Contributions to Finance and Accounting

Zhigang Qiu
Xiaolin Huo
Yue Dai

Fintech and Financial Risk in China

Springer

Contributions to Finance and Accounting

The book series ‘Contributions to Finance and Accounting’ features the latest research from research areas like financial management, investment, capital markets, financial institutions, FinTech and financial innovation, accounting methods and standards, reporting, and corporate governance, among others. Books published in this series are primarily monographs and edited volumes that present new research results, both theoretical and empirical, on a clearly defined topic. All books are published in print and digital formats and disseminated globally.

More information about this series at https://link.springer.com/bookseries/16616

Zhigang Qiu • Xiaolin Huo • Yue Dai

Fintech and Financial Risk in China

Springer

Zhigang Qiu
School of Finance
Renmin University of China
Beijing, China

Xiaolin Huo
School of Finance
Renmin University of China
Beijing, China

Yue Dai
School of Finance
Renmin University of China
Beijing, China

ISSN 2730-6038 ISSN 2730-6046 (electronic)
Contributions to Finance and Accounting
ISBN 978-981-19-0287-1 ISBN 978-981-19-0288-8 (eBook)
https://doi.org/10.1007/978-981-19-0288-8

Contents

About the Authors

Zhigang Qiu is the associate professor at School of Finance, Renmin University of China. He obtained his PhD from the London School of Economics and Political Science in the UK. His main research interests are delegated portfolio management, asset pricing theory, and FinTech. He has published his work in leading academic journals such as the *Journal of Economic Theory*, the *Journal of Financial and Quantitative Analysis* (single author), and the *Journal of Banking and Finance*.

Xiaolin Huo is a PhD student of finance at School of Finance, Renmin University of China. Her main research interests are empirical asset pricing and FinTech.

Yue Dai is a PhD student of finance at School of Finance, Renmin University of China, whose main research interest is empirical asset pricing.

Chapter 1
The Development of FinTech in China

In the last decade, FinTech is probably one of the hottest industries in the world, which also has a rapid development worldwide. As an innovation for finance, FinTech can undoubtedly bring subversive changes to the finance industry, but at the same time, it also produces various risks. The FinTech development in China is in a leading position in the world, but FinTech industry in China is also well known for unregulated and speculative market, which brings huge risks for investors. The coexistence of both financial innovation and risks has attracted attention from both academia and policy makers, so this field needs future thinking and research. This book focuses on China' market and takes the development of FinTech and its accompanying risks as the main object, analyzing and discussing the economic principles of the development of FinTech. In the first chapter of the book, we give an overview of the development of FinTech industry in China.

1.1 Overview of FinTech in China

In this section, we first give the definition of FinTech, and then discuss the two main phases of FinTech development in China.

1.1.1 Fintech: New Technology and Financial Services

FinTech is the abbreviation of financial technology, which is composed of both financial services and new technologies. The Financial Stability Board (FSB) defines FinTech as technological innovation that can create new business models, applications, processes, or products in various fields in finance. New technologies include artificial intelligence (AI), Blockchain, Cloud Computing, Big Data (also referred to as "ABCD"), which can be applied into payment, financing, investing, insurance,

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_1

Table 1.1 New technologies and financial application

	Subdivision technology	Financial application
AI	Facial recognition	Financial account security
	Voice recognition	Intelligent customer service
	OCR	Document and bill processing
	Machine learning	Robo-advisor
Blockchain	Internet of things	Transaction in goods
	Distributed transfers accounting	Cryptocurrency
Cloud computing	Data storage	User database
	Computing capability	
Big data	User portrait	Product recommendation
	Credit reporting	Automatic credit rating

and regulation. Table 1.1 summarizes new technologies and their applications to various financial services.

In the view of this book, the core of FinTech is the big data dynamically generated in the development process of FinTech, which in turn promotes the rapid development of the industry. In fact, as shown in Table 1.1, new technologies are almost all related to big data. Although new technologies help big data generate great business values, the overuse of big data may violate the privacy of consumers.[1] Therefore, some new technologies, such as Edge Computing, Federal Learning (referred to as "EF") are developed rapidly and are applied to crypto computing with privacy protection for big data. Generally speaking, FinTech is the development of the applications of big data and new data technology in the finance industry.

1.1.2 Differentiate Internet Finance and FinTech

In the last decade, China has become a world leading FinTech innovation center, with the highest FinTech adoption rate in the world (Ernest and Young 2019). We not only observe the emergence of international FinTech giants such as Alibaba, Tencent and JD, but also observe the development of global FinTech hubs such as Beijing, Shanghai, and Shenzhen. The development of FinTech in China is not plain sailing. In fact, before 2016, FinTech had another name, which called Internet finance, and the central government had high expectations for its development. However, due to the frequent bankruptcy of P2P platforms, especially the case of E Zu Bao, the name of "Internet finance" is rarely mentioned.[2] Therefore, people start to use the name FinTech instead.

Internet finance refers to the extension of the traditional financial business models by internet-based technology, and it is also regarded as the first stage of FinTech

[1] We will discuss this point in more details in the subsequent chapters.

[2] The Chinese name of E Zu Bao is "E租宝", and we will discuss this case in Chap. 3.

development. The models of Internet finance include third-party payment, peer-to-peer (P2P) lending, crowdfunding, Internet insurance and intelligent investment adviser. In terms of scale, third-party payment system and P2P lending platforms are the most prominent models. Third-party payment system is the starting point for the online business activities and can be seen as the infrastructure to collect big data, which has a positive effect on the development of FinTech. However, P2P lending has proved to be a failure and even terminated the name of Internet finance.

Although we do not mention the name of Internet finance anymore, it is the predecessor of FinTech. In fact, Internet finance is a major trial and error stage for the development of FinTech. During the development stage of Internet finance, Ali pay developed by Alibaba and WePay developed by Tencent have become the largest third-party payment systems in China. New business models and online social activities supported by third-party payment system have generated a large amount of data and created great business values. FinTech takes one step further and extends Internet-based technologies to more intelligent technologies for data analysis, which further promotes new business models and new financial products.

China's financial technology is globally representative. A large amount of evidence shows that China has always been in the forefront of the world in terms of FinTech adoption, the number of FinTech start-ups and the competitiveness of FinTech giants (Ernest and Young 2019; AIF 2020). The fast development of FinTech in China also raises several research questions. First, why does FinTech develop so fast in China? The business models of Alibaba's Taobao and Ali pay are not new. We observe similar model such as E-Bay and PayPal in the United States much earlier but with a relatively low speed of development. Second, what is the essence of rapid FinTech development in China? Is it different from that in other countries? Third, financial innovation usually covers customers that cannot be covered by the traditional financial system. In particular, financial innovations often solve the existing problems in the traditional finance system (e.g., asymmetric information). Then how does FinTech solve the problems in China? This book aims to answer the above questions. At the same time, in this chapter, we first provide a comprehensive introduction of the development of FinTech in China.

1.2 Development of FinTech in China

In this section, we discuss in detail the development of fintech at different stages in China, with a global comparison the development of different countries.

1.2.1 Computerized Finance (1980–2000)

IT Technology has Brought the Change

The era of computerized finance starts in the 1980s, which is the budding period of FinTech. At this stage, IT technology is used to realize the computerization and automation of financial business, so as to improve business efficiency. Typical examples include the computerization of bank accounting system, credit system and clearing system, as well as the establishment of ATM and POS machines. Computerized financial business has promoted a great change in finance industry. From then on, people can get rid of manual accounting and abacus. In the stage of computerized finance, the development relies on the technology of computers, and the traditional finance models do not have too many changes. Therefore, the key to financial computerization is to improve the efficiency of financial services.

1.2.2 Internet Finance (2000–2015)

A Rapid But Brutal Growth

Since the twenty-first century, with the popularity of the Internet and mobile phones, the Internet finance era has gradually formed. During this period, financial institutions begin to establish online business platforms to collect user information through the Internet or mobile phones terminals. The establishment of third-party payment system supports online business activities, leaving a large amount of data. Based on these data, new financial models are established, and the Internet finance stage begins. In this stage, Internet finance is essentially a transformation of sales channels of financial products. The most representative business forms include third-party payment system, P2P loans, crowdfunding, etc.

