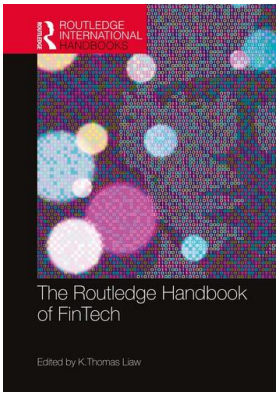

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The restructure of China's banking industry by artificial intelligence and FinTech

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THE RESTRUCTURE OF CHINA'S BANKING INDUSTRY BY ARTIFICIAL INTELLIGENCE AND FINTECH[1]

Zhuming Chen, Jing Li, Xiangyu Zhang, Xin Li, Jinghong Zeng, Shihan Wang and Weihan Zhang

1 Introduction

With the rapid development of digital technologies such as cloud computing, blockchains, big data, artificial intelligence (AI), and the Internet of Things (IOTs), financial technology has profoundly affected all areas of society, and reshaped global financial structures, economic structures, and even people's lifestyle. The deep integration of finance and technology has become an inevitable trend in the development of the financial industry. Digitalization, intelligence, networking, platformization and supplier upgrades have subverted the traditional financial industry, especially the banking industry's business model. The "FinTech Development Plan (2019–2021)" issued by the People's Bank of China clearly states that it is necessary to use FinTech (finance technology) methods to enrich service channels, improve the quality and efficiency of financial services, and promote the healthy and sustainable development of the real economy.

Since 2010, the Chinese banking industry has accelerated the deployment of FinTech. Traditional large banks have invested heavily in FinTech innovation, and emerging businesses such as small and medium-sized banks and Internet banks have relied on technology to enable innovative business models to surpass competitors. Figure 15.1 shows the establishment of Chinese banking technology subsidiaries. China Merchants Bank invested 3.633 billion yuan in information technology in the first half of 2018, a year-on-year increase of 63.87%, and 2.81% of operating income. The Postal Savings Bank's investment in the information technology field accounted for 2.75% of operating income in 2018, and will increase to about 3% in 2019; Ping An Bank's total IT capital expenditures in the first half of the year increased by 36.9% year-on-year; Bank of Communications plans to increase its expenditures in technology to 10% of the annual operating expenses. As the digital transformation of banking business continues to be propelled, commercials' banks' investment in financial technology is increasing. Up to now, banks' investment in FinTech has accounted for 3% of operating income in general.

The empowerment brought by FinTech investment has been widely used in precision marketing, service innovation, operation management, risk control, and other fields, and the

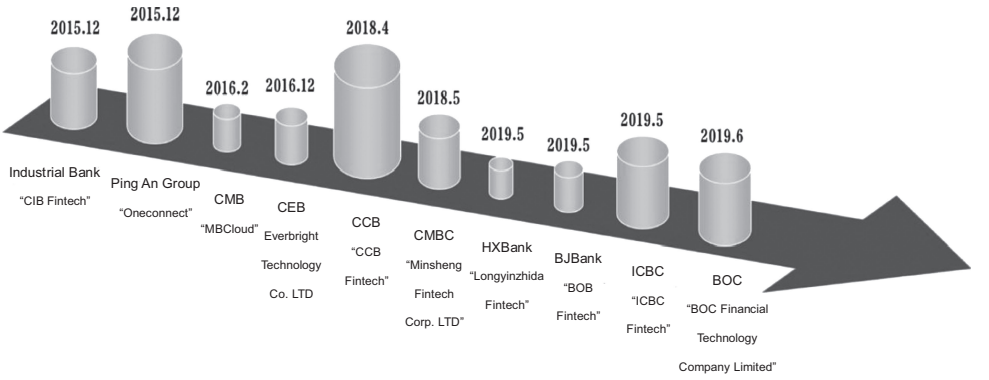

Figure 15.1 Summary of bank technology subsidiary
Source: public information

results have been fruitful. For example, cloud computing, with its advantages in resource integration, provides a hardware foundation for satisfying the new features of Internet financial transactions, high concurrency, multi-frequency, and massive traffic. Intelligent voice processing, biometrics, image recognition, machine learning, and other artificial intelligence technologies promote the continuous optimization of the front, middle and back-office processes of financial institutions. Blockchain technology application in asset registration, multi-institution reconciliation, supply chain financing, and other fields is in full swing.

The main question discussed in this chapter is, how to apply FinTech and artificial intelligence in the Chinese banking industry? Based on the actual situation, all major banks have invested heavily in FinTech, but can it bring significant revenue growth and efficiency improvement in their future competitive landscape? Or is the rise of financial technology a threat to traditional banking? How should the banking industry adapt to the development trend of the next generation of FinTech? This chapter uses qualitative analysis, case analysis, and empirical research to systematically and comprehensively interpret the disruption and reconstruction of China's banking industry by digital technologies such as AI, to transform and upgrade China's banking industry and its future in-depth discussion on competitiveness.

The structure of the chapter is as follows: The first section is an introduction, which briefly clarifies the research background, research objects and research ideas; the second section is a literature review, which makes a systematic review of the contents of the existing literature and concerns and research; the third section outlines the sparks of the collision between FinTech, artificial intelligence and the restructuring of China's banking industry; Section 4 selects two representative banks in the field of financial technology applications for case analysis – Agricultural Bank of China and WeBank; Section 5 use empirical research on the impact of FinTech on commercial bank performance. The final part includes a conclusion and recommendations.

The innovations of this chapter are as follows: First, it is the first systematic, comprehensive and detailed review, research and analysis of the status and problems of the use of FinTech and artificial intelligence in the Chinese banking industry for more than ten years; the second is an empirical analysis of the development of banks' use of FinTech and the impact of FinTech on their respective operating performance. This chapter consulted many authentic materials and data during the writing process, manually collected a large amount of data reflecting the bank's level of financial technology, and conducted case investigations on some representative banks. However, due to limitation of time, personnel, and resources, this chapter still has many shortcomings, such as the short application period of FinTech in the Chinese banking

industry, the sample size of listed banks' FinTech index is not large enough, and the empirical models and algorithms used are relatively simple. The research in this chapter, however, does not involve the supervision of financial technology. We can go deeper based on this chapter and discuss the subject by adopting the methods of expanding the sample size, extending the cross-section data length, and selecting more models and algorithms.

2 Literature review

With the rapid development of financial technology (FinTech) in the banking industry, the research in the academic world is also voluminous. We summarize the literature on the following three aspects: First, the definition of FinTech and the reasons for its prosperity; second, the impacts and shocks of FinTech on the existing financial system; third, the impact of FinTech on banks and banks' response to FinTech.

2.1 The definition of FinTech and the reasons for its prosperity

A widely accepted definition of FinTech, given by The Financial Stability Board (FSB), describes FinTech as technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions, and the provision of financial services. Besides, Gomber et al. (2017) describe it as a connection of modern and Internet-related technologies (e.g., cloud computing, mobile Internet) with established business activities of the financial services industry (e.g., money lending, transaction banking). Deloitte (2017) thinks that what generally leverages technology and innovation, delivering niche services via electronic (online) conduits by disintermediation circumventing incumbent financial institutions, can be regarded as FinTech. Zavolokina et al. (2016) conclude that FinTech, in general, is a living body with a flexible and changing nature rather than a stable notion that is transparent and clearly understood by both academia and the media. Anagnostopoulos (2018) points out that FinTech refers to the application of rapidly developing technology at both the retail and small business levels and the entrenchment of financial technology in financial services such as digital reporting, digital loan origination, and payment transfers. Thakor (2020) emphasizes that the core of FinTech is the use of technology to provide new and improved financial services. This statement sounds more concise and seizes the essence. Frame et al. (2019) add that non-intermediated peer-to-peer(P2P) lending, cryptocurrencies, and smart contracts are an emerging new mosaic of technology-assisted customized financial services, which is the same as FinTech services.

The reasons for the explosive development of FinTech is also an interesting topic which has been discussed widely. Zavolokina et al. (2016) explain that the emergence of FinTech is the result of three main factors simultaneously interacting: organizations, people, and geographical locations. Gomber et al. (2017) add that critical technologies and concepts that drive the recent changes and developments in the field of Digital Finance (or FinTech) are blockchain technology, social networks, near field communication (NFC), peer-to-peer technologies, big data analytics, and further technological enablers, like mobile devices, intuitive user interfaces, and security technologies. Thakor (2020) provides a new perspective on this problem, which is associated with an intermediary cost. He claims that part of the motivation for the emergence of FinTech is that, while information technology has made everything – from computers to cars – cheaper and more functional, the unit cost of financial intermediation has not changed much in over a century. The use of this technology and other technological advancements tend to lower the intermediary costs of financial sectors and achieve economies of scale in gathering and using extensive data.

2.2 The impacts and shocks of FinTech on the existing financial system

Existing research mainly focuses on the following aspects: First, the impact of FinTech (such as P2P and credit recognition) on the traditional lending market; second, the impact of FinTech (such as Internet finance and blockchain technology) on the macro-financial market and monetary policy transmission; third, the challenges FinTech (such as intelligent anti-fraud) brings to financial regulation.

For the first topic, a research survey by Lin et al. (2013) shows that FinTech lending, such as P2P, can better assess the lender's creditworthiness and reduce the credit risk of financial sectors by using various types of soft information related to a borrower's social network. However, inferring credit risk from one's social network does present issues related to data protection and financial regulation that need to be addressed. Morse (2015) has reviewed the existing literature on FinTech lending, focusing on whether the type of technologies employed by FinTech firms can mitigate information frictions in lending. She posits that FinTech can improve access to or price of credit by better capturing soft information contained in proximity information. Jagtiani and Lemieux (2018) explore whether FinTech firms expand credit availability in areas that may be underserved by traditional banks by examining the relationship between the various measures of credit gaps and the expansion of FinTech lending for consumers' unsecured loans.

Moreover, some research shows that by using FinTech, lending activities have penetrated areas that may be underserved by traditional banks, such as in highly concentrated markets and areas with fewer bank branches per capita. Fuster et al. (2018) provide empirical evidence that FinTech has improved the productivity of mortgage lending. Braggion et al. (2017) also find that peer-to-peer (P2P) credit can help circumvent loan-to-value (LTV) caps, a critical macroprudential tool to contain household leverage by using a difference-in-differences test which based on a novel, collected database covering all lending transactions at RenRenDai, a leading Chinese P2P credit platform.

As for the second question, Apfelbacher (2016) reports that the impact of FinTech on the macro-financial market will be significant and cross-domain. Furthermore, according to this research, the following domains are expected to have significant changes: payments, insurance, deposits and lending, retail and SME capital raising, and investment and wealth management. Also, Jan (2016) points out that FinTech, especially the distributed ledger technology, could offer a solution to a trade-off problem that traditionally exists in the market's assets transaction in general. How to trade off guaranteeing security and legality of the transaction and its cost-efficiency and anonymity is the challenge FinTech brings to the financial system. Concerning monetary policy transmission, Liu et al. (2013) posit that Internet finance has a smaller impact on replacing traditional financial intermediaries, and there is ample space for integration between traditional finance and FinTech. Besides, the status of central banks in various countries and their ability to formulate monetary policies will not be affected by the development of Internet finance, even under extreme conditions such as the electronic currency completely replacing traditional currencies. The central bank only needs to adjust the way it implements monetary policy and the carrier of monetary policy to continue to influence the macro economy's operation. Jan (2016) claims that in order to able an interbank payment system to run on a DLT (Distributed Ledger Technology) network when using blockchain technology. Central banks must allow interbank clearing and settlement transactions in central bank money on a 24/7 quasi instantaneous basis and allow them to manage interbank settlement without central bank involvement, which undoubtedly makes monetary policy more difficult. Schindler (2017) adds that FinTech is redefining the competitive setting, and is reshaping the lines that once characterized competitors in the banking industry. It disrupts the traditional value chain of financial institutions.

Since the financial sector is highly regulated, lots of literature has focused on the challenges FinTech bringing to financial regulation. Knight (2017) analyzes the regulation requirements for the financial markets in the USA. The research shows that FinTech from the same product segment can be regulated differently, which may bring uncertainty and ambiguity to financial regulation. Anagnostopoulos (2018) emphasizes that the swift revolt of FinTech creates risks and opportunities for regulators and market participants. The main current concerns of regulators are the potential impact of applying technology to finance and what improvements are required in the regulation of the technology domain. With the prosperity of FinTech, new technology in the regulatory domain comes behind; this is known as regtech. Also, research by Anagnostopoulos (2018) claims that regtech provides the means to move towards a proportionate risk-based approach where access to and management of data enables more granular, real-time, and adequate differentiated, case-by-case supervision of markets and market participants.

