions and fintech companies. This collaboration aims to integrate technologies like cloud computing, AI, mobile internet, big data, and BC in the banking, securities, and insurance sectors, enhancing cross-industry information fusion applications and innovation in security [4]. A robust financial regulatory system is deemed crucial for preventing systemic financial risks, with a cautious exploration of BC technology in areas such as financial regulation, risk control, and supply chain finance (Xu, Chen, et al., 2024; Xu, Lin, et al., 2024). Support is provided for the development of BC technologies like smart contracts, along with encouragement for research into next-generation distributed technologies [5].

Table 2. Documents on commencing advocacy for research on blockchain technology.

Theme	Sub-theme	Documents
Macro Policies Encourage the Development of Blockchain	Initiating Support for Blockchain Research.	1. Supporting Supply-Side Reform: Upgrading Banking Services(2019)
		2. Beijing's Plan to Promote Fintech Development (2018-2022)(2018);
		3. Financial Regulatory Efforts (2019);
		4. Zhejiang Provincial Local Financial Supervision and Administration's response (2020);
		5. Central Bank's announcement of the first batch of fintech innovation projects for the regulatory sandbox (2020)

After 2020, governments have become more accepting of BC. There is an emphasis on developing digital financial services across various scenarios. This includes deepening fintech application pilots, optimizing business models, enhancing product offerings, diversifying service channels, and reducing service costs [1]. Encouraging the use of BC and AI technologies to innovate data-sharing models, and exploring services like data comparison and verification [2]. Efforts are being made to establish a provincial-wide public credit information database for enterprises, aiding financial institutions in enhancing risk control and supporting smaller private enterprises in accessing financial resources more quickly and extensively [3]. In line with the construction of a modern financial system and high-quality economic development, BC is recognized for its role in building trust systems, promoting data sharing, optimizing financial business processes, reducing operational costs, and enhancing collaborative efficiency [4].

Table 3. Documents on endorsing the implementation of blockchain.

Theme	Sub-theme	Documents
Macro Policies Encourage the Development of Blockchain	Endorsement of the Utilization of Blockchain Technology.	1. Zhejiang Provincial People's Government's "14th Five-Year" Plan for Financial Industry Development (2021);
		2. Shandong's Big Data Development Promotion Regulations(2021);
		3. Response to the 2021 proposal from the Provincial People's Congress(2021)
		4. Shanxi Province's "14th Five-Year" Big Data Development and Application Plan(2021)

BC technology advances in consensus and cryptographic algorithms, secure smart contracts, and distributed systems. Emphasis is on building underlying BC tech and service platforms, targeting fintech, supply chain management, and government services [1]. Anticipated breakthroughs by 2025 include security theories, cryptographic algorithms, BC processors, smart contracts, cross-chain tech, storage, privacy computing, and regulation, supporting Web 3.0 innovations [2].

Table 4. Documents about the prospective applications of blockchain.

Theme	Sub-theme	Documents
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Macro Policies Encourage the Development of Blockchain	The Future Applications of Blockchain Technology	<ol style="list-style-type: none"> 1. 14th Five-Year" Development Plan for Software and Information Technology Service Industry (2022) 2. Shanghai's Special Action Plan for Key BC Technology Research (2023-2025)(2023)
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BC technology has had a significant impact on the banking industry by providing solutions to various challenges such as security, transparency, and efficiency [1]. Here are mainly six ways in which BC has been utilized in the banking sector.

Table 5. The document outlining the application of blockchain.

Theme	Sub-theme	Document
Macro Policies Encourage the Development of Blockchain	Applications of Blockchain in the Banking Industry	1. BC + finance": accelerating the landing of the real economy (2019).

6.1.2. Supply Chain Finance

BC's crucial application is in supply chain finance, enhancing trade finance by providing a transparent platform for tracking goods and payments, and reducing fraud and delays (Xu et al., 2024).

The government work report aims to ease financing challenges for enterprises, proposing targeted reductions in banks' reserve requirement ratios for private and small enterprises [1]. Leveraging technology and data, this initiative supports small enterprises and improves financial services for the real economy [2]. Financial institutions are urged to collaborate with core enterprises, using BC and other technologies for diverse, ecological financial solutions in supply chain optimization [3]. Initiatives include promoting movable property registration, rights guarantee systems, and regional supply chain fintech platforms to enhance financing efficiency for SMEs [4].

Table 6. Documents on guiding policies in the field of supply chain finance.

Theme	Sub-theme	Documents
Supply Chain Finance	Policy Guidance	<ol style="list-style-type: none"> 1. Supporting Supply-Side Reform: Upgrading Banking Services(2019); 2. Opinions of the Central Committee of the Communist Party of China and the State Council on Accelerating the Construction of a Nationwide Unified Large Market (2022) 3. Shanghai's Implementation Plan for Advancing Urban BC Digital Infrastructure System (2023-2025)(2023) 4. Provincial Local Financial Regulatory Authority's Response to Proposal No. 676 (2021)

Recognition of Blockchain Technology. BC technology's intrinsic features for anti-counterfeiting and tamper resistance present a paradigm shift in centralized governance, facilitating a reliance on smart contracts and code constraints within regulatory frameworks. This technological advancement provides a digital remedy for the establishment of a trustworthy societal framework [1]. When incorporated into prevailing credit financing

frameworks, BC meticulously records credit limits, historical lending records, and residual credit amounts. Its decentralized encryption and immutable nature facilitate instantaneous synchronization and verification of guarantee and credit limits, fundamentally altering the information dynamics between entities engaged in investment and financing activities [2]. The Trade Finance BC Platform initiated by the People's Bank of China in 2018 acts as a fintech infrastructure, mitigating financing obstacles and augmenting efficiency for Small and Medium-sized Enterprises (SMEs) through a secure, compliant, and shared BC-centric platform [3].

Table 7. Documents on the recognition of blockchain technology.

Theme	Sub-theme	Documents
Supply Chain Financing	Recognition of Blockchain Technology	<ol style="list-style-type: none"> 1. Industrial Consumer Finance's Application of BC in Exploring Solutions to Financial Litigation Challenges (2022) 2. Proposal on Reconstructing Financial Credit Systems Using Big Data and BC Technology to Address SME Financing Challenges (2022) 3. Launch of the People's Bank of China's Trade Finance BC Platform in Gansu (2019)

Secured Loan Utilizing Living Assets. The 'Xingmu Loan' platform collaborates with slaughter and processing enterprises, implementing a traceability system ('one cow, one code' and 'one meat, one code'). Utilizing smartphones, retailers and consumers can trace meat production, processing, and distribution. Banks, insurance, and guarantee institutions employ the traceable regulatory platform for joint monitoring and online completion of financial due *diligence*, assessment, review, approval, and signing procedures.