The year of 2013 is known as "the year of Internet finance" in which Ali pay proposes the on-line wealth management product, Yu E Bao, linking the funds in the third-party payment (Ali pay) accounts to the money market funds.[3] Therefore, a new financial model different from the traditional banking system comes into being. Since then, China's Internet finance has developed rapidly, and various new financial models have emerged one after another, from third-party payment, P2P lending, and crowdfunding to other businesses. From 2013 to 2015, Zhong An Insurance, the first Internet insurance company and WeBank, the first Internet bank are established in the FinTech industry in China, respectively. Moreover, there has been explosive growth in P2P industry, which finally becomes hidden dangers in the development of FinTech industry.

[3]The Chinese name is called "余额宝".

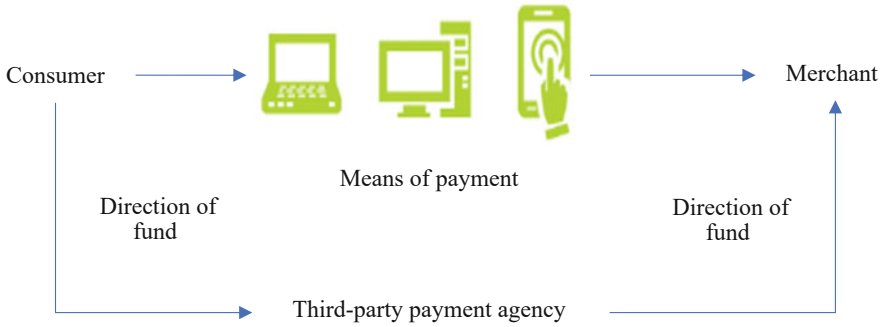


Fig. 1.1 Payment structure of third-party payment

1.2.2.1 Models of Internet Finance

The name of Internet finance is rarely mentioned nowadays, but we still discuss its various models in this subsection. Nonetheless, those models are part of FinTech development.

Third-Party Payment

Third party payment is one of the typical applications of Internet finance, which refers to an independent institution or commercial bank that provides consumers with a transaction payment platform. It is divided into Internet payment and mobile payment. The transaction process of third-party payment is illustrated in Fig. 1.1.

By definition, a third-party platform can only act as a transfer intermediary, such as Fast Money.[4] The initial development of third-party payment is only to provide a convenient payment service for platforms, such as Taobao. However, it finally competes with commercial banks. For example, to assist online transactions, the third-party payment can further provide credit guarantees for buyers and sellers in the online transactions, such as Alibaba, JD, etc. In this sense, the third-party payment plays the role of credit cards.

On May 18, 2011, the People's Bank of China officially issued the third-party payment license, and 27 companies obtained the licenses, marking the official beginning of the Internet financial era. Ali pay, originated to the transactions in Taobao platform, becomes a milestone of third-party payment in China. In order to solve the problem of asymmetric information in e-commerce transactions, Taobao launches Ali pay secured transactions, successfully attracting a large number of customers, and gave birth to the third-party payment system. Although Ali pay looks like Taobao's ancillary service, it soon becomes independent and was associated with many online and offline scenarios. In fact, Ali pay is everywhere in our daily

[4] A third party payment system with Chinese name "快钱".

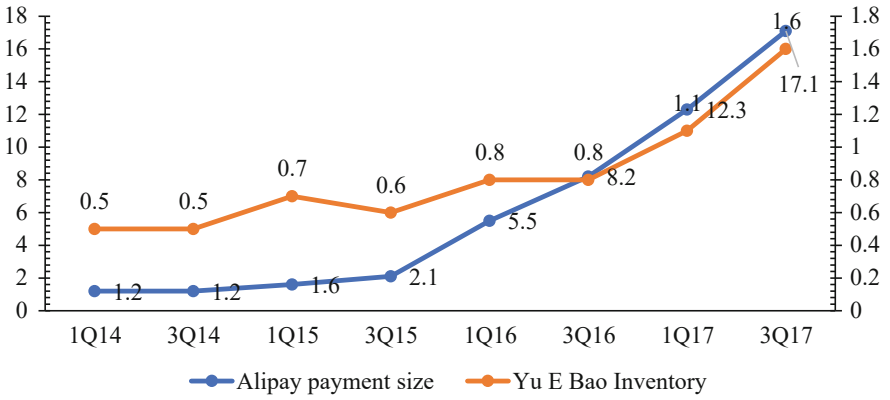


Fig. 1.2 Comparison of Alipay payment scale and Y E Bao holdings

life, from paying taxi, buying a drink to buying a car. In December 2013, "12306.cn" officially supported Ali pay's purchase of train tickets, and convenience stores across the country also supported Ali pay's use of bar code payment.

In 2013, Ali pay establishes important business partnerships with a number of companies to accelerate its profit growth. In particular, Ali pay cooperated with Tian Hong Fund, a medium size money market fund in China, to launch a new on-line wealth management product, Yu E Bao, in June 2013. The purpose of Yu E Bao is to provide value-added service to Alipay users (as shown in Fig. 1.2), but it turns out that Yu E Bao was competing with traditional banking services by enticing investors to transfer deposits from bank accounts to Yu E Bao accounts. In fact, the returns of Yu E Bao accounts are determined by the money demand and supply in the interbank market. If the returns of Yu E Bao accounts are very high, the investors would like to transfer their deposits from bank accounts to Yu E Bao accounts. If the deposit transfer is large, the banks may face liquidity needs and need to borrow in the interbank market. Their liquidity demands will push the returns even higher, resulting in more people to transfer their deposits to Yu E Bao. Therefore, there exists a feedback effect for Yu E Bao product. As a result, the existence of Yu E Bao urges traditional banks to provide similar wealth management products as Yu E Bao, which somehow changes the operation models of traditional banking system in China.

As we mentioned above, the original purpose of Yu E Bao is to support the development of Ali pay. Figure 1.2 shows the increasing trend of Ali pay users accompanying by the increase of Y E Bao users. Therefore, the service of Yu E Bao effectively increases the stickiness of Ali pay users. However, the unintended outcome this that the existence of Yu E Bao causes to a transfer of bank deposits.

Ali pay's success reveals the great benefits of the third-party payment system. In August 2013, Tencent launches a payment system based on WeChat, which soon becomes Ali pay's main competitor. Since then, third-party payments have grown rapidly. Figure 1.3 shows the overall trend of the third-party payment.

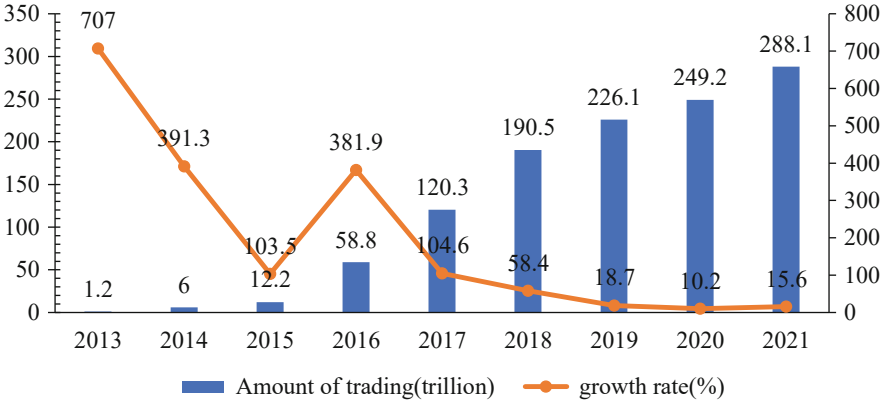


Fig. 1.3 Trends of third-party payment. Source: iResearch(“艾瑞咨询”) http://report.iresearch.cn/report_pdf.aspx?id=3360

Although Ali pay is one of the most successful third-party payment platforms in the world, it has a very similar business model to PayPal, an American third-party payment platform. PayPal, as the first mobile payment system, was founded by Elon Musk in 1998, but its speed and scale of development are far lower than that of Ali pay.

Peer-to-Peer Lending

P2P companies establish online lending platforms to provide a large amount of verified user information so that lenders and borrowers can quickly match with appropriate counterparties. In 2007, China’s first P2P online lending platform, Pai Pai Dai, was established. The development of P2P industry has accelerated since 2012, during which many large P2P companies have emerged. For example, Yi Ren Taiwan was established in 2012, Ping An Lufax went online in 2014, and Xiao Mi officially entered the P2P industry by investing in Ji Mu He Zi in 2014. Moreover, Alibaba, as the leader in the FinTech industry, officially established its P2P subsidiary, Zhao Cai Bao, in 2014. As shown in Fig. 1.4, by the end of 2015, P2P industry achieved its peak at 3464 platforms.