2.3 The impacts of FinTech on banks and banks' responses to FinTech

In this section, we mainly discuss this topic in four aspects:

1. Impacts on risk exposure and management
2. Impacts on credit business and shadow banking
3. Other impacts mentioned in the literature
4. Banks' attitude and response to FinTech and authors' suggestion for banks

The impacts of FinTech on banks' risk exposure have been discussed. Yue (2015) found: 1) Internet finance can help commercial banks reduce management costs and risk exposure first, but then it will raise the cost of funds, which in turn intensifies bank risk exposure. 2) Faced with the impact of Internet finance, the response of various commercial banks on risk exposure is different. Large commercial banks' performance is relatively slow, while the response of small and medium commercial banks is relatively sensitive. Zhonglu (2016) comes up with the conclusion that the impact of Internet finance on the risk behaviors of different types of commercial banks is different. More precisely, joint-stock commercial banks have reduced their risk exposures, but large commercial banks, urban commercial banks, and rural commercial banks have all improved to varying degrees, with urban commercial banks increasing the most. De Roure et al. (2019) develop a simple model of bank and P2P lending by using a diff-in-diff specification. The research shows that P2P platforms make riskier loans than banks, but the risk-adjusted interest rates on bank loans are lower than those on P2P loans.

Buchak et al. (2018) focus their research on the relationship between FinTech and shadow banking. They use a model which decomposes the relative contribution of technology and regulation to the rise of shadow banks to interpret the variation market shares of shadow banks. Moreover, they find an increasing regulatory burden faced by traditional banks and the growth of financial technology can account for about 70% and 30% of the recent shadow bank growth. Besides, by 2015 FinTech shadow bank lenders accounted for roughly 12% of mortgage loan issuance in the USA and comment that this is a substantial share regarding the expansion of shadow bank lending that delivers fresh tensions. This research conclusion echoes the finding of Tang (2019). This chapter uses a change in US accounting rules as a negative shock to bank credit supply and finds that US P2P lending is a substitute for bank lending and a complement for small loans.

Dapp and Slomka (2015) point out that FinTech is piling up the pressure on traditional banks. Moreover, digital change of banks requires far-reaching structural reforms that extend beyond all internal and external bank processes and systems. Scott et al. (2017) claim that the new entrants will force banks to accept lower margins on an already regulatory-diminished Return on Equity – especially for business segments that can be easily replicated. Carney (2016) adds that if commercial banks do not actively embrace FinTech and reform and open in the future, they will be condensed to regulation-driven, deposit-taking suppliers of services, secondary to emerging, FinTech companies. Kendall (2017) argues that start-ups are already confronting many modules of the traditional banking models globally, resulting in broader banking access, cost-cutting, expedience, efficacy, but also security value. Tang (2019) develops a theory of bank and non-bank lending in which banks have an endogenous advantage over non-bank lenders (including P2P lending platforms) when it comes to being trusted to make good loans. Their theory shows that even if incentive problems in banks may be more numerous and complex than in P2P platforms, banks can still keep an advantage in developing investor trust due to their unique access to low-cost deposit funding.

Banks' attitude and response to FinTech are also fascinating topics. Chen et al. (2017) adopt a comparative case study method to contrast and analyze the Industrial and Commercial Bank of China (ICBC) and Citibank. They analyze the strategies, organizations, HR systems, and product innovations adopted by these two banks in response to the impact of FinTech. Bunea et al. (2016) analyze explicit mentions of competition from FinTech in US banks' annual reports and identify 14 banks that acknowledge being threatened by FinTech companies. These banks represent only three percent of the banking sector by count but nearly a third of its assets. Also, those banks which have expressed concern about FinTech competition are more likely to be involved in the FinTech space themselves. Moreover, Bunea et al. (2016) study annual SEC filings of US bank holdings and find evidence that banks consider FinTech a severe threat. Anagnostopoulos (2018) argues that the new paradigm spearheaded by FinTech start-ups calls for stripping banking operations into separate business segments and holistically specializing in at least one of such segments. Vives (2017) suggests that commercial banks should also use bundling and tying strategies to compete with FinTech companies. These strategies can increase the incumbent's aggressiveness and make a life for the entrants more difficult since the entrant has to succeed in both markets.

3 Overview of FinTech, artificial intelligence and the restructuring of the Chinese banking industry

3.1 Outline

The core of FinTech is using modern digital technologies to optimize or innovate financial products, business models, and business processes. In May 2017, the People's Bank of China established the FinTech Committee to strengthen the overall planning and policy guidance of financial technology from the top-level design. In August 2019, the People's Bank of China issued the "FinTech Development Plan (2019–2021)", proposing to establish and improve the foundation of FinTech, and promote the in-depth integration of technology and finance, and institutionally regulate and plan the development of FinTech.

FinTech can help traditional banks solve tricky problems that they were previously unable to overcome in major business areas such as loans, deposits, payment and settlement. This new technology can bring a series of advantages to banks, such as efficiency improvement, costs reduction, and risk control enhancement. Undoubtedly, big data, cloud computing, AI,

and blockchains will play an indispensable role in the future. These four digital technologies have different task assignments; cloud computing belongs to the underlying facility, big data and artificial intelligence increase project productivity. Blockchains technology is responsible for promoting model restructuring. Although the four technologies are different from each other in the field of employment, they are inseparable from each other and all contribute to the promotion of the financial industry.

3.2 The application of FinTech in banking

3.2.1 Artificial intelligence

1 ROBO-ADVISOR

In general, Robo-Advisors use cloud computing, artificial intelligence, and other technologies, combining investors' wealth endowment, risk appetite, and financial goals, to providing investors with the best investment portfolio. Figure 15.2 introduces the current operation process of Robo-Advisor in banks. Robo-Advisors can flexibly process massive information based on user behavior, characteristics, and demands, then pass it to the user. So this consultant service not only keeps costs low but is also suitable for various customer groups. China Merchants Bank launched "Machine Gene Investment" at the end of 2016, becoming the first domestic, commercial bank to launch an intelligent investment adviser. Over the following two years, banking's Robo-Advisor products expanded rapidly. According to NDFRI (Financial Research Institute of Nanfang Metropolis Daily) statistics, 11 banks have launched smart investment advisory products, covering state-owned banks (ICBC, Bank of China, CCB), joint-stock banks (SPD Bank, CITIC, Industrial Bank, etc.) and city commercial banks (Bank of Jiangsu, etc.).

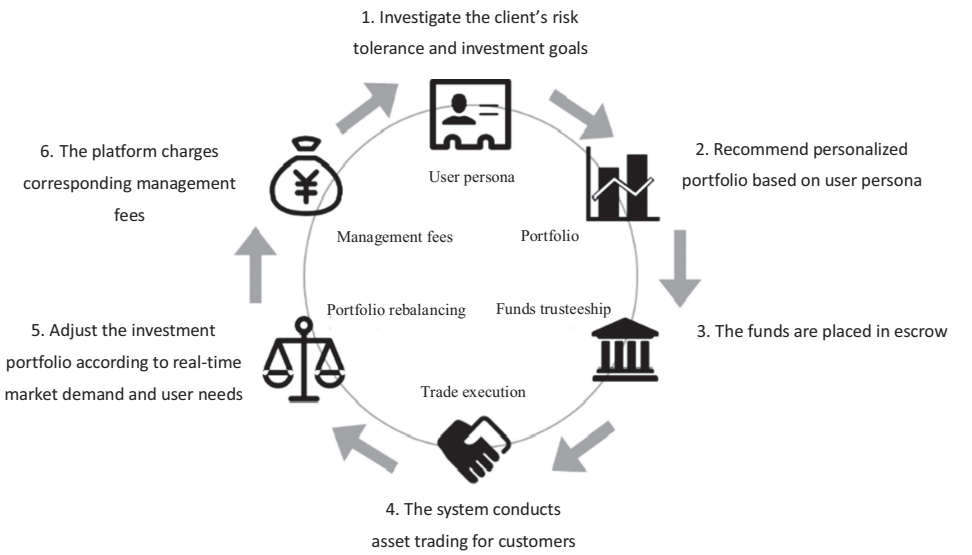

Figure 15.2 Service model of Robo-Advisor
Source: Ping An Securities

2 INTELLIGENT CUSTOMER SERVICE

According to the "Development report on China banking contact center and air bank (2018)", in 2018, the banking contact center was spurring the refinement of its business operation, exploring intelligent channels for customer contact, and lightening the cost of its traditional operation with the help of FinTech. First, Artificial intelligence leads to the construction of a smart customer service. In 2018, the level of utilization of intelligent technology in the banking customer service center was 69%, of which 65% of the customer service centers applied intelligent semantic understanding technology and robot services; this has become one of the leading methods used in online text customer service. It is a manifestation of big data analysis to improve service management capabilities. In 2018, 36% of customer service centers used big data technology to analyze customer behavior and business, making service and marketing work more precise. Third, the contact center integrates multiple channels to break the service limitations. In 2018, 60% of customer service centers actively explored channel innovation and integration, integrated traditional service resources, strengthened online and offline linkages, and improved customers' consistent service experience in all channels and scenarios.

3 INTELLIGENT RISK CONTROL

From the perspective of Chinese commercial banks, the form of intelligent risk control mainly reflects in the retail sectors. In 2017, Lanzhou Bank introduced artificial intelligence and applied it in multiple banking business scenarios such as anti-fraud, mining potential customers, and early warning of risk events, while providing valid data for pre-loan decision-making and post-loan risk control to reduce financial risks. The artificial intelligence system uses association relation reasoning to mine and identify group relationships, investment relationships, and guarantee relationships between enterprises, as well as employment relationships and equity control relationships. If a significant event occurs in a relationship node or any financial exposure risks are discovered, a risk warning system will activated through artificial intelligence. Figure 15.3 reveals the use of AI in bank lending. Banks use AI to determine whether to lend to customers by automatic identification and comparison.

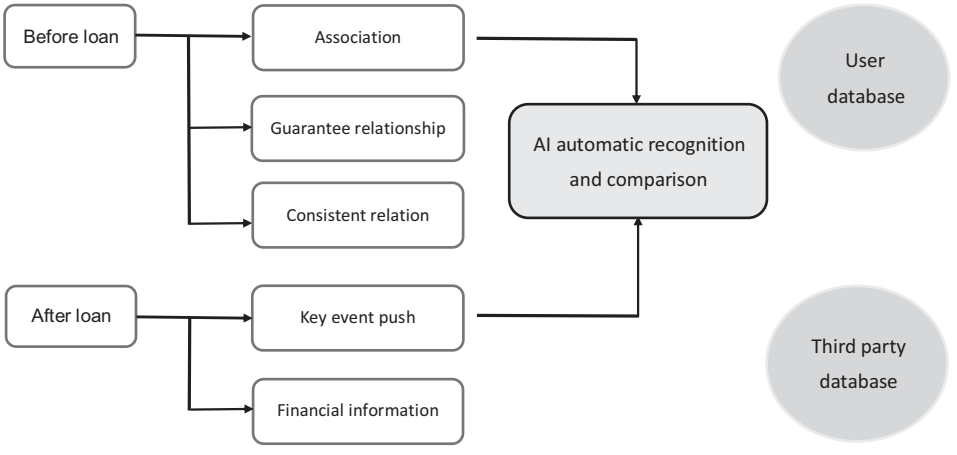

Figure 15.3 The application of AI in bank loans
Source: Ping An Securities

Before making a loan, AI determines whether a user is qualified for lending through the user database in the bank (such as association relationship, guarantee relationship) or third-party database. After the loan, the AI system can automatically track the lender's critical events and financial information to ensure the security of the loan.

3.2.2 Blockchains

Blockchains technology has the characteristics of high reliability, low cost of supervision, and decentralization; these attributes can solve most of the pain points in the traditional financial field. Hence, it is widely used in the area of commercial banks. IDC (International Data Corporation) data shows that in 2018, the total expenditure of China's financial industry in the field of blockchains was US$85 million, accounting for about 50% of all sectors. It is expected that by 2022, the expenditure of blockchains technology in the financial industry will reach US$600 million. The growth rate is almost 60.68%. The banking industry's spending accounts for almost 80% of the financial sector's total expenditure. Judging from basic data, the construction of blockchains in the next few years will focus on the financial industry. As the core of the financial sector, banks are expected to invest heavily in blockchains technology to drive significant innovations from business structure to IT architecture.