Table 8. The document on secured loans utilizing living assets.

Theme	Sub-theme	Document
Supply Chain Financing	Secured Loan Utilizing Living Assets	1. Gongzhuling City's Promotion of Live Cattle Mortgage Loans(2021)

Financing through Intellectual Property Rights. The People's Bank of China's Sichuan branch guided Chengdu to build the nation's first BC-based intellectual property financing service platform [1]. By the end of June, the platform had 25 financial institutions, completing 347 IP pledge financing transactions, amounting to 1.54 billion yuan.

Table 9. The document on financing through intellectual property rights.

Theme	Sub-theme	Document
Supply Chain Financing	Financing through Intellectual Property Rights	1. Sichuan's Promotion of Science and Innovation Financial Services Under the 'Star Plan' (2023)

Covid-19 period. Throughout the pandemic, ensuring supply chain stability has been paramount. The Shanghai Bank's 'Shangxing E-chain' online supply chain finance platform extends core enterprise credit, facilitating complete online financing processes for upstream and downstream businesses. Real transaction-based standardized electronic payment vouchers on the platform enhance supplier loans, providing over 1.7 billion yuan in financing to 600 suppliers for the 'Dingdong Grocery platform in March alone [1].

Table 10. The document on supply chain finance during the Covid-19 period.

Theme	Sub-theme	Document
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Supply Chain Financing	Covid-19 period	1. Shanghai Financial State-Owned Enterprises' Efforts During the Pandemic (2022)
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Upstream Businesses. The end of the supply chain often sees upstream businesses using the credit guarantees of downstream enterprises. High receivables ratios are a major reason for the financing difficulties of private and small and micro enterprises, affecting their capital turnover and input-output. To better support supply chain enterprises in financing, the supply chain bill platform emerged. The Central Bank expanded the scope of its re-discounted bills to include supply chain bills, with China Merchants Bank being one of the first banks to complete this innovative business pilot. In 2022, China Merchants Bank's Shanghai branch carried out the region's first batch of supply chain bill re-discounting. [1]

Table 11. The document on financing of upstream businesses.

Theme	Sub-theme	Document
Supply Chain Financing	Upstream Businesses	1. China Merchants Bank Shanghai Branch's Innovative Use of Small Bills to Solve SME Financing Difficulties (2022)

Financing through Receivables. Since 2007, receivables have served as collateral for financing. The People's Bank of China has actively developed infrastructure and supported receivable financing for small and micro enterprises. ICBC Jiangsu Provincial Branch, collaborating with third-party supply chain service platforms like Zhongqi Yunlian, utilizes BC technology for generating electronic vouchers of core enterprise receivables. This facilitates factoring financing for upstream suppliers, ensuring traceable core enterprise credit and promoting BC technology in supply chain financing [1]. Notably, China Merchants Bank's Lanzhou branch successfully disbursed a 4 million yuan accounts receivable financing loan to the Lanzhou International Port Area using the People's Bank of China's Trade Finance BC Platform [2].

Table 12. Documents on financing through receivables.

Theme	Sub-theme	Document
Supply Chain Financing	Financing through Receivables	1. Response to Proposal No. 2058 at the 13th Provincial People's Congress (2022) 2. Implementation of the People's Bank of China's Trade Finance BC Platform in Gansu (2019)

SME Credit Finance. SMEs often possess high-quality credit proofs through contracts with governments and state-owned enterprises, yet obtaining loans based on these remains challenging due to information asymmetry [1]. The platform employs BC technology to authenticate government and state-owned enterprise purchase contract receivables, aggregating various financial resources. This approach, exemplified by Xincheng Sunshine Company's success in securing unsecured loans, offers SMEs a rapid and comprehensive financing solution, addressing challenges in obtaining credit based on government contracts [2].

Table 13. Documents on SME credit finance.

Theme	Sub-theme	Document
Supply Chain Financing	SME Credit Finance	1. Technological innovation supports pandemic response, and inclusive services take another step forward. (2020) 2. Haidian Small and Medium Enterprises Financial Service Platform's First Loan Issuance (2020).

6.1.3. Cross-border Finance

In export financing, BC plays an essential role by streamlining the loan origination process, ensuring a secure and transparent platform for managing loan-related documentation. It's explored for secured loan issuance, enhancing transparency and reducing administrative overhead.

A collaboration among government, insurance, banks, and enterprises on the cross-border financial services platform established an export credit insurance bill financing application scenario [1]. The platform shares crucial information, enhancing corporate credit transparency. This approach addresses trade background review challenges, strengthens banks' credit risk prevention, and optimizes processes (Yu, Chen, et al., 2024; Yu, Xu, et al., 2024). Leveraging BC technology reduces paperwork, process steps, and procedures, enhancing efficiency and reducing financing costs for enterprises [2].

Table 14. Documents on financing through export credit insurance.

Theme	Sub-theme	Document
Cross-border Finance	Export Credit Insurance	1. Diverse scenarios emerge as BC financial applications gradually deepen. (2020)
		2. Shaanxi's First Export Credit Insurance Bill Financing Transaction Completed (2023)

Supporting from a Technical Perspective. In modern export trade financing, BC technology streamlines processes by integrating export clearance data in a tamper-proof environment, offering reliable verification. This integration of "goods, information, and funds" enhances financing channels for banks [1]. The State Administration of Foreign Exchange approved a cross-border financial BC service platform pilot in Xiamen [2]. In 2020, a Yantai Development Zone company secured \$100 million in export bill financing from the Agricultural Bank of China, utilizing the platform to swiftly verify export declaration authenticity and credit limit availability, ensuring a successful fund disbursement.

Table 15. Documents on supporting from a technical perspective.

Theme	Sub-theme	Document
Cross-border Finance	Supporting from a Technical Perspective	1. Xiamen Approved as Pilot City for Cross-Border Financial BC Service Platform (2019)
		2. Yantai Free Trade Zone Completes First Cross-border Financial BC Service Platform Transaction (2020)

Application. The cross-border financial BC service platform uses BC technology for sharing information like funds receipt and payment, pledge certificates, and financing applications [1]. In July 2020, Industrial Bank's Harbin branch processed four export financing loans totalling \$750,000 (about 5.2925 million yuan) for a company through the cross-border financial BC service platform [2]. This marked the first successful financing transaction in the province using the BC service platform. The platform significantly reduced the customer's financing approval time, addressing the financing difficulties of SMEs and enhancing the bank's ability to identify document risks.