By definition, a P2P platform should be a pure information intermediary and should not involve any businesses between borrowers and lenders. However, most of platforms do not satisfy the definition of information intermediary. As a result, many platforms go bankrupt, and the number of P2P platforms decreases after 2015. Although P2P platforms are called innovations, their development brings great risks. We will discuss more about P2P risk in Chap. 3.

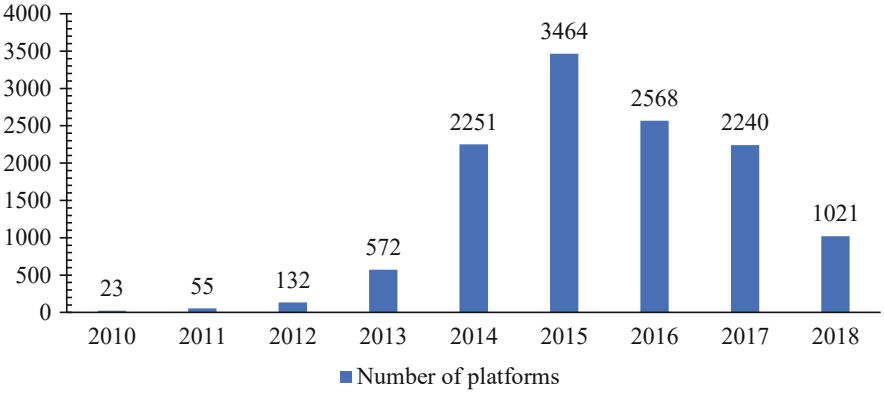


Fig. 1.4 Numbers of P2P platforms. Source: WDZJ-OFFICIAL("网贷之家") https://www.wdzj.com/news/yc/3719709.html

Crowdfunding

Crowdfunding originated from the slogan of "let's realize our dreams together". Normally, crowdfunding uses the Internet to raise funds for certain purposes and then completes a task with investments from a large number of individuals. Funds raised via crowdfunding are used to support various activities, normally including disaster reconstruction, election campaigns, entrepreneurship fund-raising, artistic creation, free software, design and invention, scientific research, and public projects. Originally, crowdfunding is a means for struggling artists to raise funds for their creation, and soon becomes a channel for start-ups and individuals to strive for funds for their own projects. The rise of crowdfunding stems from the American website Kick Starter, which raises funds from the public by building an online platform so that creative artists can get the funds they need.

Crowdfunding in China also develops fast. In 2010, China's first crowdfunding platform Call Time was established. In July 2014, JD Crowdfunding appeared, formed a "product+equity" mixed model, opening a new stage of Crowdfunding in China. In fact, crowdfunding was supported by the central government. The executive meeting of the State Council held in November 2014 first proposed relevant plans to support the crowdfunding industry. In 2015, the total amount of funds in Chinese crowdfunding industry were around 1.2 billion RMB, in which 60% of market shares are equity-based crowdfunding, with 17 projects with over ten million, and about 200 projects with several millions or above. Figure 1.5 shows the development of crowdfunding in China in terms of total asset under management.

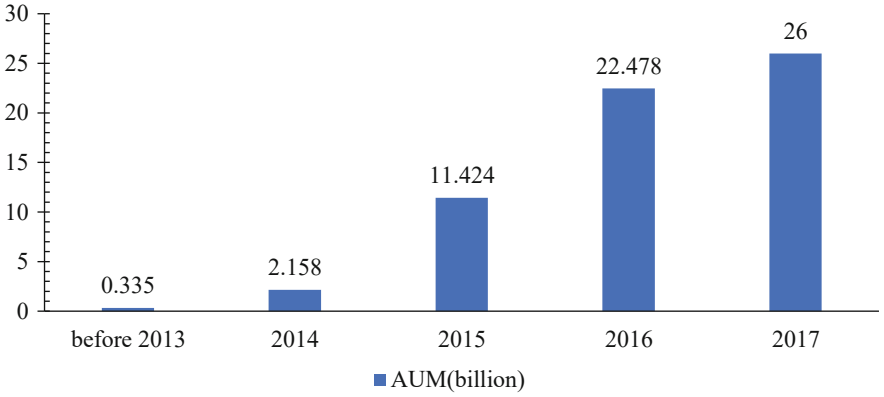


Fig. 1.5 AUM of crowdfunding. Source: Zhongchoujia("众筹家") http://www.zhongchoujia.com/data/30373.html

Consumption Finance

Traditional consumption finance is a modern financial service that provides consumption-based loans to consumers at all levels. In the context of Internet finance, the consumption-based loans can be issued based on the on-line consumption activities and big data. With the advantage of big data, two Internet giants, Alibaba and JD, launched their consumer finance products independently. In 2014, JD launched JD Bai Tiao in its online platform, and in April 2015, the personal credit product "Hua Bei" was also officially launched. These consumption-related loans were widely used by both merchants and consumers. Within half a month, more than 1.5 million merchants had opened their Hua Bei accounts.

The new consumption finance products differentiate from traditional credit card system by their applications of big data. For credit cards, users need to fill in the application forms and provide their information passively, and credit card companies only issue credit cards to those who have sound credit records. However, products like Bai Tiao and Hua Bei actively collect information from customers' on-line business activities, which provides more information based on big data. Moreover, Alibaba and JD use ABS models to raise money for users of Bai Tiao and Hua Bei. Because those consumption finance products are effective debt products, so ABS models from Alibaba and JD are essentially selling the cash flows of debt contracts to other investors. Since many borrowers of Bai Tiao and Hua Bei are young and have no stable incomes, there may be certain related risks if the magnitude of total ABS products becomes large.

Internet Insurance

Internet insurance is a new insurance marketing model based on Internet, which is different from the traditional insurance agent marketing model. Internet insurance refers to the economic behaviors of insurance companies or new third-party insurance networks to use Internet technology as tools to support the operation and management activities of insurance. In general, the on-line platform should cover the whole process of insurance information consultation, insurance plan design, payment, underwriting, insurance policy information query, preservation change, renewal payment, claim settlement and insurance payment.

In September 2013, Ant Financial, Tencent, Ping An and other enterprises initiated the world's first Internet insurance company Zhong An Insurance, which is also a FinTech company. The whole business process of Zhong An Insurance is online, and there are no branches in China. It provides underwriting and claims settlement services completely through the Internet. Moreover, Zhong An Insurance also provides various new insurance products based on big data, such as Bu Bu Bao, which relies on the data collected from wearable sports devices designed by Xiao Mi sports.

Internet Banking

Internet banking is a virtual banking platform on the Internet, in which various banking services can be completed online. In fact, the definition of internet banking was first mentioned in 1997 during which China Merchants Bank opened its own website, ushering the era of " all in One Netcom" for financial electronic services. From 2014 to 2015, leading by two Internet giants, Ant Financial and Tencent, two internet banking companies were established. In December 2014, leading by Tencent, WeBank, China's first Internet bank, was launched by a number of well-known companies. Leading by Ant Financial, MYBank, the other important internet bank, was officially opened on June 25, 2015. MYBank is the first commercial bank whose core system is based on a cloud computing algorithm in China.

To sum up, Internet finance, as a new type of financial intermediary, takes the on-line network as the platform and has incomparable advantages in information transmission and capital transfer. Internet platform is a new financial sales channel, and together with third party payment system, generating various on-line business activities. As a result, big data are collected, and various new finance models are created based on big data. In some sense, Internet finance squeezes the commercial profits of traditional banks.

1.2.2.2 Drivers of the Development of Internet Finance

The rapid development of Internet Finance in China has attracted the attention of academia, especially compared with the development speed of developed countries.

Why does Internet finance work in China? What are the key drivers for the fast development? We try to answer those questions in this section.

Misallocation Between Economic Structure and Financial Structure

For the traditional finance system in China, there exist a misallocation between economic structure and finance structure. Figure 1.6 shows the allocation of finance services to different classes of customers, which has a pyramid shape. On the top of the pyramid, wealthy class, large SOEs and large financial institutions enjoy extra of finance service. After that, middle class and middle firms have enough services of finance. However, at the bottom of the pyramid, working class, small and medium firms, and famers either lack of or do not enjoy any finance services. Therefore, in China, many small customers have financial depression in the traditional financial system. Internet finance can provide financial services according to each user's online activities or big data, which can provide finance services to those small customers. Therefore, big data generated from the FinTech development effectively provide some collaterals of credit to small customers, which can help them obtain new finance services. We will have more discussion on this issue in Chap. 6.