Table 15.1 Blockchain technology in major banks

Name	*The specific implementation of blockchain technology*
China MinSheng Banking Corp., Ltd	CMBC joined R3 in June 2016 to build a blockchain cloud platform. The head of the information technology department of Minsheng Bank revealed the bank's purpose to join R3. It is to seek cooperation opportunities with other large international financial institutions, learn and explore the business model of blockchain.
Ping An Group	Xinying Chen, executive vice president of Ping An Group, revealed that Ping An as a team is exploring blockchain technology application in seven or eight different scenarios. Among them, asset trading and credit reporting have been launched, and the transaction has also started.
China Merchants Bank	The bank mainly applies blockchain technology to the direct settlement system, a system used for cross-border clearing within China Merchants Bank. China Merchants Bank has six overseas institutions, one sub-branch, and five branches. In the past, banks only allowed clearing between branches and head offices. In the cross-border liquidation scenario, the blockchain seems more suitable for jobs. The use of a decentralized system enables clearing requests to be initiated between branches. Relying on the private chain technology, the security of the network environment can also be guaranteed. At the same time, the original minute-level message delivery speed elevates to second-level.
Postal Savings Bank of China (PSBC)	In 2016, PSBC and International Business Machines (China) Co. Ltd. announced the launch of a blockchain-based asset custody system. The system runs and completes transactions stably after it goes online. It is one of the first asset custody systems based on blockchain in the banking industry, and for the first time blockchain technology has been utilized on the bank's core business system. Later, in the field of trade finance, PSBC also launched the "U-chain platform" to realize cross-bank domestic L/C (letter of credit) transactions.

(*Continued*)

Name	*The specific implementation of blockchain technology*
Industrial and Commercial Bank of China (ICBC)	ICBC was the first bank to set up a blockchain laboratory. It spent three years building a blockchain service system that serves the real economy in areas such as government affairs, industry, and people's livelihood. At present, ICBC has achieved more than 60 core technological breakthroughs and submitted 41 patents. This proprietary technology is used in more than 60 scenarios such as fund collection, fund liquidation, fund grant, and bank-enterprise interconnection.
Agricultural Bank of China (ABC)	ABC's application exploration of blockchain technology is mainly focused on the "Three rural" areas. In August 2017, with the help of the underlying blockchain technology, Agricultural Bank of China launched an agricultural e-commerce financing system named "e-chain loan," which provides credit services such as order purchase, batch credit, flexible pricing, automatic approval, trusted payment, and self-service repayment.
Bank of China	The main application of blockchain is in the field of cross-border payment. By establishing a cross-border block chain platform, Bank of China carries out the chain of information flow and query function. By participating in the supervision node, the bank realizes the interaction between block chain information and actual transactions.
China Construction Bank (CCB)	The bank applies blockchain technology to the trade factoring business. In January 2018, CCB's first international factoring blockchain transaction was completed, making it the first Chinese bank to apply the blockchain technology to international factoring.
Bank of Communications (BCM)	Bank of Communications built the first asset securitization platform "chain integration" in China, which formed an alliance chain between original equity holders, trusts, securities brokers, investors, rating parties, accountants, lawyers and regulators, connected the capital end and the asset end, and realized credit penetration of the Asset Backed Securitization (ABS) business system by using block chain technology.

Source: organized public information

3.2.3 Cloud computing

The rapid and in-depth implementation of the "Internet +" strategy in the financial industry poses severe challenges to the efficient and agile operation of banking business and operational systems. Thus, banks have begun to attach great importance to the development and application of IT under the distributed cloud computing architecture. The banking industry's IT system is relatively old. Therefore, its IT system migration to the distributed architecture still needs to be carried out step by step.

In 2016, the China Banking Regulatory Commission issued the Guiding Opinions of Chinese Banking Information Technology on the "13th Five-Year Development Plan". This Plan sets out clear goals for the banking industry's need to migrate to the cloud. It points out that the banking industry should implement the architecture migration steadily, so that by the end of the "13th Five-Year Plan", all essential information systems for the Internet scene should be migrated to the cloud computing architecture platform, and residual systems migration should not be less than 60%.

In this process, large banks with strong technical strength and economic foundation tend to deploy private clouds, transferring some of their core business systems and most of their sensitive data to private clouds. However, small and medium-sized banks with weak

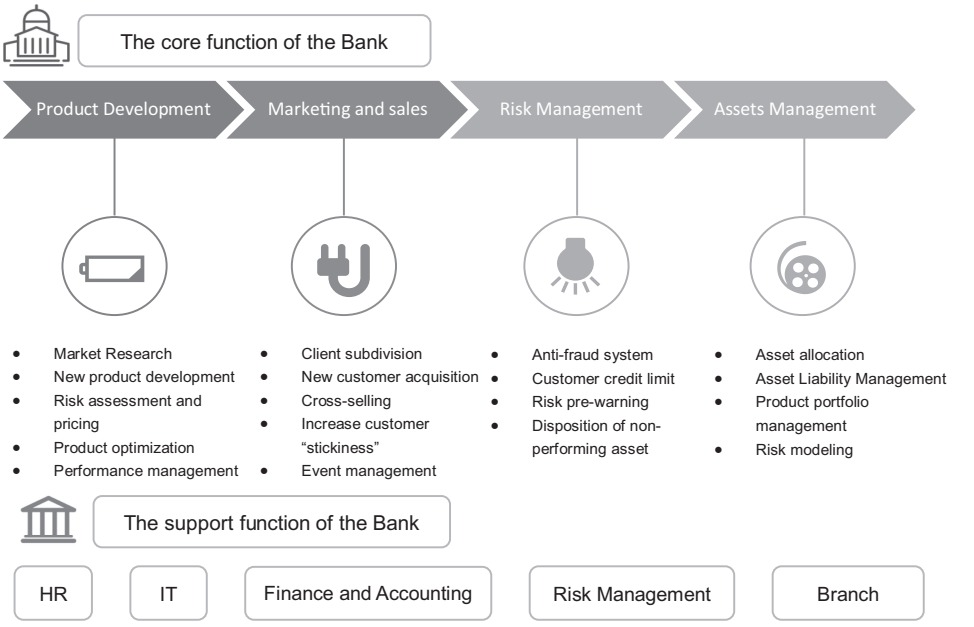

Figure 15.4 The role of big data in the bank value chain
Source: Ping An Securities

technical strength and economic foundation usually adopt the industry cloud approach. Through cooperation in the field of infrastructure among financial institutions, the cloud in the financial industry forms a batch of technical public services, such as public infrastructure, public interface and public application in the way of resource sharing.

3.2.4 Big data

The role of big data is reflected in all aspects of the value chain of banks, as shown in Figure 15.4. Along the whole value chain of banks, big data technology can be used for reforms in product development, sales, middle and back-end data management, and asset management. Banks can also use digital technology to boost revenues, improve capital utilization, and, most importantly, cut costs. According to McKinsey forecast, if the entire industry adopts digital measures, the industry's cost-to-income ratio can be reduced from the current 54% to 38% by 2025.

3.3 FinTech: restructuring the Chinese banking industry

3.3.1 FinTech strategic arrangement

Commercial banks have positioned technology finance as an essential weapon for business model transformation and services upgrade. At present, the main directional focus of national commercial banks are: 1) to raise technology finance to the level of strategic support, concentrate on promoting FinTech construction, upgrade existing IT systems, build data and cloud service platforms, etc. 2) to promote physical channel end's transformation, emphasize the application of new counters such as smart counters and the transformation and upgrading of outlets.

Table 15.2 FinTech layout of domestic listed banks

Name	*FinTech positioning and main measures*
ICBC	(1) Promote the application of financial technology in business management. Establish a highly aggregated, customer-oriented information system. Build a new online and offline integrated service marketing model. Comprehensively promote business model reform and service upgrade.
China Construction Bank	(1) Innovative products and services. Launch the payment product "Dragon Pay" that integrates NFC, QR code, and biometrics technology. Apply smart teller machines widely. (2) Promote physical channel transformation and achieve customer intelligence (identification, guidance, management, perception).
Bank of China	(1) Improve its service level in the midst of technological changes. Use advanced information technology and Internet thinking, pilot smart counters. (2) Actively shape the Internet finance brand of "E-BOC". Enrich four product lines of payment, asset management, transaction and financing.
Agricultural Bank of China	(1) Promote the construction of crucial scientific and technological projects. Complete the installation of three major platforms for Internet financial services, e-commerce and social life. Launch essential innovative products such as electronic accounts, online pledge loans, Kuai e-bao and Kuai e-pay. (2) Use biometrics to enhance identification and security capabilities. Complete the construction of big data underlying platform. Build a dynamic and elastic, on-demand infrastructure based on cloud computing technology. Explore the application mode of blockchain technology in the financial industry, and constantly explore the application of the Internet of Things technology in the banking field.
China Merchants Bank	(1) Promote business model transformation: build a leading digital innovation bank + an excellent wealth management bank. Create a new model of retail services in the Internet age. Promote the competitiveness of retail financial systemization to a new level.
CITIC Bank	(1) The "13th Five-Year Plan for Information Technology of China CITIC Bank" has formulated and released. Establish further improvement of IT governance. Accelerate the application of new technologies such as big data, machine learning, blockchain, and cloud computing. Encourage financial technology innovation and its implementation.
Minsheng Bank	(1) Launch mobile payment products such as fingerprint payment, cloud flash payment, Apple Pay, Huawei Pay, Xiaomi payment, iris payment, wearable device payment, QR code payment, etc. And launch online payment products such as Kuahang Tong, Minsheng payment, Shoufu Yi. Thus, effectively connect the consumption scenario and the application of financial products.
Industrial Bank	(1) Promote the construction of private cloud and industry financial cloud. Launch a series of smart risk control products such as "GoldenEye" and various mobile payment products such as "Xingye Butler". Explore the application of big data, artificial intelligence, blockchain and other new technologies in the bank. Support the exploration of different financial service way and operate models to prepare for the "future bank".
SPD Bank	(1) Produce 52 types of star products in FinTech on time. Achieve linkage between local and foreign currencies, the liaison between domestic and international banks. Establish a panoramic view of technology financial services.

Name	*FinTech positioning and main measures*
China Everbright Bank	(1) Construct a new generation of custody, Corporate customer unified quota, mobile payment, Internet credit, overseas core, overseas trade funds, asset management system phase II, and RMB cross-border payment. (2) Constantly promote the application of new technologies. Carry out the construction of intermediary business cloud platform, cash management cloud platform and big data application development platform, and incubate charity donation platform based on block chain technology
Hua Xia Bank	(1) Absorb big data and biometric technology. Vigorously develop new online channels and new online financial services. Realize the leapfrog development from transactional products to smart products. (2) Build multimedia, integrated customer service center. Optimize intelligent voice and video services to lay the foundation for multi-channel collaborative services.
Ping An Bank	(1) Create a retail banking service system with "SAT (social + mobile application + process service) + smart master account". Achieve breakthroughs in performance, services, products, channels, organizations, etc., and promote the overall discovery of retail business. (2) In the transformation of retail strategy, FinTech has become an important part to drive the transformation of Ping An Bank.
Bank of Beijing	(1) The first bank to launch the "Direct Bank" brand. Then launched a new e-banking platform. Established the industry's first "investment, loan, incubation integrative service" maker space, and explored a full-process networked financial service model of the "internet + fast loan". (2) Has actively established an open service platform for big data and launched a risk early warning application project of the Knowledge Atlas of big data to explore innovative application models of big data, artificial intelligence and risk prevention and control, so as to safeguard the sound operation of the whole bank.
Bank of Nanjing	(1) Continue to build a new technological, financial model. Launch Xinzhi 2.0 upgraded version. Launch "Xinhangbiao" big data platform. Build an external data access platform suitable for small and micro-businesses. (2) Create an open platform with name "Xinyun+" on the Internet and provide application-level services, including software deployment, application contracting, and architecture design consulting.