The State Administration of Foreign Exchange's cross-border financial BC service platform started a pilot project in 2021 across twelve provinces and cities. Under the guidance of the Foreign Exchange Bureau of Guangdong Province, ICBC's Guangzhou Southern Branch processed a \$360,000 non-recourse short-term export credit insurance financing transaction for an export company in Guangzhou [3].

Table 16. Documents on the application of in the field of cross-border finance.

Theme	Sub-theme	Documents
Cross-border Finance	Application	1. China's (Yunnan) Free Trade Pilot Zone Honghe Area Completes First Cross-border Financing Registration Transaction (2021)
		2. Cross-border Financial BC Service Platform Pilot Launched (2020)
		3. Cross-border Financial BC Service Platform's 'Export Credit Insurance Bill Financing' Application Scenario Successfully Launched in the Greater Bay Area (2021)

Covid-19 period. During the COVID-19 pandemic in late September 2021, there was a further integration of cross-border financial BC with the real economy. The first batch of "Export Credit Insurance Financing" application scenarios went online nationwide, with the financing amount ranking among the highest in the country. Banks in Fujian Province processed a total of 2,594 trade financing transactions through the cross-border BC platform, amounting to 1.1 billion US dollars. The average monthly financing amount was 123 million US dollars, showing an 84.21% increase compared to the pre-pandemic period [1].

In 2022, the cross-border financial BC service platform successfully handled the first BC platform export receivables financing transaction in Qinhuangdao City, which provided credit financing support for \$42,000 in receivables to a local private export enterprise [2]

Table 17. Documents on cross-border finance during Covid-19 period.

Theme	Sub-theme	Documents
Cross-border Finance	Covid-19 period	1. Significant Achievements in the Contribution of Finance to the High-Quality Development of the Real Economy (2021)
	Application	2. City Foreign Exchange Management Bureau Facilitates Cross-border Trade Financing for Foreign Trade Enterprises with 'Dual Chain Integration'(2022)

6.1.4. Cross-Border Settlement

BC streamlines cross-border settlement in the financial sector, removing intermediaries like correspondent banks. Ripple's BC-based platform facilitates real-time, efficient cross-border transactions.

BC's decentralization is particularly effective for remittances, challenging traditional networks like SWIFT [1]. Accenture's report notes current challenges in integrating all banks into a single BC network but envisions revolutionary changes with cumulative experience and upgrades [2]. In 2020, cross-border financial BC platforms supported trade and logistics financing, blending BC with the real economy. In Xi'an, over 20.34 million digital wallets and 558,000 scenic spots were established by 2022, with 30.9 million transactions totalling 4.4 billion yuan [3].

Table 18. Documents on the application in the field of cross-border settlement.

Theme	Sub-theme	Documents
Cross-Border Settlement	Application	1. Blockchain gives you a trusted world(2016)
		2. Shanxi 13 financial measures(2020)
		3. Shanxi social financing scale over 680 billion RMB(2022)

6.1.5. Identity Verification (KYC)

BC enhances security and decentralization in managing and verifying customer identities, streamlining onboarding processes, reducing identity theft risks, and improving overall banking sector security. In 2020, the

BC-based eKYC system was launched, achieving its first account opening [1]. The system, utilizing distributed ledger, data sharing, video authentication, and timestamp technologies, establishes a consortium chain of trusted nodes, facilitating diverse data sharing and accelerating online credit applications. Tianhao Environmental Co., Ltd. in Beijing, the first practical case, experienced an 80% reduction in data entry requirements and a 40% time-saving in account opening, showcasing the eKYC system's efficiency and practicality [2].

Table 19. Documents on applications in the field of identity verification.

Theme	Sub-theme	Documents
Identity Verification (KYC)	Application	1. Launch of the BC-based Enterprise Electronic Identity Authentication Information System (eKYC) and Its First Account Opening
		2. eKYC and Its First Account Opening (2020)

6.1.6. Fraud Prevention and Security

BC's immutability and transparency serve as powerful tools for preventing fraud and enhancing security in the financial sector. The tamper-proof recording of transactions reduces the risk of fraudulent activities and improves overall financial data integrity.

The current challenges of financial fraud and money laundering can be addressed through the combined use of artificial intelligence and BC for big data analysis and anomaly detection, enabling timely identification and prevention [1]. Fintech applications have proven to offer more effective anti-money laundering measures, strengthening the financial system's security. Regulatory bodies benefit from adopting BC for consistent, auditable data, enhancing the speed and accuracy of financial activity regulation compared to traditional processes [2]. In the credit reporting sector, BC's market potential lies in customer credit reporting and anti-fraud measures. The assured authenticity of BC data facilitates direct investor verification and regulatory oversight, contributing to enhanced effectiveness in anti-money laundering efforts [3].

Table 20. Documents acknowledging the application of blockchain technology in the realms of fraud prevention and security.

Theme	Sub-theme	Documents
Fraud Prevention and Security	Recognition of Blockchain Technology	1. Positive Trend in the Fintech Industry Remains Unchanged (2023)
		2. Financial Blockchain Underlying Platform FISCO BCOS Whitepaper (2017)
		3. Blockchain: A Trustworthy World (2016)

6.1.7. Central Bank Digital Currencies (CBDCs)

Central banks are considering using BC technology for issuing Central Bank Digital Currencies (CBDCs), aiming to enhance payment system efficiency, reduce transaction costs, and provide a more secure digital currency [1]. Since 2017, the People's Bank of China (PBoC) has been exploring BC technology for its digital currency development. The envisioned system involves a distributed ledger for registering CBDCs, with the PBoC offering identity verification-free and download-free basic digital wallets. As of June 2023, over 1.36 million practical application scenarios have been established, positioning it as a national leader in this field [2].

Table 21. Documents on the application in the field of Central Bank Digital Currencies.

Theme	Sub-theme	Documents
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Central Bank Digital Currencies (CBDCs)	Application	<ol style="list-style-type: none"> 1. Trial Operation of Digital Currency Issued by the Central Bank (2017) 2. Building a Globally Competitive Fintech Center: Significant Achievements in Shanghai (2023)
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Because of BC technology, these business units in the banking sector have been developed more efficiently. While these applications showcase the potential benefits of BC in the banking industry, it's important to note that the technology is still evolving, and widespread adoption may take time as regulatory, technical, and operational challenges are addressed.

6.2. Analysis – A Case Study to Illustrate Objective 2.

6.2.1. Overview of the Industrial and Commercial Bank of China (ICBC)

Company Profile. Established in 1984, ICBC, a global leader by asset size, prioritizes technological innovation. ICBC has been researching blockchain since 2016. Focusing on fintech and digital transformation, the bank established ICBC Technology in May 2019, with a Financial Technology Research Institute in November. ICBC has developed labs in BC, 5G, and AI, unveiling the ECOS1.0 smart banking ecosystem. BC technology is a key focus, leading to the launch of ICBC Xi Chain in 2018, which passed National Ministry of Industry and Information Technology evaluations in January 2021, reflecting ICBC's commitment to technological-driven innovation in its business strategy.