Strong User Base

Rapid development of Internet technologies built up the infrastructure, which attracts huge number of users for Internet finance. According to CNNIC, in 1998, only 119 thousand people have internet access, while in 2012, China itself has more than 500 million netizens, and 99.7% percent of them have mobile phones (Fig. 1.7). FinTech benefits from the Internet growth because the on-line platform brings a huge

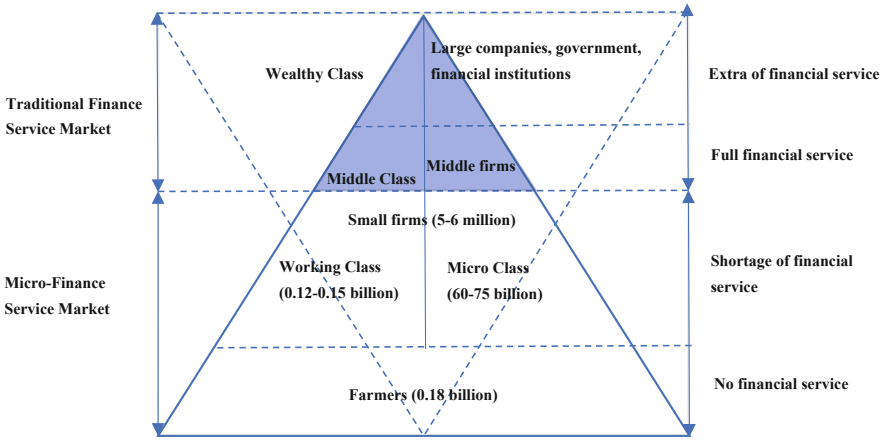


Fig. 1.6 Allocation of finance services to different classes of customers

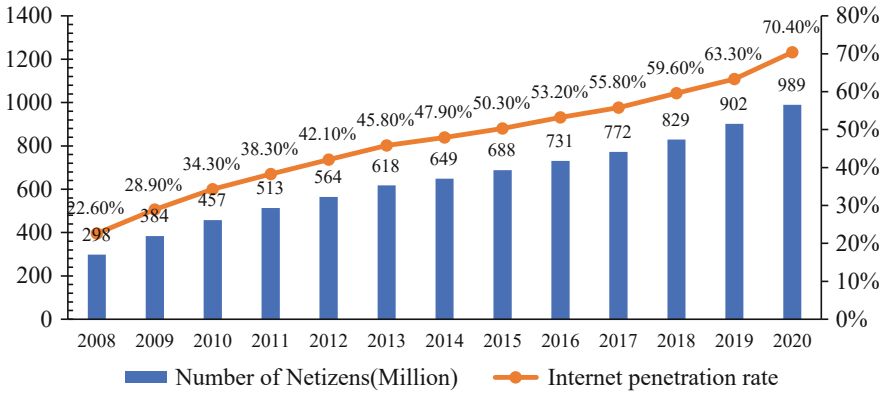


Fig. 1.7 The growth trend of Chinese internet penetration rate and number of netizens. Source: China Internet Network Information Center (CNNIC)

number of netizens who have strong user stickiness. In 2019, the utilization rate of internet finance in China reached 87% (Ernest and Young 2019), higher than the global average of 64%.

Neglect of Rivals

As competitors, traditional commercial banks do not pay enough attention to Internet finance, which also contributes to the rapid development of Internet finance. Traditional banks are the main competitors of these start-up Internet companies, but they do not make full use of big data and new technology. Although they do have plenty of credit data, such as loan records, they do not realize the necessity of fully using these data in their business. Moreover, working class, small and medium firms and famers are not the main customers for traditional banks because they do not have enough collaterals.[5] Therefore, this situation gives room for the growth of Internet finance industry in which Internet firms pay attention to big data and aim to provide financial services for small, medium and micro enterprises and individuals.

Government Support

The Chinese government strongly supports for "Internet+" entrepreneurship projects, and many obstacles have been circumvented in the initiation and development of Internet finance projects. In fact, the central government provides tolerant regulations to Internet finance firms at the early stage. For example, Ali pay was put into service in 2003, but the license of third-party payment was officially issued in 2011.

[5]The theoretical foundation of collateral will be discussed in Chap. 6.

The same thing happened in the development of offline QR code payment of third party payment system.

1.2.2.3 The Role of Big Data

In our opinion, big data is the core of Internet finance or FinTech. With the development of Internet technology, many platforms transfer the offline businesses to the online businesses, and the online business activities generate huge amount of data, so called big data. Moreover, with the development of data technology such as machine learning and artificial intelligence, some useful information can be extracted from the big data, which are not available for traditional finance system. In this sense, finance models related to big data can be regarded as financial innovations, and big data is also considered as the core of development of FinTech. Moreover, as we will discussed in Chap. 6, big data can also solve the problem of information asymmetry, such as moral hazard (Qiu et al. 2021).

Although we rarely mention the word of Internet finance nowadays, it is an indispensable part of the development of FinTech, in which big data play an important role. First, transaction data can be used to predict the quality of products (Qiu et al. 2021), and properly sharing of data can bring the effects of scale (Jones and Tonetti 2020). Second, based on big data, the law of large numbers can form more accurate analysis results about risk control, which is of great significance for the probability of default and rare disasters in Internet banking and insurance. Third, the establishment of user portrait is conducive to the accurate delivery of advertising and products, which further improves sales efficiency and has "the economy of scale ". Finally, using algorism of big data can explore new customers and create cross business "scope effect" through information sharing between different platforms.

1.2.2.4 Creative Destruction

Schumpeter (1939) pointed out that the "new combination" brought by innovation often means the elimination of old organizations through competition, which is a kind of "creative destruction". In the period of Internet finance, the view that Internet finance subverts traditional finance was once very popular. It is believed that Internet finance, as a new business model, will squeeze a large number of industry profits and eventually replace traditional financial institutions.

It turns out that data competition plays an important role in the industrial organization. For traditional banks and Internet financial giants, they both have a large amount of data, but the former only has credit data, while the latter controls various consumption and behavior data. The efficiency of data collection and utilization determines the profit margin and competitiveness. We thus observe the fast development of Internet finance industry. However, once traditional banks have proper sources of data, the data advantage of Internet finance firms will vanish.

In addition, from the perspective of regulation, traditional financial institutions play an important role in the financial system and cannot be easily replaced. Traditional financial institutions are highly regulated because the central government wants to keep the financial system stable. Internet finance firms are less regulated, and some models even pose a threat to the stability of the financial system (e.g., P2P platforms). Therefore, if Internet finance is properly regulated, the creative destruction to traditional finance may disappear.

1.2.2.5 Risk of FinTech

In the early stage, FinTech industry is less regulated, and many illegal business models (also called innovative models) emerge. Those models, although risky, are difficult to identify and effectively regulate for several reasons. Firstly, the information dissemination on the Internet is anonymous and fast, which makes these activities highly hidden and difficult for regulators to find in time. Second, the definition of Internet finance was vague. For example, the boundary of private lending and illegal fund-raising was unclear, making it difficult to deal with every case. Third, the rules for data collection and disclosure are not standardized, which leads to malicious manipulation of data, violating the privacy of consumers. The lack of regulations leads to the continuous spread of financial risks, and the bankruptcy of P2P platforms after 2015 also affected the stability of the financial system. We will discuss the risks for P2P platforms in Chap. 3 in more details.

1.2.3 FinTech (2015.07 -)

Regulations and New Creations
After the stage of Internet finance, especially the bankruptcy wave of P2P platforms, the word of Internet finance is somehow abandoned, and the development comes into the stage of FinTech.

1.2.3.1 Regulations

Outbreak of Risk in Internet Finance

Although Internet finance industry develops very fast in the last decade, some unsuccessful models emerge, especially P2P platforms, which brings huge risk to millions of investors. Since 2015, the risk of P2P platform suddenly broke out. Among them, the “E Zu Bao” platform with a total capital of more than 74 billion RMB is suspected of illegally raising public fund, which is immediately investigated by the police, causing a significant shock within the whole industry. Subsequently,

other P2P platforms go bankrupt one after another, which attracted extensive attention of the society. We will discuss those cases in detail in Chap. 3.