Source: Ping An Securities

3.3.2 Channel structure innovation

Cloud networking and mobile cloud networking are gaining popularity in China. As of June 2017, there were more than 750 million Internet users in China, and the penetration rate of cloud Internet was 54.3%, of which more than 90% were mobile Internet users. In recent years, commercial banks have been constantly expanding the layout of cloud networking and mobile terminals. At present, the scale of online banking users is about 500 million, and the utilization rate of online banking is about 50%. Given that there is still room for improvement in the utilization rate of online banking, commercial banks have chosen to continuously digitize and convert existing customers online, laying the foundation for further application of FinTech. At present, commercial banks have formed an electronic banking business structure based on online banking payment, with mobile payment as the main force, telephone payment, self-service terminal, WeChat bank and other electronic channels as the auxiliary.

Table 15.3 FinTech innovation in banking channels

Main Channel	*Merits*	*Defects*	*Innovative methods*	*Application*
Web Interface	Low operating costs No time and geographical restrictions	Cybersecurity risks Complex steps	Blockchain + enterprise cash management AI Customer Service	China Merchants Bank "U-Bank X"
APP	7 x 24 Service High degree of innovation Convenient, Multifuction	Risk of information leakage Bad APP experience	Big data mining and risk control Online account opening, no card withdrawal Face/fingerprint login	Bank of Jiangsu "QianRenQianMian" System
Wechat Public Number	Wide customer base Easy to open Low service cost	Different Public Number Public account authenticity Personal information leakage	Big data marketing QR code recognition	China Merchants Bank Big data constellation bill
Direct Bank	Asset-light, Low rates No physical card	Low customer stickiness Single product type Coincide with e-banking functions	Robo-Advisor Distributed core system Face/fingerprint/ voiceprint authentication	Huishang Bank "Tianjizhitou"
Intelligent physical outlets	Small footprint, convenient business handling Paperless, employee optimization	No emotional communication Lack of human support	Self-service bank Smart counter/ outlet	SPD Bank i-Counter

Source: Zhejiang University AIF

According to IDC, the scale of China's banking channel solutions in 2018 was 7.68 billion yuan, the compound growth rate will reach 13.78% in 2018–2022, and it is expected to reach 12.878 billion yuan in 2022. The online banking system consisting of mobile banking and network banking systems will have a total scale of 2.9 billion yuan in 2018 and is expected to reach 6.623 billion yuan in 2022, with a compound growth rate of 22.92%. The income from electronic channels in China's banking sector has maintained a sustained and rapid growth. The proportion of the income from electronic banking in some medium and large commercial banks has reached more than 90% of the overall business income.

3.3.3 Digital ecosphere construction

1 DIRECT BANK

The so-called "direct bank" is actually compared to the "distribution" type of traditional bank with a multi-tier branch operating structure. Although it is mostly set up by traditional

banks, it basically does not set up physical branches, does not issue physical bank cards, operates mainly through the Internet, mobile Internet, telephone and other tools to achieve the business instructions between the background processing center and front-end customers. Its source of funds is mainly from the sale of standardized financial products, which can be said to be a channel allocation of the parent bank. And its main task is to realize the statement of assets through the sale of assets management products. In terms of use of funds, direct banks will choose to make small loans in cooperation with Internet companies, and transfer them to the parent bank, that is, to absorb a large number of low-cost liabilities. The banks' purpose is to create an asset-light, mass customer, high-income banking model through the Internet and other means. By combining with the Internet and utilizing big data technology, banks can basically achieve risk coverage and complete risk pricing, which may be a future development direction for banks.

According to IDC's forecast, the size of Chinese direct selling bank (Internet banking) IT solutions market was 1.583 billion yuan in 2018, and the scale is expected to reach 4.459 billion yuan in 2022, with a compound growth rate of 29.55%, a growth rate far exceeding that of online banking IT investment. By the end of November 2018, there were 135 direct banks in China, including 72 city commercial banks, which accounted for 53.3% of domestic direct banks. This is because city commercial banks broke through regional restrictions and used electronic accounts (type II accounts) to fulfill the urgent need to expand users outside the domain. However, the rural commercial banks and RCC are both regional banks like city commercial banks. Although there are a large number of them in the industry, the proportion of banks that have opened direct banking business is lower, which is related to the low autonomy of banks' IT system under the dual system management mode.

2 BANK E-COMMERCE

The China Banking Association reported that the e-commerce of banks was booming in 2018. Data shows that 23 banks have self-built e-commerce platforms. In 2018, the total amount of bank-based e-commerce transactions reached 2009.804 billion yuan, with a total number of sales amounting to 548.4592 million. And the number of existing individual customers was 161.56 million, up from about 46.1886 million compared to 2017, over 40% increase. To be specific, among the big state-owned banks, ICBC, ABC and CCB ranked the top three in terms of e-commerce. Among them, the number of ICBC customers reached 122,863,300, and the number of transactions and volume reached 460,0100 and 1113,177 million, respectively.

3.3.4 Technology business specialization

1 ESTABLISHED TECHNOLOGY SUBSIDIARIES

In December 2015, Industrial Bank was the earliest joint-stock commercial bank to establish a FinTech subsidiary. In the same year, OneConnect, a financial technology company under Ping An Group, was created. Relying on five core technologies including artificial intelligence, big data, blockchain, cloud platform, and commercial applications. Meanwhile, OneConnect provides business technology services support to other financial institutions, and strives to become the world's leading financial technology company.

In February 2016, MBCloud, a wholly owned subsidiary of China Merchants Bank, was established. MBCloud's primary business is cloud services, as a technology export platform

of CMB, it is exporting the retail capacity, transaction banking, consumer finance, and financial IT solutions accumulated by China Merchants Bank to its peers.

In December 2016, Everbright Technology was born to promote the science and technology innovation of the Everbright Group. The chairman of the Everbright Group pointed out that Everbright Technology should strictly focus on three major tasks of building a technology development platform for the group, promoting "finance + Internet," and exploring the "Internet + Finance" technology innovation development model. At the same time, it must encourage cooperation with Internet technology companies, striving to achieve breakthroughs in drainage, customer acquisition, innovation, and efficiency enhancement.

In April 2018, CCB announced the establishment of a wholly owned subsidiary, CCB FinTech. In terms of positioning, CCB called its FinTech company, "a practitioner who empowers traditional finance, a linker that integrates group resources, and an innovator that promotes bank transformation." "CCB FinTech" is the first FinTech company established by a state-owned bank in China, and also the first new company in the banking industry to be named with FinTech.

In May 2018, Minsheng Bank officially announced the establishment of Minsheng FinTech in Beijing. The newly established Minsheng FinTech is positioned as "based on the parent bank, serving the group company and the whole market," which mainly serves the Minsheng Banking Group, its subsidiaries, and the group's business partners. At the same time, it aims to provide an output of technological capabilities to meet the needs of solutions and professional sci-tech products required by small and medium-sized financial institutions, private enterprises and micro enterprises as they begin the FinTech transformation.

2 BANKS' COOPERATION WITH THIRD-PARTY TECHNOLOGY COMPANIES

Third-party technology companies have their unique technical advantages and customer acquisition advantages. Commercial banks have gradually strengthened their cooperation with third-party technology companies, with a view to sharing various fields, such as customer resources, technology applications, risk prevention and control, customer service. Thus, two parties can jointly promote the understanding and improvement of financial technology.

3.4 Chapter summary

3.4.1 Deep integration of FinTech and banking

In Section 3.2, we elaborate on the application of the four primary financial technology methods in China's banking business, reflecting the increasingly closer integration of financial technology with Chinese banking business. This process improves service efficiency, optimizes service experience, and has broad application space and profound development significance.

The combination of AI and banking business reflects in Robo-advisory intelligent customer service and intelligent risk control. It helps banks simplify transaction links, reduce service costs, and effectively identify risks. However, blockchain technology hits the core points of the financial industry, due to its tamper-proofness, decentralization and other useful characteristics. The current application scenarios of this technology are cross-border liquidation, fund collection, fund clearing, asset custody, bank-enterprise interconnection, asset securitization, etc. Major banks have basically completed the migration of important information systems to the cloud computing architecture platform, which is better adapted

to the new financial business features of instantaneous high concurrency, multi-frequency and large traffic of Internet channel transactions, and this has improved the quality of financial services. While big data is the basic strategic resource for the development of financial technology in banks, its application runs through the entire value chain of banking business. It is of great significance for banks to realize the effective integration and in-depth utilization of data resources in business and give full play to the agglomeration and value-added role of financial big data.

3.4.2 Opportunities and challenges

The application of Chinese information technology in the financial field started in the 1980s. It has successively gone through the stage of financial service electronization and the stage of financial channel networking. Currently, it is ushering in the wave of development of FinTech. Information technology is gradually developing from a supporting business to the leading position, and the deep integration of finance and technology has become a new trend. In recent years, China has successively introduced a series of policy documents, such as "the action program for promoting the development of big data", "a new generation of artificial intelligence development planning", "Financial Technology (FinTech) Development Plan (2019–2021)", and also released new technology financial application norms and guidelines, such as cloud computing, voiceprint recognition financial application specification, which have created a profitable policy environment for the development of FinTech. After years of experience accumulation, the development of the FinTech industry has made considerable progress. The R&D and application of key core technologies in some areas have also achieved essential breakthroughs. The market size of key sub-sectors has doubled, and user penetration has increased rapidly. Financial institutions use technological means to innovate financial products, change operating methods, and optimize business processes, making the value of financial data more prominent. Financial products and services are making great strides in the direction of being more intelligent, more refined, more pluralistic, and can be used in multiple scenarios. Financial technology has become a new driving force for implementing inclusive finance and the digital economy.

Although China has a certain foundation in FinTech, it should be clearly noted that with the rapid development of FinTech, the boundary of financial business becomes gradually blurred. The transmission of financial risks has broken the limitation of time and space, bringing certain difficulties to monetary policy, the financial market, financial stability, financial supervision and other aspects. Moreover, the problem of unbalanced development of China's financial technology still exists. There is a lack of superior design and overall planning. Various market players are relatively unstable in terms of technological capabilities, innovation power, talent teams, and institutional mechanisms. The financial technology industry has a relatively weak foundation, has not yet formed an ecological system with international influence, and lacks a systematic and advanced R&D layout. At the same time, the infrastructure, policies, regulations and standards that can adapt to the development of FinTech need to be improved urgently.

4 Case study of FinTech application

The application of FinTech in China's banking industry is booming. Banks have different backgrounds, constraints and businesses, so they have different performances and effects in the development of FinTech. We select two representative banks for case analysis. One bank

is mainly engaged in traditional business and agriculture-related loans, with poor information basis, simple scale, low asset quality and low profitability. However, the Agricultural Bank of China has performed outstandingly in this financial technology reform. The other case study is the newly established, good asset quality, natural digital WeBank. We conduct comparative studies from multiple perspectives, such as FinTech infrastructure construction and business development.

4.1 Agricultural Bank of China

In 2018, the head office of Agricultural Bank of China (ABC) issued the "Agricultural Bank of China Financial Technology Innovation Three-year Action Plan (2018–2020)". In the same year, the Agricultural Bank of China's financial technology investment reached 12 billion yuan, accounting for 2.21% of total revenue. The overall investment was in the highest proportion of the four state-owned banks. In recent years, the ABC has made significant breakthroughs in cloud platform construction, blockchain, AI and big data.

4.1.1 The construction of a cloud platform

It has become a trend for banks to deploy the "cloud." As a highly sensitive industry, most commercial banks are actively using cloud platforms. Of course, the foundation of digital transformation is to build a technical architecture supported by the "cloud." Once a sizeable traditional bank begins to transform, its investment in information infrastructure will be vast, and it will need to equip itself with a full-time technical department, and the requirements for risk control level usually are stringent, so generally the path taken is to purchase hardware and software equipment and build a private cloud.

The ABC has been deploying cloud platforms since 2012 and has formed a professional team specializing in cloud computing development. The "cloud" process divides into three stages: first, at the IaaS (Infrastructure as a Service) level, the infrastructure cloud platform is independently developed based on server virtualization, and the underlying resources of the server system are managed through OpenStack. The second step is to build a cloud platform PaaS (Platform as a service); the technical department uses Docker container technology to isolate the upper-layer applications from the underlying infrastructure to provide an environment for subsequent efficient development and management. Third, the system is made to "cloud-friendly" and quickly migrated to the cloud platform, to realize the sharing of computing resources and comprehensive dynamic management of programs.