Financial Situation. During the "13th Five-Year Plan," China's economy steadily improved. From 2016 to 2023, the total assets of the country's banking institutions grew by 37.65%, reaching 319.7 trillion yuan. ICBC's total assets grew by 38.15%, surpassing the industry average. Despite the challenges posed by the COVID-19 pandemic in 2020, ICBC demonstrated stable operational capability and risk resilience. As the world's largest commercial bank, ICBC has expanded its business scope and customer base, resulting in increased risks. However, the bank's non-performing loan ratio has steadily decreased since the "13th Five-Year Plan," attributed to the strategic application of financial technology. The bank's digital transformation, leveraging big data, blockchain (BC), and artificial intelligence, has made transactions transparent and traceable on the chain, significantly reducing credit risk.

6.2.2. The Motivation of Introducing Blockchain

Externally, the adoption of blockchain (BC) is driven by policy and its intrinsic nature. Financial technology became a focus in the "13th Five-Year" National Science and Technology Information Plan in 2016, aligning with national policies. In response to the flourishing development of technologies like BC and big data, China introduced supportive policies to guide financial technology development, with a focus on BC. (See table 22).

Table 22. Crucial Documents Facilitating the Advancement of Blockchain Technology.

Time	Documents	Main Content
2016	13th Five-Year Plan" for National Informatization	Emerging technologies, including IoT, cloud computing, big data analytics, machine learning, BC, and biogenetic engineering, propel cyberspace's transformation towards ubiquitous connectivity, intelligence, and services.
2019	Financial Technology Development Plan (2019-2021)	By 2021, deepen financial industry technology applications for integrated development of finance and technology.
2021	Notice on Further Promoting the High-	Leverage financial technologies like big data and BC

Quality Development of Financial Services for Small and Micro Enterprises in 2021	for supply chain finance, ensuring legality, compliance, and manageable risk in key areas.
2022 Proposal on Utilizing Big Data and Blockchain Technology to Restructure the Financial Credit System to Address the Financing Challenges Faced by Small and Medium Enterprises	BC's distributed encryption and tamper-resistant features enable real-time synchronized verification, potentially transforming information asymmetry in investment and financing dynamics.

Internally, ICBC's development strategy prioritizes business transformation. The bank's "e-ICBC" strategy (where 'e' stands for internet; ICBC is an acronym for Information, Commerce, Banking, Credit) (shown as Figure) formulated in September 2015, centres on an integrated internet finance framework, enhancing efficiency, quality, and dynamics in the real economy. The framework, featuring "three platforms and one centre," connects financial services, social life, and e-commerce, serving as an engine for ICBC's business transformation. The online financing centre, employing the internet and big data technologies, enables the mass development of small and micro enterprises, ensuring risk control and a faster loan experience for customers.

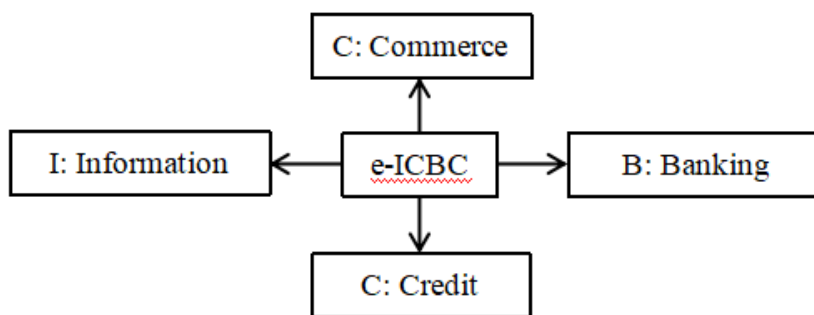


Figure 2. Illustration representing e-ICBC.

6.2.3. The Pathway for the Introduction of BC Technology at ICBC

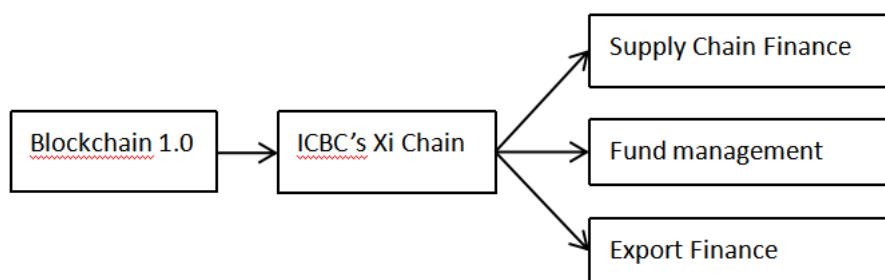


Figure 3. Illustration of ICBC developing blockchain.

After the release of the BC 1.0 platform, it found success in diverse applications, including poverty alleviation in Guizhou, smart forests in Xiong'an, ICBC Gather, and precious metal gifting. In 2017, with a significant investment in poverty alleviation, Guizhou established a fund of over 300 billion yuan. ICBC, in collaboration with Guizhou Minsheng Group and government support, developed the Poverty Alleviation Fund BC Platform to ensure transparent, precise, and efficient fund management. Leveraging the tamper-proof and traceable nature of BC, the platform integrated the approval chain across different financial service chains, making fund flows publicly transparent. This approach, compared to the traditional disbursement of funds before project

formulation, now formulates and approves projects before disbursing funds, achieving efficient management.

Recognizing the potential of BC technology in practical scenarios, ICBC expanded its exploration into broader business scenarios with the upgraded BC platform, "ICBC Xilinx Chain." This initiative applied BC to supply chain finance, trade financing, and fund management, introducing applications like "ICBC e-credit," "China-Europe e-Single Window," and the "Xiong'an New Area Demolition and Relocation Fund Management Platform," empowering business operations.

Analysis of the Effects of BC Introduction at ICBC

ICBC actively engages in financial technology development, particularly in big data, blockchain (BC), and artificial intelligence. In 2016, the bank invested 16.734 billion yuan (2.2% of revenue) in fintech, with increased investment to 26.22 billion yuan (3.8% of revenue) in 2022, showcasing sustained financial technology advancements.

Improvement in Asset Quality. Asset quality in banking refers to the ability of assets to generate returns and the level of associated risks. An asset with low returns and high risk is considered of low quality, and vice versa. The primary asset business for commercial banks is lending, where inevitably some borrowers may default, leading to asset impairment – an unavoidable risk in lending operations.