Overall Regulations on Internet finance

At the early stage, we have relatively tolerant regulations for Internet finance, which promotes the development of the industry. Since July 2015, right after the case of "E Zu Bao", targeted Internet finance regulations have been issued. The government has formulated a detailed regulatory plan to better regulate Internet finance and reduce systemic risks.

On July 18, 2015, the People's Bank of China and other ten relevant ministries and commissions jointly issued the "Guidelines on Promoting the Healthy Development of Internet Finance", which officially defined the concept of Internet finance for the first time. The Guidelines establish the division of regulatory responsibilities for major forms of Internet finance, such as Internet payment, online lending, Internet fund sales, Internet insurance, Internet trust, and Internet consumption finance, and clearly define boundaries of these businesses. In August 2016, the "Interim Measures for the Management of Business Activities of Internet Lending Information Intermediaries" was issued, so the regulatory framework of the Internet finance industry had been basically established. On October 13, 2016, the general office of the State Council issued "the implementation plan for special rectification of Internet financial risks", which screened online lending, crowdfunding, insurance, third-party payment, and other businesses in a wide range of fields, aiming to encourage the rapid closure of the non-standard Internet platforms.

Regulations on P2P

Some regulations are targeted to P2P platforms, which prohibits P2P from absorbing public deposits, collecting funds to set up a capital pool, and providing any forms of guarantee for the lenders.[6] We summarize major regulations on P2P industry in the following Table 1.2.[7]

"Regtech"

In 2015, the UK Financial Conduct Authority (FCA) put forward the concept of regulatory technology, which mainly refers to the use of new technologies and new means to meet diversified regulatory requirements, mainly for financial institutions. In the same year, the Institute of International Finance (IFC) added regulatory

[6] In fact, there are 12 behaviors of P2P platforms that are defined as" risky" or "illegal".

[7] To make the regulations precise, we also leave the Chinese names of each regulation in Table 1.2.

Table 1.2 Major regulations on P2P industry

Date	Major regulations on P2P
August 2016	Interim measures for the Management of Business Activities of internet lending information intermediaries ("网络借贷信息中介机构业务活动暂行办法")
October 13, 2016	Implementation plan for special rectification of P2P network lending risks ("P2P 网络借贷风险专项整治工作实施方案")
	Carry out the implementation plan of asset management and cross-border financial business risk rectification through the internet ("通过互联网开展资产管理及跨界从事金融业务风险专项整治工作实施方案")
January, 2017	Guidelines for the depository and management of online lending funds ("网络借贷资金存管业务指引")
March, 2017	7 other laws from CBRC

technology to FinTech. Regulation plays a vital role in the development of FinTech industry. The term "regtech" emphasizes the role of technology for FinTech regulation. FinTech is an emerging industry, and most rules and consequences are not in common with traditional finance industries, which means that regulators should be familiar with these technologies first.

1.2.3.2 FinTech Stage

With stricter regulations, the FinTech industry has been cleaned up because of the existence of regulatory arbitrage. Some institutions mainly do traditional finance business, but because the policies of the FinTech are better, they are renamed as FinTech firms to avoid supervision and realize a regulatory arbitrage. The halt of the IPO of Ant Financial shows that the regulators need FinTech companies to really do the technology-based businesses. Therefore, any FinTech companies began to pay attention to technological innovations including artificial intelligence, blockchain, cloud computing and big data. Despite strict regulations, the government still strongly supports the development of FinTech. In 2017, FinTech was included in the 13th five-year national plan, entering the FinTech stage. Different from Internet finance state, FinTech stage has a strong focus on technology. In what follows, we discuss several widely applied technologies.

Artificial Intelligence

Artificial intelligence includes several aspects including machine learning, natural language processing, computer vision, speech recognition, and deep learning. Driven by these technologies, many businesses in the finance industry have been intelligently optimized. Artificial intelligence, blockchain, cloud computing and big data technologies are not isolated but interdependent. For example, big data can

Table 1.3 Firms in Intelligent risk management industry

Firm	Intellectual risk management System	Characteristics
Ant financial	Ant shield	AI technologies combined
NetEase financial	NetEase Beidou	AI technologies combined
JD finance	Compass	Specified modeling
Baidu finance	God disposes	Combined with big data
Lufax	KYC1.0/ KYC2.0	AI technologies combined
WeBank	Internet risk management	Internet banking specified
Suning finance	Bank-level risk control system	AI technologies combined
Phoenix finance	Intellectual risk management system of Phoenix	Consider full life circle of debt
Fox finance	Wind blade	Multi-dimension, full life circle of debt
Gomei finance	Water drop	AI technologies combined
Finance 360	Mystery	Combined with big data

support artificial intelligence technologies of machine learning and algorithm optimization, and cloud computing can provide powerful computing and storage capabilities for big data, significantly reducing operating costs. Moreover, blockchain can solve the problems of information leakage and data tampering, which are commonly observe for the applications of big data. We will discuss more about blockchain technology in Chap. 5.

Intelligent Risk Management

Intelligent risk management refers to the comprehensive use of several artificial intelligence technologies to build a credit risk control system and improve business efficiency. Intelligent risk management is the core technology of FinTech companies. Almost every large FinTech company has a unique intelligent risk management system. The intelligent risk management system is very efficient in loan approval. For example, Ant Financial proposes a "310" model of loan approval for small and micro customers, which are 3-min application, 1-second loan, and 0 manual review. Table 1.3 summarizes the various applications of Intelligent risk management by internet giants in China, and Fig. 1.8 presents the trend of the number of firms in Intelligent risk management industry.

Intelligent Investment Management /Robo-Advisor

Intelligent investment management or Robo-advisor refers to the use of specific algorithm models to provide automatic asset allocation for investors with different risk preferences and investment needs. Although intelligent investment management starts late in China, but it has a rapid development. For example, Rubik's Cube,

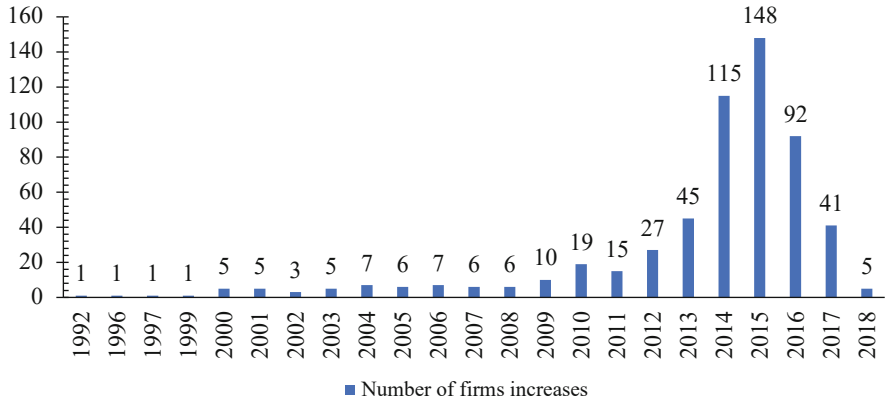


Fig. 1.8 Number of firms increased in Intelligent risk management industry. Source: iyiou research ("亿欧咨询") https://www.iyiou.com/research/20181130594

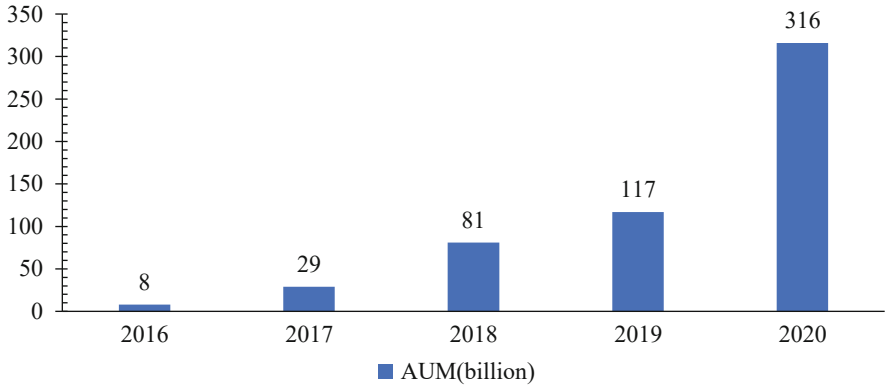


Fig. 1.9 AUM of intelligent asset management. Source: Accenture https://doc.mbalib.com/view/1062ee863fde1b5ebd4c6f80f199260b.html

China Merchants Bank, GF Securities, Harvest Fund and other institutions launch their own intelligent investment management products from 2015 to 2016. According to Accenture's estimation, in 2017, the asset management scale of China's intelligent investment management reached US $28.9 billion, with an annual growth rate of 261%. China's asset scale ranks second in the world after the United States. It is estimated that by 2022, the total assets under management of China's intelligent investment management will exceed 660 billion US dollars and the number of users will exceed 100 million. Figure 1.9 presents the trend of asset under management from 2016 to 2020.