Based on IaaS and PaaS, Agricultural Bank migrated some traditional business processes to cloud computing platforms. For easy migration, the application must be "cloud-appropriate" before deployment to achieve the decoupling of service modules. After that, IaaS completes the implementation of the host machine, and PaaS realizes the rapid response of the container, such as the e-commerce platform of preferential agriculture, the payment platform, etc. (the application runs in each vessel).

4.1.2 Financial brain-Athena platform

In June 2017, Agricultural Bank of China and Baidu signed a strategic cooperation agreement to build an intelligent bank, and build a financial brain-Athena platform; its specific functions are shown in Figure 15.5. It is the industry's first proposed enterprise-level AI commercial platform solution.

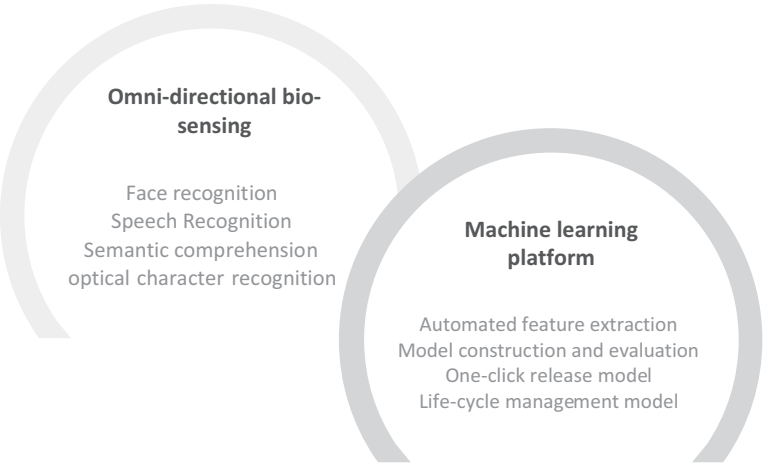

Figure 15.5 Athena platform

The financial brain-Athena platform has created a perception engine and a thinking engine. Perception engines include face recognition, image recognition, optical character recognition (OCR), and other all-round biological perception capabilities and real-time high-availability unified access capabilities to support AI applications in all business areas of the bank. The thinking engine builds a full-process integrated intelligent model development, operation and management platform; this includes automated feature extraction, automated model construction and evaluation, one-click model release, real-time model service, model life cycle management, AI basic computing, model library, machine learning modeling and model management service functions such as knowledge base.

4.1.3 Blockchains technology

The Agricultural Bank of China has been committed to deeply integrating the advantages of blockchains technology with the characteristics of supply chain business, to improve the efficiency of agriculture, rural areas and farmers. As early as 2015, the Agricultural Bank of China began to explore blockchains technology. In July 2017, an e-commerce's supply chain financing project based on blockchains was put into operation. This project is the first in the domestic banking industry to apply blockchains technology to electricity in supply chain finance. In 2018, two more blockchains products landed which were a digital credit project of network finance and a pension project and both received a strong market response. The digital point project "Xiaodou Paradise" went online and accumulated over 13 million customers in one year. At the end of 2019, the loans of inclusive small and micro enterprises of Agricultural Bank of China had increased by 217.9 billion yuan from the end of the previous year, an increase of 58.2%.

Example e-commerce financing "E-chain loan" products

"E-chain loan" was launched in August 2017. It is an Internet product that applies blockchains technology to agriculture-related supply chain financing. The product creatively integrates multi-channel information such as e-commerce, supply chain financing, online payment, enterprise ERP, and farmer credit files into the supply chain, establishes a multi-dimensional credit evaluation model, and develops pure credit network financing business.

Agriculture-related credit business has been plagued by problems such as asymmetric information, high management costs, and difficulty in online credit and credit scenarios. From the perspective of traditional financial services, due to the lack of credit data of small and micro customers, it is difficult to effectively measure their credit level. Besides, these customers often have insufficient collateral. It is challenging to meet the bank's risk prevention and control requirements. As a result, the cost of banks providing financial services to such customers is often higher than the benefits, making their financing difficult and expensive.

The "E-chain loan" uses the transaction and operating data generated by the Agricultural Bank's e-commerce platform as a breakthrough channel to analysis. It relies on online supply and marketing relationships, operation, trade, and financial data to establish customer credit files. Second, it cooperates with core enterprises to obtain ERP order data, through cooperation with local rural supply and marketing cooperatives and government departments. Farmer credit data is obtained after authorization, including agricultural transactions, file information, government subsidies, etc. Logistics data is obtained through docking with local agricultural resources supervision and logistics tracking platforms. The providers of these data include production enterprises, distributors, county wholesalers, farm shops, and farmers. They join the blockchain network as participating nodes, and each node continuously pushes valid data to the blockchain network, and multi-party data is shared on the chain. Finally, the smooth circle of capital data, information and logistics data on the chain is achieved.

This product provides customers with e-commerce financing services, including order procurement, batch credit, flexible pricing, automatic approval, and trusted payment. The customer's rating, credit and pricing are achieved through the data model. The automated loan approval and credit usage process are also directly embedded in the order payment scenario, thereby achieving a seamless connection between financing and payment. It can efficiently prevent risks and realize fixed funds for a set purpose.

4.2 WeBank

4.2.1 Introduction

WeBank opened in 2014. It was initiated by many well-known enterprises such as Tencent, Baiyeyuan and Liye, and was the first private bank in China to open. WeBank disclosed in its 2018 annual report: "In 2018, the bank insisted on core technology and independent innovation as its development engines. It continued to research and develop cutting-edge financial technologies such as artificial intelligence, blockchain, cloud computing, and big data. As a result, the bank's account operation and maintenance costs have continued to fall by 45%, far below the average level of domestic and foreign peers." From this, we can see that WeBank attaches great importance to the development of financial technology. And financial technology has improved its operation and maintenance efficiency, and tapped new profit points, improving the level of risk control plays an important role.

4.2.2 AI technology strengthens banking capabilities

Based on artificial intelligence technology, applications developed by WeBank include "WeiJinXiaoYun" (微金小云) intelligent customer service robot, KYC (Know Your Customer) service, etc. "WeijinXiaoyun" is supported by AI technology such as natural language processing and WeChat data platform. It takes customer service scenarios related to financial business as

research objects. Intelligent customer service is trained using the deep learning model. Since the amount of data plays a decisive role in the training effects of the model, WeChat, as the social platform of WeiJinXiaoYun's parent company, provides hundreds of billions of pieces of analytical data. The data dimension covers almost all the characteristic information of users, which guarantees that WeiJinXiaoyun is able to respond to various complex scenarios, and provides users with 7×24 hours of efficient and accurate online consulting services.

Some 98% of the customer service of WeBank is completed by its intelligent customer service, which not only effectively supports the needs of a large number of customers, but also greatly saves labor costs. With robotic customer service plus eight manual customer services, WeBank can handle an average of 900,000 messages per day.[2] Based on the operation strategy of "mainly online customer service, supplemented by telephone customer service," WeBank focuses on small high-frequency problems and responds quickly through intelligent robots. When the robot cannot meet the need, it immediately switches to manual customer service. Through the free switching of online and manual processing platforms a high quality customer service experience can be realized.

To prevent fraud risks more effectively, WeBank, together with Tencent Cloud Security and Vision Seed, has developed a financial-grade multi-factor authentication service – KYC – with face recognition as the core. The multi-factor identification includes ID card OCR and verification, bank card OCR, and three or four-element verification. Moreover, KYC supports the access of software development kits WeChat public account, WeChat Mini program, etc. Based on KYC, WeBank launched the light living detection technology "Aurora Guard" in November 2017. The technology is built on a solid foundation of cryptography. It is one of the techniques with the highest known security level. Due to the small number of personal consumption loans and bulk approval, it is a high-risk area for fraud. Were criminals to use the identity information of others to apply for consumer loans, it would bring high business risks. Based on artificial intelligence and "Aurora Guard" technology, WeBank can effectively prevent such fraud risks.

4.2.3 The application of blockchains technology

BaaS is a service platform that helps users to create, manage and maintain an enterprise-class blockchain network. It reduces development and use cost, has rapid deployment, is easy to use, and offers high security and reliability. BaaS makes application development and application deployment simple and efficient by transforming computing resources, communication resources, storage resources and other capabilities into programmable interfaces.

Meanwhile, through standardized capacity building, it ensures the safety and reliability of blockchain application, provides support for the operation of blockchain business, and solves operational problems such as flexibility, security and performance. The specific capabilities of BaaS include blockchain node and whole chain construction, blockchain application development, blockchain application deployment, and blockchain operation monitoring.

As a cloud service, the multi-tenant feature of BaaS enables the maximum sharing of computing resources, platform resources and software resources. BaaS provides node hire, chain hire and tool hire. Through a large capacity resource pool, the tenant's business scale can be flexible and secure, and necessary technical support services are also provided. Figure 15.6 shows the main structure of Baas. Blockchains technology has the attributes of decentralization, openness, autonomy, non-tampering, and anonymity. And WeBank positions itself as a "strong connector and connection platform," which fits in with the properties of the blockchains.

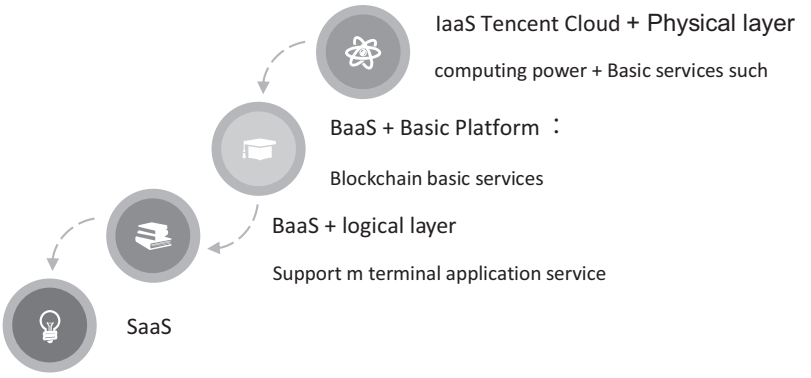

Figure 15.6 BaaS structure

The achievements of WeBank in the application of blockchain are as follows:

(1) In May 2016, WeBank joined 25 organizations, including Ping An Bank, JD Finance, and Shenzhen Financial Information Service Association, to establish the "Financial Blockchains Shenzhen Consortium," or "FISCO" for short. So far, FISCO members have included more than 80 institutions in six major industries, including banks, funds, securities, insurance, local equity exchanges, and technology companies. In July 2016, WeBank and QCloud successfully developed the blockchains product "Blockchains Cloud Service BaaS," which is only open to "FISCO" members. BaaS is a low-level development tool for blockchains. It provides development of API (application programming interface), graphical management console and browser, which can be used to develop blockchains programs quickly.

(2) WeBank, together with Wanxiang Blockchains and Juzix, established a joint blockchains laboratory in 2016. The laboratory is committed to jointly developing the underlying platform of the blockchains and promoting the application of blockchains. On July 31, 2017, the fully open-source blockchains platform BCOS (Blockchains Open Source) was launched. It aims to build a multi-party cooperative community with deep mutual trust and promote the formation of a distributed business ecosystem.

(3) In September 2016, WeBank and SHRB (Shanghai Huarui Bank) launched the "Weilidai" reserve management and reconciliation platform based on the early version of the BCOS platform. Under the joint loan model, the settlement of funds between WeBank and dozens of partner banks is much more frequent than traditional banks. In the conventional liquidation model, the transaction and fund settlement are separated, and the two parties keep separate accounts. When the transaction is completed, both sides need to spend a large amount of time checking accounts. this is due to part of the data required for reconciliation being recorded by the other party, neither party can confirm the authenticity of the data. After introducing the "Weilidai" reserve management and reconciliation platform, since all information is recorded on the blockchain network, the transaction process can be cleared in parallel. The data that was only available to the cooperative bank before "T+1" can now be reviewed and checked in real-time.