Bank asset quality is assessed through key indicators like the non-performing loan (NPL) ratio and provision coverage ratio. Regulatory standards set the NPL ratio limit at 5%. Ratios above industry averages suggest lower asset quality, while lower ratios indicate higher quality. In 2018, the regulatory requirement was adjusted to 120%-150%, which signifies sufficient loan loss provisions. A bank surpassing the industry NPL ratio with ample loan loss reserves has superior asset quality to those with lower NPL ratios but insufficient reserves, emphasizing the significance of loan loss provisions in evaluating asset quality.

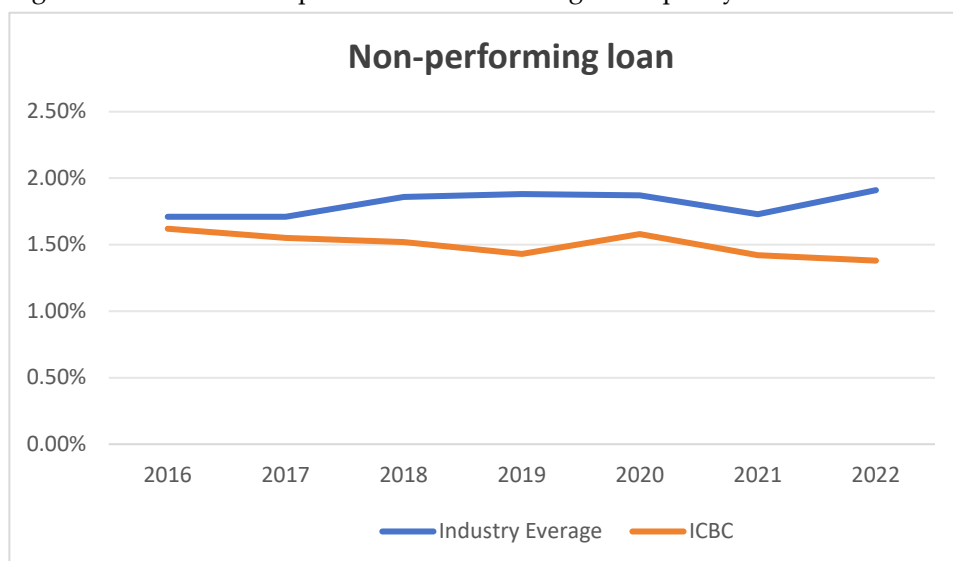


Figure 4. Non-performing loan.

As depicted in Figure 4, Post-2016, while the industry's NPL rate escalated annually, ICBC exhibited a downward trend in its NPL rate, showing stability amidst the industry's worsening scenario. The anomalous increase in 2020 was primarily due to the impact of the COVID-19 pandemic, which significantly affected state-owned banks like ICBC, elevating their NPL rates, but still within regulatory norms.

ICBC's enhanced asset quality can be attributed to the integration of BC technology in its operations, addressing information asymmetry. By utilizing BC-recorded transaction data, ICBC accurately assessed client credit, replacing traditional pre-loan investigations. Multi-party information comparisons during loan approval

minimized risks. Real-time disbursement monitoring in post-loan management ensured transparency, curbing non-performing loans. BC technology's role in the comprehensive approach significantly improved ICBC's asset quality amid global pandemic challenges.

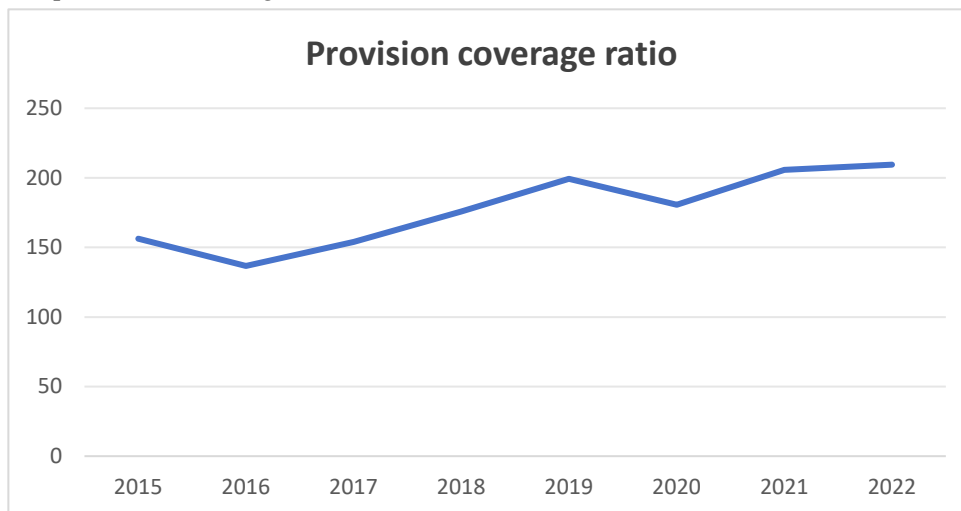


Figure 5. Provision coverage ratio.

As shown in Figure 5, before 2016, ICBC's provision coverage ratio declined, falling below the 150% regulatory standard. Post-2016, the ratio consistently surpassed 150%, reflecting a substantial reserve for loan loss provisions. BC technology contributed to this improvement, providing real-time insights into transaction data and operational status. This facilitated accurate estimations of potential losses, enhancing the quality of ICBC's credit assets.

Reduction of Costs and Enhancement of Profits. BC integration in banking can reduce transaction costs and enhance SME profitability. SMEs, facing credit rating barriers, find it challenging to secure funding. ICBC's BC-based supply chain finance addresses this, allowing real-time data sharing among enterprises. The transparent network aids in creating electronic vouchers, replacing traditional bills, and facilitating efficient fund flow. ICBC benefits by accessing SME operational data, identifying quality clients, and expanding profit avenues at lower costs. This application of BC streamlines the lending process, allowing banks to offer financial services to SMEs more efficiently and at reduced operational expenses.

In this analysis, the cost-to-income ratio is utilized to reflect the impact of the BC application on ICBC's profitability. This metric serves as an indicator of the bank's ability to manage operational costs relative to its income, demonstrating how BC technology can streamline processes and improve financial performance.