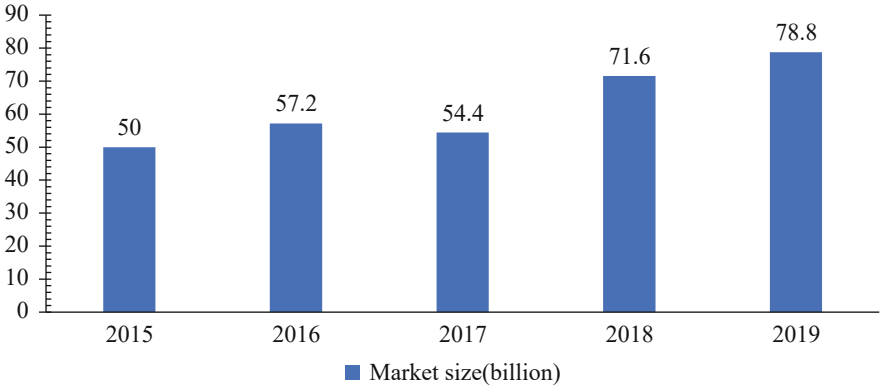


Fig. 1.10 market size of intelligent customer service industry. Source: Zhiyan Research("智研咨询") https://www.chyxx.com/industry/202102/928317.htmls

Intelligent Customer Service

Intelligent customer service refers to the technology that uses natural language processing technology (NLP) to automatically communicate with customers and provide customers with personalized services. As the first commercial field of NLP technology, the intelligent customer service industry has attracted many market participants. From traditional call center providers to SaaS cloud service companies and customer service robot companies, they are actively using artificial intelligence to enhance customer service capabilities. China's typical intelligent customer service suppliers are iFlytek, Far Pass Technology, NetEase Seven Fish, and Weier Technology.[8] Fig. 1.10 shows the trend of market size of intelligent customer service industry.

1.2.3.3 From "Internet Finance" to "Fintech"

Due to the impact of bankruptcy wave of P2P platforms and tightening regulatory attitude, the use of the term "Internet finance" gradually decreased after 2015, and then was replaced by the word "FinTech". Figure 1.11 presents the Baidu search index of the words "Internet finance" and "FinTech". Clearly, people are more interested in FinTech more recently.

Unlike Internet finance, which relies only on Internet technology, FinTech focuses on using more advanced data technology. At the Bo Ao Forum ("博鳌论坛") in 2017, Shengqiang CHEN, the CEO of JD Finance, pointed out that "Internet finance is actually an expansion of sales channels, and FinTech is a technological

[8]The Chinese names of those companies are iFlytek ("科大讯飞"), Far Pass Technology("远传科技"), NetEase Seven Fish("网易七鱼"), Weier Technology("微洱科技").

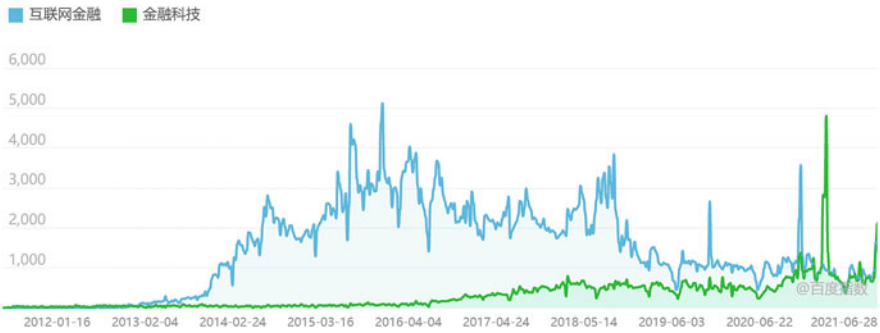


Fig. 1.11 Baidu Index of Internet finance and FinTech

revolution in using technology to design new financial products". In addition, compared with Internet finance, the target audience of FinTech business has also changed. Internet finance is customer oriented and is a B2C business model. However, FinTech companies focus on providing technical services to financial companies, which is a B2B2C model, emphasizing serving financial institutions first, and then consumers. As we mentioned before, Internet finance is a major trial and error stage of FinTech. Although we rarely mention the word of Internet finance nowadays, its development is crucial for the future development of FinTech.

1.3 Summary

With the development of Internet technology and popularity of smart mobile phones, China becomes a pioneer in global development of FinTech. Before 2015, less regulated policies and long-term financial repression with the traditional finance system led to the rapid development of Internet finance models such as third-party payment system and P2P platforms. The development Internet technology creates many on-line business activities, which in turn generates a large amount of data. Therefore, big data becomes the driving force of the development of FinTech, which complements to the traditional finance system. P2P online lending platforms are also the major form Internet finance or FinTech, but the frequent bankruptcy of the platforms makes the development of FinTech less optimistic, which even makes the name of Internet finance disappeared. Therefore, we move from the Internet stage to the FinTech stage. In the rest of the book, we will elaborate the topics on big data, P2P risks and blockchain technologies. Moreover, we will summarize the points of view from academia and provide a framework to link all those topics together.

References

AIF (2020) Global Fintech Hub Report. Available at: http://www.aif.zju.edu.cn/news/detail/1716.html

Ernest, Young (2019) Global FinTech Adoption Index. Available at: https://assets.ey.com/content/dam/ey-sites/eycom/en_gl/topics/banking-and-capital-markets/ey-global-fintech-adoption-index.pdf

Jones CI, Tonetti C (2020) Nonrivalry and the economics of data. Am Econ Rev 110(9):2819–2858

Qiu Z, Luo Y, Jiang Y, Wu C (2021) Is Fintech the gravedigger of traditional credit intermediaries? An economic analysis of credit based on big data. Stud Int Financ 8:35–45

Schumpeter JA (1939) Business cycles, vol 1. McGraw-Hill, New York, pp 161–174

Chapter 2
Introduction of Big Data, the Core of Fintech

> Many people do not yet figure out what the PC internet is, mobile internet comes, and do not figure out what the mobile internet is, big data come!
> ——Jack Ma

As we mentioned in Chap. 1, the core of the development of FinTech in China is big data. Under the traditional financial system, due to the misallocation of economic structure and financial structure, small and medium businesses and customers in China cannot enjoy enough finance services. With the emergence of Internet technology and smart mobile phones, Internet users have generated a large amount of data from the online business activities. The generated big data provides some new information and can be used as collateral for financial services. As mentioned by Jack Ma, the founder of Alibaba, we are in an era of big data. In this chapter, we give a brief introduction of big data.

2.1 The Development of Big Data

Big data is a concept that has evolved over time. As early as 1980s, Alvin Toffler, an American futurist first proposed the terminology of "big data" in his book《The Third Wave》. He enthusiastically praised big data as "the third wave of cadenza". In recent years, big data has become popular and attracted a lot of attention from both academia and policy makers. For example, in 2011, in a research report by McKinsey, "Big data" is defined as "the datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze."[1] In the report, McKinsey also pointed out that the era of big data has come.

[1] The research report is《Big data: The next frontier for innovation, competition, and productivity》.