4.2.4 Cloud computing significantly reduces IT costs

WeBank's IT architecture is a fully distributed IOE open-source architecture. The IT architecture of traditional banks is usually composed of IBM minicomputers, Oracle databases

and EMC (EMC Corporation) storage devices, commonly known as IOE. There are four disadvantages of IOE architecture. One is that the software and hardware equipment are monopolized by the above three companies, resulting in a prohibitive price. In a big data environment, the system and data stock increments are substantial. The cost of purchasing is too high, and it is easy to form a dependence. The second is that under the IOE architecture, data storage and processing are based on a structured relational database, which cannot adequately handle unstructured data in a big data environment. The third is poor hardware platform compatibility of IOE, such as HP hardware and the IBM system cannot form a seamless cross-platform link. Fourth, the scalability of the architecture is limited. The data processing of the IOE system belongs to TB (T bit) level, and the ability to analyze transactions at the PB (P bit) level is limited.

Due to various constraints of the IOE structure, coupled with capital restrictions, short construction time and other factors, WeBank chose to develop a fully distributed architecture with IOE being controled independently. The entire IT system is based on cloud computing. On December 8, 2016, WeBank President Qingnan Li stated at the Banking Regulatory Commission's regular banking press conference that WeBank is the first bank in China to have established a "de-IOE" technology architecture to which it owns all intellectual property rights. The "de IOE" strategy brought extremely significant benefits to the bank. After WeBank completed the IOE architecture, its IT cost was less than 10%. At the same time, WeBank also packaged its cloud computing products for commercial export to meet the needs of interbank financial customers. There are already many banks using WeBank's intelligent cloud customer service. This smart cloud customer service system can be accessed quickly, safely and at zero cost through QCloud.

4.2.5 Big data significantly improves the risk control level

WeBank's big data technology is used to build its risk control system. That is, with the help of traditional credit reference data sources and Tencent's private data sources, WeBank has developed its own proprietary credit reference data source. At the same time, based on proprietary data sources, it uses big data technology to create a series of models with "Internet risk control" features. it carries out a comprehensive credit evaluation for customers and implements full-process risk management and control before, during and after the loan. This technology has been fully applied in WeBank's financial product "Particle Loan".

"Weilidai" performs white-list screening based on big data credit ratings. It uses thousands of dimensions of data to build models, including credit information of the people's Bank of China, social data, public security data, population registration data, education data, and transaction records. This is used to comprehensively evaluate the applicant's credit rating, decide whether to issue loans and the amount of credit accorded. All these operations are completed within a few seconds after the customer opens the "Weilidai" page. WeBank's model includes not only the elements of traditional banks' offline approval but also parts that conventional banks cannot reach. Hundreds of millions of transactions have verified the validity of the model.

In addition, post-loan early warning, blacklist identification, multi-level collection (telephone, SMS, litigation, territorial debt-collection) and other functions are helping "Weilidai" manage the work of post-loan, until the customers repay the loans. At the same time, "WeiLiDai" relies on AI and "Aurora Guard" technology to help customers prevent fraud risk, and uses big data technology to protect customer assets.

4.3 Comparison and analysis

Banks use new technologies represented by big data, cloud computing, blockchain and artificial intelligence as the underlying driving force. Banks can provide targeted, differentiated, and personalized financial services more efficiently and substantially improve the service level. This covers long-tail customers that traditional financial institutions could not. For example, the "smart investment adviser" launched by both Agricultural Bank and WeBank allows learning-capable machines (artificial intelligence) to help customers manage their wealth. The inclusive financial evaluation system of commercial banks also breaks through a single mode of evaluation that relies solely on corporate financial information and financial reports. With the help of financial technology and big data, a comprehensive and multi-dimensional enterprise assessment is possible, for instance, the e-commerce financing "E-chain loan" launched by Agricultural Bank and the "Weilidai" credit loan product launched by WeBank. Commercial banks can also use financial technology to build risk control models to improve the quality and efficiency of operations, promote the online service of microfinance business, and then put intelligence into the risk control system.

We found that there are differences between the development and application of financial technology in traditional banks and Internet banks. Both banks are working hard to create an economic "ecosphere," but the starting point is different, and the final results are also different. Internet banking mainly relies on the parent company's business accumulation and brings advantages in technology, traffic and data to the market. They are starting from the third-party payment business, gradually expanding the business scope to financial management, insurance, inclusive credit and other business fields, and developing into an emerging force on the commercial supply side.

Third-party financial service platforms currently are built on social platforms such as Alipay, WeChat Pay, and Ant Financial. They use social platforms' large customer base, robust data infrastructure and adequate financial support. They actively promote the penetration and extension of technology in the financial industry and gradually erode commercial banks' traditional business. The advantages of traditional banks like the Agricultural Bank of China are that they have a large group of original users, strong funds, and strong business replication capabilities. Relying on its long-term accumulated capabilities, the Agricultural Bank is actively adapting to the innovative trend of Internet finance. The bank promotes the rapid integration of digital accounts into customers' social, travel, consumption and other life scenarios, such as building a life shop app that covers clothing, food, housing, and transportation. In addition, the bank provides corporate advertising in the front desk of online banking, and categorizes users' preference to push business Information, or draining bank's users to official cooperative shops; ABC is trying to create an ecological closed loop of the combination of finance and commerce, and gradually embedding financial services into various scenes of customers' production and life.

In general, in the application of financial technology, traditional large banks face more problems in terms of efficiency and coordination. Traditional banks are subject to too long a decision-making chain, a wide variety of businesses, and branch staff complexity. How to coordinate the financial technology business of various departments and branches, promote the integration of finance and technology (not only at the technical level), and promote the comprehensive integration of development concepts, business models, management models, service models, are just some of the current problems facing long-established banks. An Internet bank could be called a technology company. The original intention of Internet banking is to reform the financial industry by means of science and technology, so as to

practice an inclusive financial strategy, and then promote the traditional commercial banks to accelerate the process of digital transformation.

5 Has FinTech improved the performance of banks?

In this section the following question is addressed: Does the use of FinTech improve the performance level of banks as a whole? We analyzed the data disclosed in the annual reports of Chinese A-share listed banks from 2009 to 2018 to test whether the use of FinTech has improved the performance of banks. The first part of this section introduces data sources and variable descriptions, the second part introduces methods, the third part reports empirical results, and the fourth part summarizes conclusions.

5.1 Date and variable description

This study uses five indicators that reflect bank performance. They are ROE (return on equity), COI (cost to income ratio), NIR (non-interest income ratio), NIM (net interest margin), and the sum of the first four indicators — Yield Sustainability (YSA). The selection of the early four signs based on the "Gyroscope Evaluation System" of the China Banking Association[3] was first launched in 2015. It is currently the most influential and authoritative of Chinese comprehensive evaluation systems on the sound development capabilities of commercial banks.

We use ROE to investigate the profitability of banks. The higher the indicator, the better the profitability will be. The control ability of unit cost is examined by the COI index. The lower the index is, the better the profitability is. NIR indicator reflects the operating income of banks in addition to spread income, and NIM indicator reflects the capital utilization of commercial banks. To facilitate the measurement of the bank's performance level, in this chapter we compile these four indicators into a comprehensive indicator and create a total indicator to measure performance: earnings sustainability (YSA). YSA=ROE+NIR+NIM+1/COI. Since the lower COI is, the better the profitability of the bank is, we choose to put the reciprocal of this indicator into the formula to sum it up, so as to keep in line with other profitability indicators.

To measure the use of FinTech by Chinese commercial banks, we collected public information such as the annual reports of various commercial banks and recruitment advertisements from bank websites. We manually collected relevant parameters, and tried to use these variables to measure the extent of FinTech used by commercial banks.

Simultaneously, this chapter selects other financial indicators and control variables into the model. The specific meaning of each variable is shown in Table 15.4.

By the end of 2018, A total of 32 banks had been listed on the Chinese A-share market. This chapter selects a total of 320 records of listed banks in the ten years from 2009 to 2018 as samples. The data sources are from the following: 1) Proportion of FinTech investment by banks, the proportion of R&D personnel, patent data and number of R&D personnel recruitment, frequency of FinTech mentions, etc. are from annual and semi-annual reports disclosed by listed companies (obtained by hand). 2) The rest of the data are derived from the Wind database (each variable is directly obtained or calculated according to the companies' balance sheet).

We chose to delete the absolute number of R&D personnel and retain the proportion of R&D personnel. As the absolute amount and the proportion of FinTech input belong to missing data (only 45 variables can be collected), so we delete them. Other manually collected data are retained. At the same time, other incomplete data are deleted, and the remaining data are shown in the Table 15.5.

Table 15.4 Definition of variables

Variable type	*Variable name*	*Variable code*	*Variable definitions*
Performance variables	Return on equity	ROE	Ratio of fixed annual net income to average shareholders' equity
	Cost to income ratio	COI	Cost to Income ratio = Business and management expenses/Operating income
	Non-interest income ratio	NIR	Non-interest income/Total interest income*100%
	Net interest margin	NIM	(Interest income-interest expense)/ total assets
	Yield sustainability (Comprehensive index)	YSA	YSA = ROE + NIR + NIM +1 / COI
	TOBINQ	TOBINQ	Total market value/Annual total book value of assets
Risk variable	Non-performing Loans Ratio	NPL	Non-performing Loans Ratio
FinTech indicators (collected manually)	Recruitment times of scientific research staff of head office (incomplete statistics)	FREQUENCY	The number of times that the head office of a bank recruits' scientific researchers each year
	Number of R&D personnel	R&D	Number of bank R&D personnel disclosed in the annual report
	Ratio of R&D personnel	R&D RATIO	Number of R&D personnel/Number of all employees
	Percentage of FinTech Investment	FINANCIAL	Investment expenses in the financial technology field/Annual operating income
	FinTech investment (100 million)	FINANCIAL INVEST	The bank's annual investment in the financial technology field
	Number of patents held	PATENT	The number of valid patents held by the bank during the specified period
	Number of patent applications	PATENT APPLICATION	The number of patent applications filed by the bank during the specified period
	Number of patents approved	PATENT APPROVALS	The number of bank patent applications approved during the specified period
	Mention frequency	REFERENCE	The total times of the bank's annual report mentioned the five terms "financial technology," "big data," "cloud computing," "artificial intelligence," and "blockchain." (If the same term is mentioned multiple times in a sentence, it will only be counted once.)

Variable type	*Variable name*	*Variable code*	*Variable definitions*
Other indicators that may affect performance	Proportion of the largest shareholder	TOPSH1	Number of shares held by the company's largest shareholder/total shares of company
	Equity balance degree	EQUBALAN	The sum of the shareholding ratio of the 2nd to the 10th largest shareholder/the shareholding ratio of the largest shareholder. (It reflects the ability of other shareholders to check and balance the first major shareholder.)
	Relative market share	REMASH	The ratio of the company's market share (the company's net sales / the net sales of all companies in the industry) to the company's market share that cannot control (the company's market share minus 1) within a year
	Institutional shareholding ratio	INSTRATIO	The sum shares of the listed company's stock held by various institutions at the end of the year/the tradable shares in the market
Control variable	Company Size	LNASSET	The natural logarithm of the book value of a company's assets per year
	Listing age	LIAGE	The difference between this year and the year the company went public
	Company age	AGE	The difference between this year and the year the company was established
	GDP growth rate	GDPGROWRATIO	Annual growth rate of China's GDP

Table 15.5 Descriptive analysis of variables

Variable name	*Parameter*	*Number of samples*	*Mean*	*SD*	*Min*	*Max*
Return on Equity	ROE	315	17.2696	4.5754	7.6912	35.7235
Cost-to-income	COI	315	31.8074	4.7985	20.5200	44.8800
Non-interest income Ratio	NIR	315	17.1797	10.1479	0.2636	51.0900
Net Interest Margin	NIM	309	2.2774	0.4821	1.0600	4.0800
Yields sustainability	YSA	309	39.9163	9.8630	19.6761	70.8744
Mon-performing loan ratio	NPL	306	1.2578	0.5120	0.3800	3.8118

(*Continued*)

Variable name	*Parameter*	*Number of samples*	*Mean*	*SD*	*Min*	*Max*
Number of scientific research staff recruitment (Incomplete statistics)	FREQUENCY	309	39.9163	9.8630	19.6761	70.8744
Proportion of R&D personnel	R&D RATIO	309	1.4545	0.3058	0.6059	2.2042
Number of patents	PATENT	315	17.2696	4.5754	7.6912	35.7235
Number of patent applications	PATENT APPLICATION	315	0.3417	0.1632	0.0000	1.0000
Patent approvals	PATENT APPROVALS	315	31.8074	4.7985	20.5200	44.8800
Mention frequency	REFERENCE	315	0.4634	0.1970	0.0000	1.0000
Proportion of the largest shareholder	TOPSH1	315	17.1797	10.1479	0.2636	51.0900
Scale of company	EQUBALAN	315	0.3328	0.1997	0.0000	1.0000
Relative market share	REMASH	309	2.2774	0.4821	1.0600	4.0800
Institutional ownership	INSTRATIO	309	0.4031	0.1596	0.0000	1.0000
Scale of company	LNASSET	320	0.9000	0.6452	0.0000	3.0000
Listed age	LIAGE	103	0.0728	0.1121	0.0110	0.4158
Company age	AGE	320	60.2719	190.3154	0.0000	1481.0000
GDP growth rate	GDPGROWRATIO	320	16.1125	55.8502	0.0000	491.0000

5.2 Method and model introduction

We use two methods to estimate the impact of FinTech on bank performance. One type of approach is the traditional regression analysis method, and the second method is the emerging machine learning method: random forest algorithm.