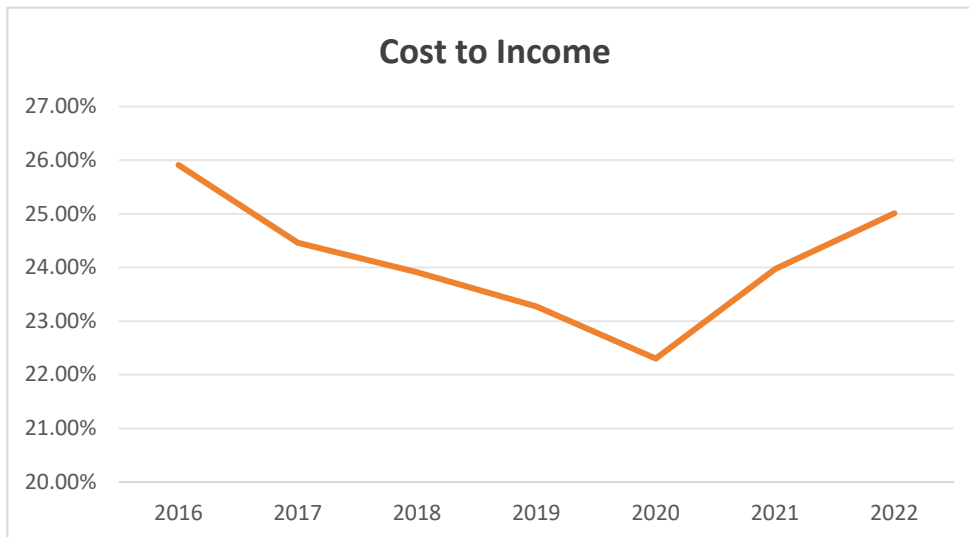


Figure 6. Cost to Income.

As depicted in Figure 6, there was a reduction of 3.61% from 2016 to 2020. This comparison underscores the significant impact of BC technology in reducing operational costs at ICBC. Although there is an upward trend from 2020 to 2022, the overall trend is downward. The increase in costs from 2020 to 2022 was primarily attributed to the impact of the COVID-19 pandemic. Many small and medium-sized enterprises faced imminent bankruptcy due to difficulties in cash flow, leading to the inability to repay loans on time, consequently resulting in an escalation of costs for ICBC.

The overall decline in the cost-to-income ratio reflects the efficiency gains achieved through the bank's technological advancements. By integrating BC technology into its operations, ICBC has been able to streamline processes, reduce redundancies, and enhance transactional efficiencies, leading to lower operational costs relative to its income. This demonstrates the effectiveness of BC technology in optimizing banking operations and improving financial performance.

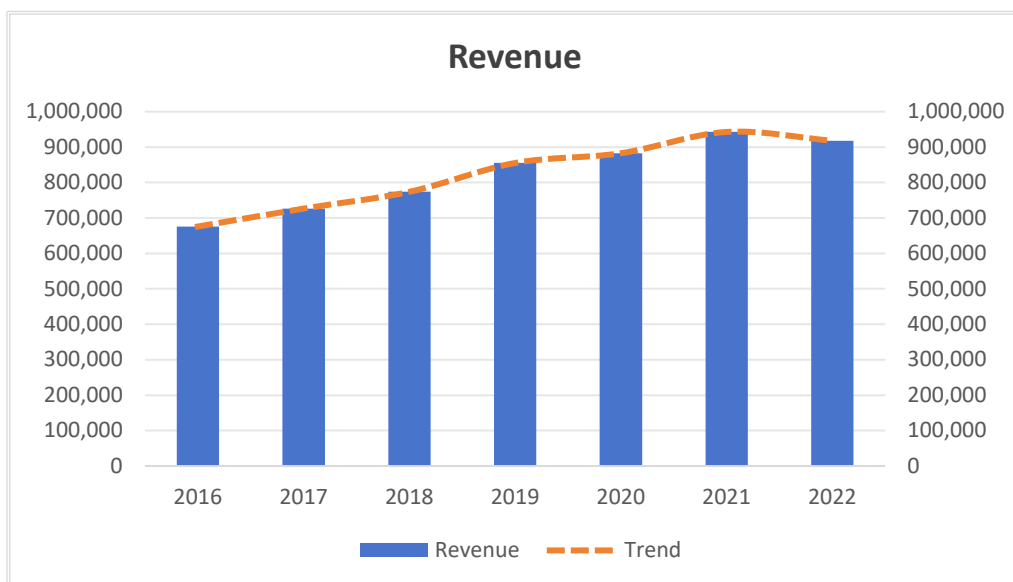


Figure 7. Revenue.

As indicated in Figure 8, ICBC's operating income exhibits a 35.81% overall growth trend, as depicted in

Figure 8. The integration of BC technology has spurred the development of innovative loan services like "Jingying Kuaidai" (Operational Express Loan), "Gongyin e-Xin" (ICBC e-Trust), "Gongyin e-Qifu" (ICBC e-Corporate Payment), and "Cross-border e-Diantong" (Cross-border e-Channel). These BC-based financial products have attracted a substantial customer base, diversifying services and contributing to revenue growth. ICBC's embrace of BC technology showcases its commitment to adapting to market needs and leveraging emerging technologies to strengthen its market position.

7. Conclusion

Through research, it has been found that in mainland China, the development of BC in the banking industry is primarily attributed to two main factors. Firstly, it relies on government policy guidance. Currently, with the support and guidance of policies, BC technology in the banking industry is mainly utilized for supply chain financing and cross-border financing, addressing difficulties in loans for small and micro-enterprises. It is also applied in customer surveys, anti-fraud measures, digital currency, cross-border settlements, and other areas.

Secondly, there is research and application in the leading banks in the industry. Taking the Industrial and Commercial Bank of China (ICBC) as an example, BC technology meets the developmental needs of the banking business, effectively controlling non-performing loan rates and improving provisioning coverage. Simultaneously, the application of BC has attracted more clients with financing needs, receiving government support (as seen in the poverty alleviation project in Guizhou). Consequently, the development of BC in the banking industry creates a win-win situation. Banks experience increased revenue, enhanced asset quality, and the resolution of cash flow difficulties for small and micro-enterprises, thereby promoting business development. As a result, BC has been rapidly deployed in the Chinese banking industry.

8. Recommendations

From a banking perspective, the utilization of blockchain (BC) technology is primarily limited to corporate applications, with potential expansion to individual residents in the future. However, public awareness of blockchain services offered by banks remains relatively low. It is recommended that banks undertake promotional initiatives for blockchain-based service projects to attract a broader customer base and augment revenue. Developing financial projects utilizing blockchain technology can enhance transparency in deposits and investments, further attracting deposits and investments. Looking ahead, detailed encouragement and regulatory frameworks are essential to guide the continued development of blockchain and align it with global standards.

In the academic realm, the absence of a recognized theoretical framework for blockchain technology necessitates future development. Establishing such a framework would provide an academic benchmark for assessing the advantages and disadvantages of blockchain applications in the banking industry, facilitating more comprehensive and comparative evaluations.