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_2

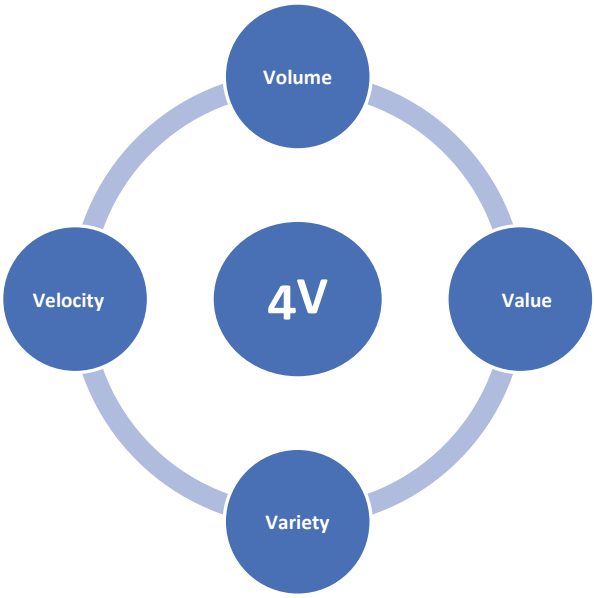


Fig. 2.1 The "4 V" characteristics of big data

In 2012, one of the bestsellers of big data, ⟪Big Data: A Revolution that will Transform How We Live, Work, and Think⟫, by Viktor Mayer-Schönberger has been published. In the book, the authors pointed out that the core of big data is prediction, and big data should focus on comprehensiveness and integrity, rather than analysis and utilization on small-scale data. Moreover, the authors describe the widely recognized characteristics of big data as "4 V": Volume, Velocity, Variety, and Value, respectively (as shown in Fig. 2.1). In 2012, UN Global Pulse also published a new White Paper, entitled "Big Data for Development: Challenges & Opportunities", which aims to serve as a reference for further reflection and discussion.

At the same time, academic journals also put forward unique opinions on big data technology (as shown in Fig. 2.2). In September 2008, Nature launched a cover column named⟪Big data: Science in the Petabyte Era⟫, and Science also published a special issues, ⟪Dealing with Data⟫, in 2011. Moreover, in April 2012, ERCIM news also published a special issue on big data. The progress of IT technology and the accumulation of massive data have laid the foundation for the wide application of big data.

As we discussed in Chap. 1, the year 2013 is known as "the year of Internet finance", but it is also called "the year of big data" by some media in China. The key driving force is the rapid growth of third-party payment, which is served as the infrastructure of big data collection (ss shown in Fig. 2.3). By the end of 2013, the number of mobile payment businesses has increased by more than 200%, and the

Fig. 2.2 The front cover of Nature and Science special issues

Fig. 2.3 The third-party payment platforms in China

amount of mobile payment has increased by more than 300% year-on-year.[2] At the same time, Ali pay, with 300 million users with real names, had become the largest

[2]The data are from《2013年支付体系运行总体情况》.

Fig. 2.4 The Global Big Data Exchange in Gui Yang(“贵阳大数据交易所”). Source: Baidu baike (“百度百科”)

mobile payment company in the world. Although Ali pay was created to assist online trading platform Taobao, it quickly became independent and applied to many scenarios, such as utilities and other daily micro payments. In 2013, there are more than 2.78 billion 780 on-line transactions (over 900 billion RMB) that were processed through Ali pay. In addition, on August 5, 2013, Tencent launched WeChat payment, which soon became one of the most popular payment systems in China. WeChat payment uses the traditional Chinese tip, the “red bag”, during the Spring Festival, and the celebrating scenario leads billions of WeChat users to link the WeChat payment to their bank accounts over one night. Therefore, the third-party payment system provides a scenario for online commerce and a platform for big data collection.

The Chinese government has successively provided a series of policy support for the big data industry. In 2014, big data was written into the government work report for the first time, which determines the future development of the industry. In 2015, the State Council issued the action plan for promoting the development of big data, highlighting the importance of big data. On April 14, 2015, the Global Big Data Exchange (GBDEx), the first big data exchange in China, was officially put into operation in Gui Yang (as shown in Fig. 2.4). In 2016, the outline of the 13th five-year plan proposed to implement the national big data strategy, taking big data as the basic resource. Thus, the development of big data becomes a national strategy in China.

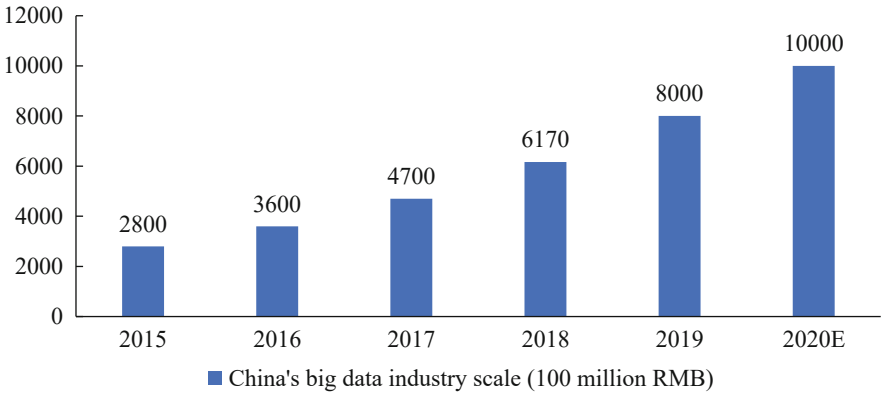


Fig. 2.5 Development of data industry in China (2015–2020). Source: The China Academy of Information and Communications Technology (CAICT), Forward industry research institute

In fact, big data is the core of the development of FinTech. With the acceleration of digital transformation of various industries, the total amount of data in the whole society has increased explosively. As shown in Fig. 2.5, since 2015, the scale of China's big data industry has increased year by year from 280 billion RMB to about 1000 billion RMB by 2020. China is accelerating the development of data industry.

2.2 The Third-Party Payments

The rise of third-party payment platforms has played an indispensable role in the formation and development of big data. The emergence of third-party payment platform can be traced back to 1970s–1980s in which third-party payment originated from the independent sales system of the United States. At that time, the credit card companies such as Visa and MasterCard quickly seized the market. After that, in 1990s, the transaction is processed through the middleman's account, resulting in a new charging method with lower cost, which is called the third-party payment system. In twenty-first century, the global well-known e-commerce dealers including eBay, Amazon, Google, and many others were born, which promotes the prosperity and development of PayPal, Amazon payment, Google checkout and other third-party payment systems. Table 2.1 shows the well-known third-party payment system around the world.

Third party payment platforms are developing rapidly in China. As shown in Fig. 2.6, at the end of the third quarter of 2020, the market share of Ali pay in China reaches 21.37%, ranking first in the industry. ChinaUMS accounted for 21.35%, ranking second, Tencent Finance accounting for 19.28%, ranking third.[3] In addition,

[3]The Chinese name of China UMS is "中国银联".

Table 2.1 The well-known third-party payment in different countries

Region	Name	Website
Global	Paypal	www.paypal.com
Global	Epay global	www.epay.com
US	MoneyGram	www.moneygram.com
US	Google checkout	http://checkout.google.com
US	Authorize.net	www.authorize.net
US	GSPAY	www.gspay.cn
US	ClickandBuy	www.clickandbuy.com
UK	Worldpay	www.worldpay.com
UK	Moneybookers	www.MoneyBookers.com
UK	Ukash	www.ukash.com
Canada	AlertPay	www.alertpay.com
Australia	eWAY	www.eway.com.au
Australia	Paymate	www.paymate.com
Netherlands	GlobalCollect	www.globalcollect.com

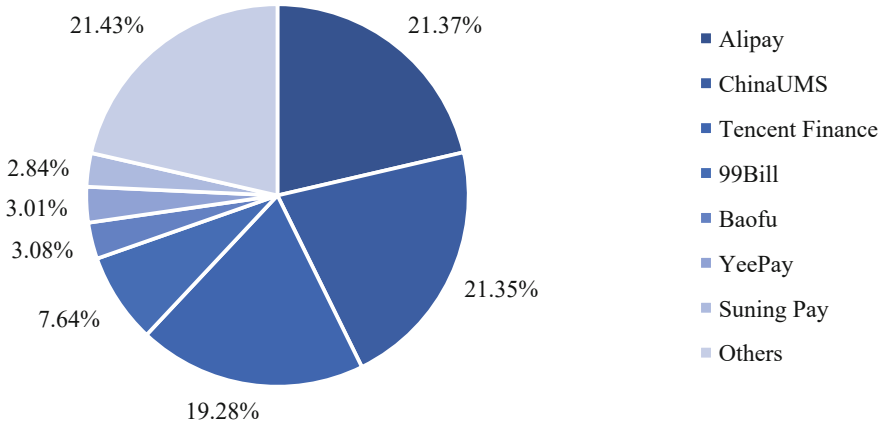


Fig. 2.6 2020Q3: Market share of China's third-party payment industry. Source: Analysys ("易观分析") 2020Q3 Report on China's Third-Party Payment

99Bill, Baofu, YeePay and Suning pay also have rapid development and have a good market share. To sum up, the third-party payment industry is highly concentrated.