5.2.1 Panel data regression

Panel data modeling takes the following steps: first, we use an OLS (ordinary least squares) model, which assumes that there are no unobservable company-specific impacts. Then the fixed and random effects models are used to analyze whether there are fixed and random effects in the above relationships. To test whether there is a fixed effect in the panel data, we perform an F test for each associated model. This will test whether the fixed effects model produces better goodness of fit. However, the fixed effects model in this chapter is estimated by the least squares virtual variable (LSDV) regression method. On the other hand, for the random effect model, performing the Lagrange multiplier (LM) test can reveal whether the random effect in the model is significant or not. Finally, the Hausman test is carried out for each relational model studied in this section, to compare the relative influence of fixed effect and random effect on the model and see which model has better goodness of fit.

Basic model setting: PERFORMANCE is represented by ROE, COI, NIR, NIM and YSA, which are the explained variables of the model. Explanatory variables are a series of

FinTech indicators collected manually in Table 15.5, and other control variables will also be added to the model. The specific regression equation is:

$$PERFORMANCE_{i,t} = \beta_0 + \beta_1 REMASH_{i,t} + \beta_2 LNASSET_{i,t} + \beta_3 FILEV_{i,t} + \beta_4 AGE_{i,t} + \beta_5 FCAPIN_{i,t} + \beta_6 FRDIN1_{i,t} + \beta_7 OPINGRATE_{i,t} + \varepsilon_{i,t} \quad (5.1)$$

5.2.2 Random forest

The term random forest is proposed by Breiman (2001). It uses the bootstrap resampling technique to repeated and random extract k samples from the original training sample set N. Then the program forms a random forest according to the k classification trees generated by the self-help sample set, and the classification of new data will be determined according to the score formed by the classification tree voting. In essence, it is an improvement of the decision tree algorithm, which combines multiple decision trees together. The establishment of each tree depends on an independently extracted sample. Each tree in the forest has the same distribution, and the classification error depends on the classification ability of each tree and the correlation between them.

Feature selection uses a random method to split each node, and then compares the errors generated under different circumstances. This method can detect intrinsic estimation error, classification ability and number of features selected according to correlation. The classification ability of a single tree may be small, but after the model randomly generates a large number of decision trees, a test sample selects the optimal classification based on the classification results of each tree before.

5.3 Empirical results

Following the research objectives, we need to verify whether the use of FinTech has improved the bank's performance level. Also, we check which financial technology indicators have an essential impact on the performance level of banks.

First, let us see how the various performance indicators change from the X axis (time) in Figures 15.7–15.9.

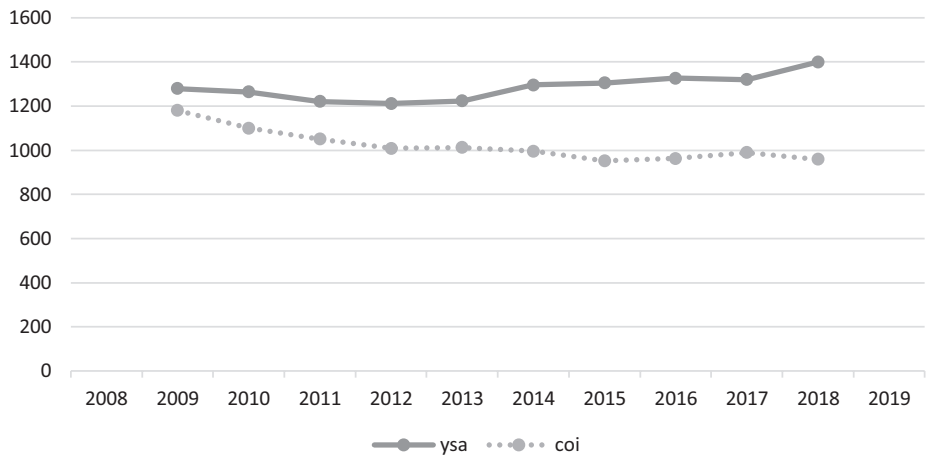

Figure 15.7 YSA and COI trend

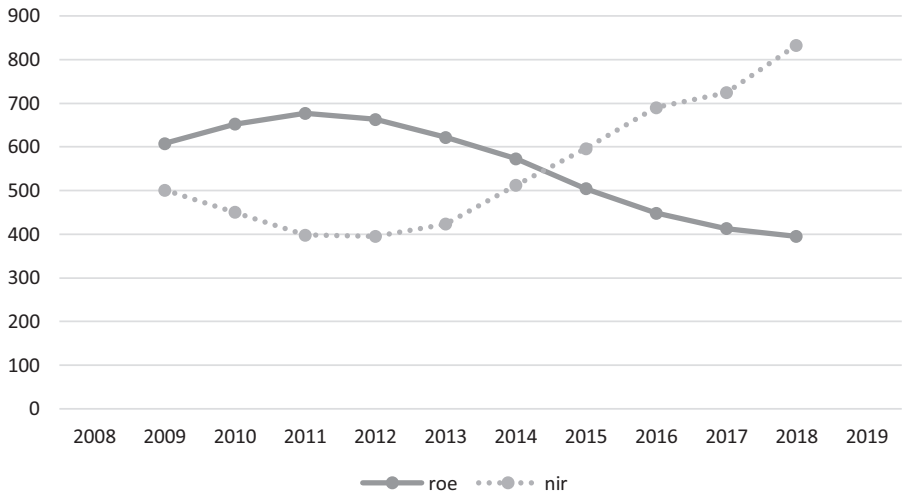

Figure 15.8 NIR and ROE trend

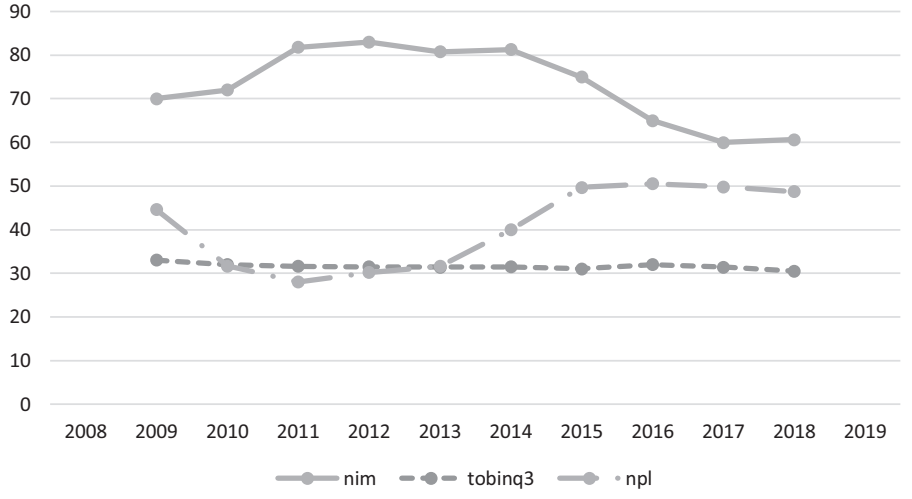

Figure 15.9 NIM, NPL and Tobing trend

As can be seen from the figures, performance indicators in these ten years generally show an upward trend. In particular, comprehensive performance indicators YSA show a clear upward trend. COI is presenting a downward trend. The next thing we need to analyze is, which factors contribute to the improvement of performance? In addition to traditional control variables, do FinTech variables have a significant impact on performance improvement?

In the panel data regression model, we can see whether the estimated slope parameter is significant or not to determine whether the variable has a significant impact on the performance variable. However, other machine learning algorithms, such as decision trees and random forests, do not have such parameters, but we have feature importance index to replace them. Next, we will report the estimation results of these two methods separately.

5.3.1 YSA

We select random forest and panel data regression to do an empirical test, and the estimated results of these two methods are shown in Table 15.6.

These two methods have reached entirely consistent conclusions: two variables, Patent and Reference, have a significant impact on performance. The random forest method shows that the Patent variable's importance coefficient is as high as 0.2136, ranking first in the FinTech indicators collected by hand, followed by Reference, and the variable importance coefficient value is 0.02279 ranking second. In the panel data regression, in the FinTech indicators, the regression coefficients are also the two parameters of Patent and Reference. Among them, Patent and Performance show a significant negative correlation at the level of 1%. Moreover, there is a significant positive correlation between Reference and performance at the level of 10%.

The patent is negatively correlated with performance. The reason may be that the more the bank's R&D investment in the current year, the less profit retained, resulting in poor performance on the balance sheet. This causality can be understood as the "crowding-out effect" of financial technology investment on the performance of this year.

Reference is significantly and positively correlated with annual performance, indicating that the more banks value financial technology, the better their performance level. It shows that the use of financial technology can improve the overall performance level of banks as a whole.

Table 15.6 Estimated results

Dependent variable: YSA

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	-0.6729996	-0.66	0.511	0.008597
RDRATIO	19.8847	1.28	0.202	0.019575
PATENT	**-0.0188174*** **	**-3.01**	**0.003**	**0.213562**
PATENTAPPLI	-0.0130638	-1.41	0.158	0.006177
PATENTAPPR	0.0176839	0.9	0.369	0.003517
REFERENCE	**0.1156362***	**1.88**	**0.061**	**0.022792**
TOPSH1	-0.0525195	-0.53	0.596	0.03958
EQUBALANCE	-0.2830481	-0.6	0.55	0.031407
REMASH	320.1504	0.82	0.412	0.420498
INSTRATIO	-0.0329783	-0.72	0.471	0.026796
LNASSET	4.754609	3.32	0.001	0.037991
LIAGE	0.0034352	0.49	0.625	0.070703
AGE	0.0664575	0.25	0.801	0.065703
GDPGROWRATIO	-211.7955	-3.13	0.002	0.033101
CONS	-75.60268	-1.97	0.049	

Note: *, **, *** indicate that they are significant at the statistical level of 10%, 5% and 1%

5.3.2 NIR

Using random forest and panel data regression, the estimated results of these two methods are shown in Table 15.7.

Two methods have reached a consistent conclusion: the two variables of Patent and Reference have a significant effect on NIR.

The random forest method shows that the importance of the parameter of Patent is as high as 0.0569, ranking first in the FinTech indicators collected by hand; followed by Reference, the importance value of the parameter is 0.0503, ranking second. In panel data regression, the FinTech indicators with significant regression coefficients are also Patent and Reference. Among them, Patent and performance are significantly negatively correlated at 5%, and Reference and performance are significantly positively correlated at 1%.

The reason for the negative correlation between Patent and NIR may be that the more the bank's R&D investment in the year, the less the balance of the year's income; that is, the more patents held, the lower the proportion of the non-interest income of the company that year.

The frequency of FinTech mentions in the bank's annual report is significantly positively correlated with NIR, indicating that the higher the bank's emphasis on FinTech, the higher the bank's NIR level.