9. Contribution and Limitation

The deployment of BC in the Chinese banking industry has not been systematically studied. This paper examined 121 relevant documents, spanning from 2016 to 2023, to investigate the policy-driven development of BC and analyzed the practical effects of BC applications through case studies. The findings suggest that BC holds significant potential in the banking sector, enhancing productivity and offering substantial advantages for economic development, thereby addressing a research gap in this area.

However, the study has its limitations. Firstly, the sample size for data collection is insufficient, with a lack of research reports on the banking industry, domestic literature, and business journals. Secondly, the selection

of companies focused only on one bank, the Industrial and Commercial Bank of China, comparing data from previous years, without conducting a more extensive analysis and peer comparison within the industry.

10. Key Terms and Definitions

10.1. Blockchain Technology

Blockchain technology is a distributed database or shared ledger, public or private, of all digital transactions executed and disseminated among participating entities within the BC network (Crosby et al., 2016).

10.2. Supply Chain Finance

Supply chain finance is utilizing financial instruments and technology to enhance working capital efficiency. Financial institutions provide short-term credit to suppliers based on the buyer's creditworthiness, enabling early payment for invoices and extended payment terms (GONG, BAN & ZHANG, 2022).

Appendix A

Table A1. Policy summary.

Year	Policies
2016	1. "13th Five-Year Plan" National Information Plan.
	2. Blockchain: Building a Trustworthy World.
	3. White Paper on the Development of Blockchain Technology and Applications in China 2016
2017	1. Zhejiang Merchants Bank Completes First Real Transaction Using "Blockchain" Technology.
	2. Trial Operation of Digital Currency Issued by the Central Bank.
	3. China National Aviation Trust actively lays out blockchain financial applications.
	4. Technology and Finance integration, Supporting Industrial Innovation and Upgrading.
2018	1. Safeguarding Financial Science and Innovation: Commercial Banks Launch a Network Security "Offensive-Defensive Combination".
	2. Three Questions about Blockchain.
	3. A Long Article Reveals the Eight Pain Points of Hexing Blockchain.
	4. "2018 Financial Technology Summit Forum" held in Mancheng District.
	5. Financial Blockchain Research Report
2019	1. Beijing Bank's Blockchain 2.0 Platform has been Launched and upgraded to the Most Advanced BaaS Platform in the Industry.
	2. Huaxia Bank Actively Develops Blockchain Technology to Serve Tianjin Pilot Free Trade Zone.
	3. National Blockchain Exhibition and Service Network Launched.
	4. Guarding against fraudulent fundraising activities conducted under the names of "virtual currency" and "blockchain".
	5. Bank of China Shandong Branch completes the province's first "Blockchain Forfaiting Trading Platform" secondary market cross-bank buying and selling business.
	6. The world's first blockchain loan lands in Chengdu.
	7. "Blockchain + Finance": Accelerating landing for the real economy.
	8. Xiamen approved for the pilot of the cross-border financial blockchain service platform.
	9. Blockchain + Supply Chain Emerges as the Mainstream Implementation Scene
2020	1. Industrial and Commercial Bank of China Successfully Connects to the Financial Blockchain Service Platform.
	2. Safeguarding Global Industrial Chain Coordination: Construction Bank's "Combined Punch" Safeguards Cross-border Financial Business.
	3. Technological Innovation Assists in "Epidemic" Services, Bank of China Beijing Branch Lands the First Blockchain Loan to Support Small and Medium-sized Enterprises.
	4. Postal Savings Bank Completes the First Cross-chain Transaction in Forfaiting, Making a Breakthrough in Blockchain Application Innovation.

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5. Haidian Small and Medium-sized Enterprise Financial Service Platform Achieves the First Loan.
 6. The Enterprise Electronic Identity Authentication Information System (eKYC) Based on Blockchain Goes Online and Completes the First Account Opening.
 7. Haidian Small and Medium-sized Enterprise Financial Service Platform Achieves the First Loan.
 8. Huaxia Bank's First Blockchain Resale Transaction Lands, Adding a New Wing to Serving the Real Economy.
 9. Blockchain Gambling, Games? These fundraising schemes under the guise of blockchain are all routines.
 10. Yantai Free Trade Zone completes its first cross-border financial blockchain service platform transaction.
 11. Bank of China Shandong Branch successfully handles the province's first cross-border financial blockchain service platform export financing business.
 12. Cross-border cooperation between trade finance blockchain platforms and Hong Kong TradeLink platforms kicks off trial operation.
 13. How small and medium-sized banks can catch the financial technology express.
 14. Deepening the interaction of blockchain technology with banking and taxation, Shenzhen tax support helps stabilize the development of banks.
 15. Tracking the forefront of technology, focusing on the trends of the times, using blockchain technology to innovate and develop, activate new energy, and cultivate new business formats.
 16. Tonghua City promotes live cattle collateralized loans.
 17. Diverse scenarios emerge as blockchain financial applications gradually become popular.
 18. On the wind of blockchain, what obstacles still need to be overcome?
 19. Reply to Proposal No. 20201324 of the 12th Session of the Provincial CPPCC.
 20. The Foreign Exchange Administration assists foreign trade enterprises in cross-border trade financing to achieve "double-chain integration".
 21. The scale of cross-border fund flow in Shaanxi increased by 11.67% year-on-year in the first half of the year.
 22. 13 financial measures in Shaanxi support the construction of the Central and European (Xi'an) Assembly Center for China-Europe freight trains.
 23. Bai Rong Yun Cang focuses on the financial scene to relieve the pressure of small and microloans.
 24. The financial industry's application of blockchain technology has a "security token".
 25. The pilot of the cross-border financial blockchain service platform is launched.
 26. Everbright Bank: Actively serving the real economy, comprehensively promoting the construction of wealth management banks.
 27. The "Six Specializations" service rapidly responds to the financial needs of enterprises.
 28. Concerning the Proposal for the Technical Support of "Blockchain + Supply Chain Finance" to Facilitate the High-Quality Development of Small and Micro Enterprises.
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2021