Table 15.7 Estimated results

Dependent variable: NIR

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	−1.448744	−1.26	0.206	0.002377
RDRATIO	32.65712	1.68	0.093	0.020337
PATENT	**−0.0172059****	**−2.42**	**0.016**	**0.056971**
PATENTAPPLI	−0.0149355	−1.45	0.148	0.005916
PATENTAPPR	0.0229227	1.04	0.3	0.073153
REFERENCE	**0.2015912*****	**2.88**	**0.004**	**0.050395**
TOPSH1	−0.0776292	−0.7	0.486	0.029528
EQUBALANCE	−0.9340709	−1.75	0.08	0.042289
REMASH	364.9882	0.81	0.42	0.319796
INSTRATIO	−0.031943	−0.61	0.54	0.029645
LNASSET	2.305395	1.35	0.176	0.14192
LIAGE	−0.0058377	−0.67	0.501	0.085765
AGE	0.7286498	2.23	0.026	0.076201
GDPGROWRATIO	−240.9308	−3.08	0.002	0.065707
CONS	−34.54667	−0.76	0.448	

Note: *, **, *** indicate that they are significant at the statistical level of 10%, 5% and 1%

5.3.3 NIM

Table 15.8 Estimated results

Dependent variable: NIM

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	−0.0209919	−0.44	0.661	0.009958
RDRATIO	**4.610713****	**2.59**	**0.012**	**0.019388**
PATENT	−0.0000595	−0.19	0.853	0.024825
PATENTAPPLI	0.0003343	0.78	0.439	0.011212
PATENTAPPR	−0.0003021	−0.32	0.749	0.011498
REFERENCE	−0.0041497	−1.24	0.218	0.030237
TOPSH1	0.0028604	0.6	0.552	0.107041
EQUBALANCE	0.0298987	1.22	0.225	0.023227
REMASH	103.7619	3.74	0	0.062636
INSTRATIO	−0.0013265	−0.57	0.569	0.061579
LNASSET	0.6083163	2.97	0.004	0.373815
LIAGE	−0.2176	−5.15	0	0.077731
AGE	0			0.095059
GDPGROWRATIO	0.0873765	0.02	0.985	0.091794
CONS	50.95965	5.89	0	

Note: *, **, *** indicate that they are significant at the statistical level of 10%, 5% and 1%

5.3.4 COI

Table 15.9 Estimated results

Dependent variable: COI

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	0.8662273	1.94	0.056	0.006178
RDRATIO	**0.1054267*****	**0.01**	**0.995**	**0.044165**
PATENT	0.0040077	1.34	0.185	0.029528
PATENTAPPLI	**0.0075419***	**1.88**	**0.065**	**0.01467**
PATENTAPPR	−0.0096197	−1.1	0.278	0.009667
REFERENCE	0.0403811	1.29	0.201	0.015697
TOPSH1	−0.0120983	−0.27	0.788	0.075648
EQUBALANCE	−0.1575275	−0.69	0.493	0.06631
REMASH	−811.815	−3.13	0.003	0.056927
INSTRATIO	0.0389501	1.8	0.077	0.063204
LNASSET	−2.780474	−1.45	0.152	0.16438
LIAGE	−0.0499042	−0.13	0.9	0.147587
AGE	0			0.077547
GDPGROWRATIO	56.00522	1.25	0.214	0.228491
CONS	124.9441	1.54	0.128	

Note: *, **, *** indicate that they are significant at the statistical level of 10%, 5% and 1%

Both panel data regression and random forest algorithms show that the proportion of R&D personnel in RD-ratio has a significant impact on COI. In the random forest, the variable importance coefficient of R&D personnel accounted for RD-ratio is as high as 0.04416; in the panel data regression method, the most significant variable of the regression coefficient is the R&D personnel ratio Rd-ratio, and it is significant at the level of 1%; this means the higher the proportion of R&D personnel, the higher the cost-to-income ratio. In other words, the more R&D personnel in the current period, the more R&D investment, the higher the current cost ratio.

5.3.5 ROE

In the random forest algorithm, the variables with the highest importance coefficients are the ratio of R&D personnel ratio and the frequency of recruiting scientific research personnel by the head office, which is 0.02226 and 0.01949, respectively, indicating that these two variables have a significant impact on the ROE of the bank's net asset return.

The panel data regression method shows that the ratio of R&D personnel and the frequency of the head office's recruitment of scientific researchers are positively related to the ROE. The P-value of the coefficient is around 0.15, which is close to significant.

The higher the RD-ratio of R&D personnel, the higher the ROE of the bank's net asset return. The reason is that the more R&D personnel in the bank, the higher the efficiency of the bank's use of FinTech, and the higher the bank's performance.

The higher the frequency of recruiting scientific research personnel at the head office, the higher the ROE of the bank's net asset return. The reason is that the more frequently the bank recruits scientific research personnel, indicating that the higher the bank's demand for FinTech and the more widely used, the higher the bank's performance.

Table 15.10 Estimated results

Dependent variable: ROE

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	**0.6744212**	**1.46**	**0.149**	**0.022268**
RDRATIO	**24.03301**	**1.4**	**0.168**	**0.019494**
PATENT	−0.0005142	−0.17	0.869	0.008156
PATENTAPPLI	0.0022915	0.55	0.584	0.004146
PATENTAPPR	0.0001212	0.01	0.989	0.004589
REFERENCE	0.0119105	0.37	0.714	0.01785
TOPSH1	0.0063106	0.14	0.892	0.072589
EQUBALANCE	0.1845853	0.78	0.438	0.06331
REMASH	167.6799	0.62	0.535	0.105834
INSTRATIO	−0.0121708	−0.54	0.589	0.027937
LNASSET	8.571306	4.32	0	0.061702
LIAGE	−2.448474	−5.98	0	0.063457
AGE	0			0.069413
GDPGROWRATIO	−44.39731	−0.96	0.341	0.459254
CONS	528.5571	6.3	0	

Note: ⋆, ⋆⋆, ⋆⋆⋆ indicate that they are significant at the statistical level of 10%, 5% and 1%

5.3.6 NPL

Table 15.11 Estimated results

Dependent variable: NPL

	Method1: Panel data regression			*Method2: Random forest*
Independent variable	*coefficient*	*T value*	*P value*	*importance*
FREQUENCY	−0.0756589	−1.03	0.307	0.002707
RDRATIO	**−6.172558****	**−2.25**	**0.028**	**0.042305**
PATENT	−0.0005939	−1.2	0.233	0.011803
PATENTAPPLI	−0.0004087	−0.62	0.54	0.005929
PATENTAPPR	0.0006613	0.46	0.65	0.007343
REFERENCE	**−0.006217**	**−1.21**	**0.232**	**0.015505**
TOPSH1	0.0060346	0.82	0.417	0.045288
EQUBALANCE	0.055987	1.49	0.142	0.019963
REMASH	−29.50174	−0.69	0.493	0.091174
INSTRATIO	0.0017284	0.48	0.63	0.011791
LNASSET	−1.108338	−3.51	0.001	0.115815
LIAGE	0.2754945	4.22	0	0.078407
AGE	0			0.217736
GDPGROWRATIO	−11.32525	−1.54	0.129	0.334234
CONS	−50.92592	−3.81	0	

Note: *, **, *** indicate that they are significant at the statistical level of 10%, 5% and 1%

The random forest algorithm shows that the highest importance is the ratio of R&D personnel and the frequency of mention, which are 0.04230 and 0.0155, respectively, indicating that these two variables significantly impact the bank's NPL ratio.

In the panel data regression model, the two variables of R&D personnel ratio RD-ratio and reference are negatively correlated with NPL. Among them, the ratio of R&D personnel and RD-ratio are negatively correlated with the NPL ratio at 1% significantly. The correlation between Reference and NPL ratio is negative, but it is not significant enough.

The higher the RD-ratio of R&D personnel, the lower the NPL of the bank. Because the more R&D personnel in the bank, the efficiency of the bank's use of FinTech will raise to a certain extent, and the corresponding bank's risk management level will also be improved, and the bank's bad loan rate will decline, reflecting the use of FinTech can reduce the risk of banks.

In summary, the three variables RD-ratio, Reference and Frequency will substantially affect the performance of banks.

5.4 Empirical conclusion

Based on the above research results, we can draw the following conclusions.

(1) The frequency of mentioning FinTech keywords mentioned in the bank's annual report is significantly and positively correlated with the overall performance. This conclusion reveals that the more the bank attaches importance to FinTech and the higher the frequency

of use, the higher the bank's performance level. It means that the use of financial technology can improve the bank's overall performance level as a whole.

(2) The frequency of mentioning FinTech keywords in the bank's annual report is significantly and positively related to the proportion of non-interest income, indicating that the more banks value FinTech and the higher the technology penetration, the higher the percentage of the non-interest income of banks will be. This confirms that the application of FinTech can increase the proportion of banks' non-interest income.

(3) The higher the RD-ratio of R&D personnel, the higher the ROE of the Bank. The higher the frequency of the head office's recruitment of scientific researchers, the higher the ROE the bank has. The results show that the higher the bank's acceptance of FinTech, the better the bank's performance.

(4) The higher the proportion of R&D personnel in the RD-ratio, the lower the bank's NPL ratio. The higher the frequency of FinTech keywords mentioned in the annual report (reference), the lower the NPL ratio of the bank is. It shows that the more banks apply FinTech, the higher their risk management level will be, and the lower their non-performing loan ratio will be, which proves that the use of FinTech will reduce the risk of banks.

In general, the innovative development of FinTech is under the combined action of a series of factors such as digital technology advancement, strong financial demand, changes in customer perception, and regulatory tolerance environment. The emergence of FinTech has brought a certain degree of competitive pressure to traditional banks, but the collision of traditional banks and FinTech also accelerates the realization of mutual benefit. According to the current status of FinTech innovation in Chinese banks, both large banks and small and medium-sized banks are adding strength in the development of FinTech. From the results of empirical analysis, the use of FinTech does improve the comprehensive performance level of banks and reduces the risks of banks.

6 Conclusions

Under the background of technological revolution and financial industry reforms, information technologies represented by artificial intelligence, blockchains, cloud computing, and big data are gradually integrating with financial services, injecting a steady vitality into the development of the financial industry. This revolution has also brought tremendous change to the product form, business service mode and business process of financial institutions, thus promoting the digitization and intellectualization of financial services. In this context, it is of practical significance to study the development strategy, business model, application status and transformation results of China's banking industry

This chapter makes a systematic review and inventory of what FinTech is, in terms of industry development, industry scale, business model, typical enterprises, practical effect and other aspects. Two leading banks that use FinTech – Agricultural Bank of China and WeBank – have been selected for case analysis. After the empirical analysis of the data of China's listed banks in the past ten years, we found evidence that the application of FinTech can improve the performance of commercial banks.

However, in the process of digital transformation, commercial banks are subject to their past business habits, and still need to face the challenges of strategic culture, organizational system and technology reserve. The reasons leading to these problems can be divided into four areas. First, the strategic culture is not open enough. In the past, most commercial banks relied on physical branches to carry out business, resulting in limited business boundaries. In addition, the banks' internal strategic deployment tends to be closed, and the emergence of

financial technology has shaken the position of the traditional banking industry. Therefore, if traditional banks want to survive in this wave, they face the problem of physical branch transformation. Second, the internal organization structure of the banks stick to administration, which means banks are not agile enough in organizational transformation. At present, most commercial banks adopt a "top-down" multi-level organizational management structure, while the banking technology department is subordinate to the back-end department, and its management authority is usually not high. Unlike the brand-new WeBank, which has no branches and front-end technical departments, more than 50% of the staff structure is technical personnel. However, it is a very common phenomenon that there is a shortage of FinTech talents inside traditional banks. Thus, it is difficult for traditional banks to use sufficient human resources and obtain top-level authorization to carry out financial technology innovation. Third, the banks headquarters' incentive policies for financial innovation are limited. Traditional banks' incentive policies are mainly in favor of the bank counter operation, because this can directly bring profits to the branches, while the short-term performance of FinTech innovation is not obvious, resulting in low enthusiasm for branch managers. Lastly, insufficient attention is paid to the mastery and development ability of underlying technology by banks. In the past, the banking industry tended to adopt "take-ism", usually focusing on direct procurement of systems and services, and so it did not pay special attention to underlying technologies. With the ever-increasing degree of closeness between the economy and the Internet, the impact of FinTech on traditional banks will continue to ascend, which also means that commercial banks still have great room for development in the application of FinTech. Whereas, due to the low-risk nature of the bank itself, the long-held business philosophy and risk appetite cannot be reversed in a short time, and the various problems will be encountered in the process of transformation. This means that commercial banks still have a long way to go in the development of FinTech.

Notes

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2 Speech by Daohe Lu, Head of Infrastructure Products Department of WeBank, at the 2016 China Industrial Internet Conference.

3 The "Gyro Evaluation System" contains nine evaluation dimensions: governance, yield sustainability, risk control, operational management, service quality, competitiveness, organizational intellectualization, personnel competence, equity funding.

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