1. "14th Five-Year Plan" National Information Plan.
 2. State Council Opinions on Carrying out Innovative Pilot Work on Business Environment.
 3. Gansu Delegates Speak to the Central Committee: Promoting the Integration and Innovative Development of Big Data, Blockchain, and the Economy and Society.
 4. Industrial and Commercial Bank of China Successfully Connects to the Financial Blockchain Service Platform.
 5. Digital technology boosts the innovation of the supply chain finance model.
 6. The application scenario of "Export Credit Insurance Policy Financing" on the cross-border financial blockchain service platform successfully lands in the Guangdong-Hong Kong-Macao Greater Bay Area.
 7. Hengfeng Bank leverages technology to create credit products and promote the revitalization of rural industries.
 8. The first financing of export credit insurance policy in the province landed in the revolutionary old area of Southern Teng.
 9. Pingtan Comprehensive Experimental Zone introduces a new model of "all-process online intelligent approval and paperless handling" for real estate registration and transactions.
 10. Significant Achievements in Financial Support for High-Quality Development of the Real Economy.
 11. Announcement of the "14th Five-Year Plan" Digital Special Plan for Fujian Province.
 12. Baoding City Blockchain Financial Comprehensive Service Platform goes online and launches.
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13. Qinchuang Innovation Voucher is about to debut.
 14. Hubei Private Banks enter the national team.
 15. Recognize the true face of fraudulent fundraising and secure the people's money bags.
 16. Hainan Province's "14th Five-Year Plan" for the development of the financial industry.
 17. "14th Five-Year Plan" for financial development clarifies the roadmap - Jiangsu prepares to build a financially strong province.
 18. Regarding the Suggestion to Address the Financing Difficulties of Small and Micro Enterprises in Our Province).
 19. Notice from the National Development and Reform Commission and Various Departments Regarding the Oversight of 'Mining' Operations in Virtual Currencies
 20. Notice of addressing the need for additional measures to mitigate and manage the risks associated with speculative trading in virtual currencies
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1. State Council Notice on Issuing a Package of Policy Measures to Solidly Stabilize the Economy.
 2. Over the Past Decade, Small and Medium-sized Enterprises Have Developed Fast and Well.
 3. People's Bank of China Issues "Financial Technology Development Plan (2022-2025)".
 4. Jing County Issues the First Intellectual Property Notarized Electronic Data Certification.
 5. Beijing Digital Economy Full Industrial Chain Open Development Action Plan.
 6. Financial Technology "Brightens" the First Batch of Listed Banks, with a Double-digit Increase in Financial Technology Investment in the 2021 Annual Report.
 7. Proposal on Using Big Data and Blockchain Technology to Restructure the Financial Credit System and Solve the Financing Difficulties of Small and Medium-sized Enterprises.
 8. Letter from the Municipal Local Financial Supervision and Administration Bureau Regarding the Hosting Opinions on the Handling of Proposal No. 20220307.
 9. People's Bank of China Chongqing Branch: "Five Strengthenings" to attract financial vitality and assist in the development of small and micro enterprises in distress.
 10. Jiangxi Joint Equity Trading Center: "Blockchain Pilot + Credit Information" dual-wheel drive serves the real economy.
 11. Using "Blockchain + Big Data" Technology to Promote the Development of Forest Rights Mortgage Loans.
 12. Hebei Equity Exchange launches the Shenzhen Tong blockchain platform.
 13. Foreign banks actively participate in the Import Expo, confident in China's opening-up opportunities.
 14. Financial technology talents remain the favourite of banks.
 - 2022 15. Making finance better for the relief and resolution of difficulties for small and micro enterprises.
 16. During the epidemic, banks can still provide loans, and stocks can still be traded, thanks to the efforts of Shanghai's financial state-owned enterprises.
 17. Boosting the Quality and Efficiency of the Real Economy - The Financial Technology Power Behind the "Wave Acid" and "Shenzhen Speed".
 18. China Merchants Bank Shanghai Branch Ingeniously Uses Small Bills to Solve the Financing Difficulties of Small and Medium-sized Enterprises.
 19. Industrial Consumer Finance of Industrial Bank Applies Blockchain to Explore Solutions to Financial Litigation Challenges.
 20. Industrial and Commercial Bank of China's various digital financial service scenarios will be showcased at the 2022 Service Trade Fair Financial Services Special Exhibition.
 21. 2022 Annual Report on the Construction of the Rule of Law Government of the Provincial Local Financial Supervision and Administration Bureau.
 22. Heilongjiang Provincial Government Notice on Printing and Issuing the Industrial Revitalization Action Plan of Heilongjiang Province (2022-2026).
 23. Notice on Printing and Issuing Several Policy Measures to Support the Development of Ice and Snow Economy in Heilongjiang Province.
 24. State Council Office Opinion on Further Releasing Consumption Potential to Promote Sustainable Consumption Recovery.
 25. Full Text of the "Regulations of Heilongjiang Province on Promoting the Development of Small and Medium-sized Enterprises".
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26. Comprehensive Promotion of High-Quality Development - Seeking Blockchain Strengths (Part 1).
 27. Comprehensive Promotion of High-Quality Development - Seeking Blockchain Strengths (Part 2).
 28. Hubei introduces fifteen financing support measures to promote the development of foreign trade industries.
 29. Continuous release of policy benefits, the financial industry supports small and micro enterprises more intensively.
 30. Give full play to the driving role of Jin Cang District.
 31. The Foreign Exchange Bureau Hubei Branch promotes the effective landing of foreign exchange policies benefiting people and enterprises in the current account.
 32. The law enforcement authorities successfully investigated the inaugural case of 'mining' activities involving virtual currencies.
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1. Shenzhen Supply Chain Finance Encourages Banks to Research Exclusive Credit Products for Key Industrial Chains.
 2. Export-Import Bank's digital letter of credit business goes smoothly and completes its first reply.
 3. From the first launch of "Tianfu Zhilai Loan" to the first establishment of the Sichuan blockchain technology platform
 4. Promoting the science and innovation of warehouse financial services with the "Starry Plan".
 5. Riding the wave of "digital" and leading the development with "intelligence".
 6. Giving "Jiniu" a "digital makeover".
 7. Xiamen International Bank launches the "Data Broker" application scenario for Fujian Big Data Exchange.
 8. Putian: Financial institutions grant online credit of 185 million yuan to foreign trade companies.
 9. New Era, New Journey, New Great Cause | Blockchain New Track "Xin" Runs Fast.
 10. Anyang High-tech Zone approved to create a leading area for blockchain development in Henan Province.
- 2023
11. A group of blockchain troops are coming.
 12. Henan plans blockchain construction with a forward-looking vision.
 13. Zhengzhou clarifies: By 2025, the "Zhengzhou Chain Service System" will be fully established.
 14. Shanghai promotes the implementation plan for the urban blockchain digital infrastructure system (2023-2025).
 15. The Industrial Consumer Finance Industry targets new urban residents' financial needs and provides lifecycle services.
 16. The trend of improvement in the financial technology industry remains unchanged.
 17. Shanghai has made significant progress in building a globally competitive fintech centre.
 18. Commercial banks issued 240 billion yuan in green financial bonds within the year, a year-on-year increase of over 88%.
 19. The first landing of export credit insurance policy financing business in Shaanxi.
 20. Shaanxi's social financing scale exceeded 680 billion yuan in 2022.
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