Figure 2.7 shows the number of users and utilization rate for Internet payment. By December 2020, the number of online payment users in China had reached 854 million, an increase of 86.36 million over March 2020, accounting for 86.4% of the total Internet users. The number of mobile network payment users reached 853 million, an increase of 87.44 million over March 2020, accounting for 86.5% of mobile Internet users. The large number of users can generate huge amount of data, so the rise of third-party payment platforms is one of the important sources of big data.

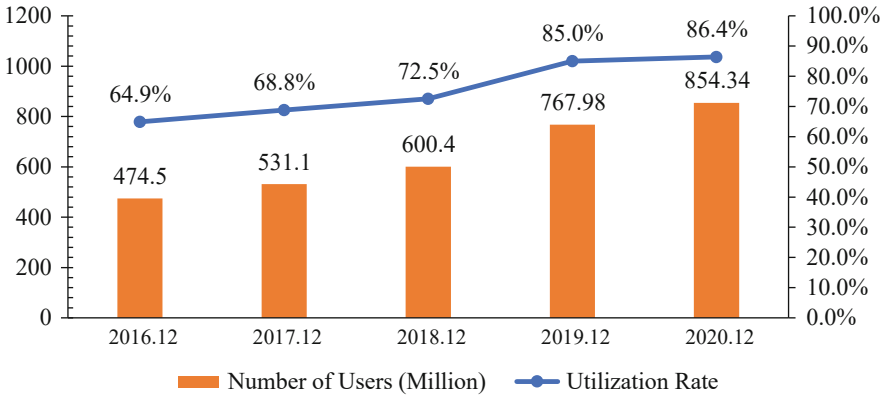


Fig. 2.7 The number of users and utilization rate for Internet payment. Source: China Internet Network Information Center (CNNIC)

2.3 The Application of Big Data

As an emerging industry, big data, combined with 5G, cloud computing, artificial intelligence, industrial Internet and other new generation information and communication technologies, has been widely used in various fields and reshaped the model of economic development. In this section, we briefly describe various application of big data in different fields.

2.3.1 The Industry Distribution of Big Data Applications

Figure 2.8 gives an overview of industries of enterprises in China with big data applications by October 2020. Among all industries, big data has been the most widely used in the finance industry, accounting for more than 30%. The application of big data in health care and government industries ranked second, accounting for 14% and 13% respectively. In addition, big data is also applied in education, Internet, transportation, e-commerce, supply chain and logistics, agriculture, industry and manufacturing, sports culture, environmental meteorology, energy industry, etc.

2.3.2 The Examples of Big Data Applications in Finance

Big data is widely used in finance industry. On the one hand, big data can provide some new information that is unobtainable in the traditional financial system. For example, big data can be used as the basis of personal credit, such as Sesame credit

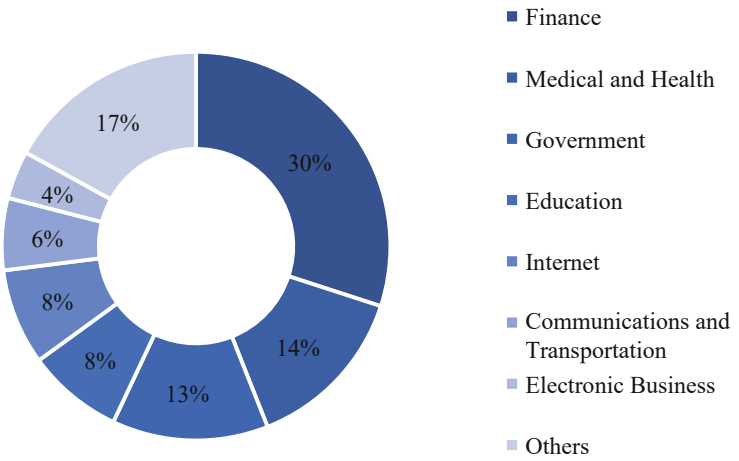


Fig. 2.8 The industry distribution of big data applications. Source: The China Academy of Information and Communications Technology (CAICT) Report, "The 2020 Big Data White Paper" Oct 2020

develop by Alibaba. On the other hand, based on big data, the application of data mining technology can reveal customers preferences, which helps on-line stores for "targeted advertising". Therefore, the scope of on-line business is widened by using big data. We will briefly describe the two applications in the following subsections.

2.3.2.1 Big Data and Credit

Big data is widely used in credit scoring systems. For example, the sesame credit score launched by Alibaba (as shown in Fig. 2.9) is based on big data analysis technology. Figure 2.9 decomposes the sesame credit into different components. It not only considers the data from traditional financial behaviors, such as credit history, but also considers the data from non-financial behaviors, such as Internet social platform information, shopping software purchase, etc. For traditional credit scoring system, such as FICO proposed by Fair Isaac, only data generated by financial behaviors are considered. Figure 2.10 breaks down the components of FICO. FICO is scored by the traditional logistic regression model mainly according to the customer's demographic statistics and loan repayment credit information, including historical loan repayment information, historical financial transaction information etc.

Compared with sesame credit scoring system with big data for credit investigation, FICO uses smaller data volume and more centralized information sources, which are strongly correlated with credit behaviors. However, some useful information may be ignored. For example, ZestFinance, an American FinTech company, aims to provide financial services to those who have low FICO score but good credit quality. At present, major credit investigation institutions have begun to invest in

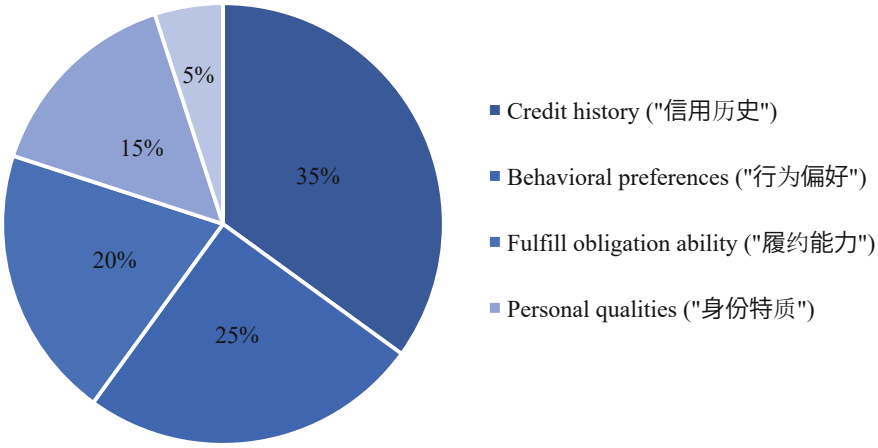


Fig. 2.9 How Sesame Credit breaks down

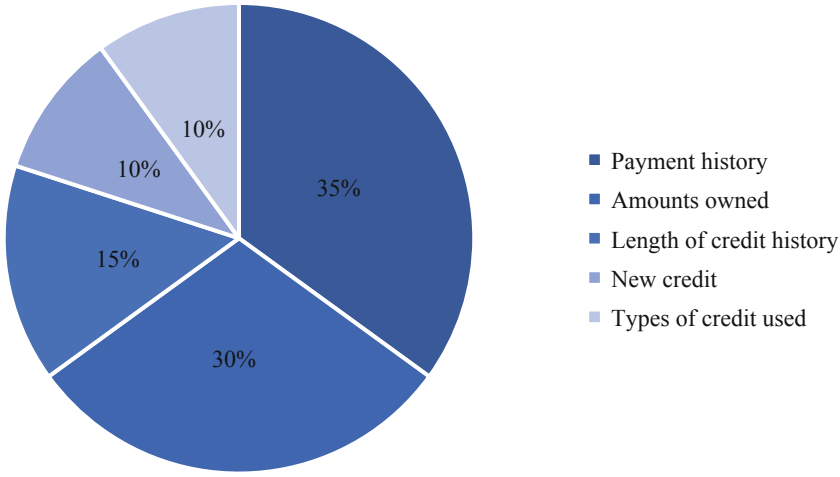


Fig. 2.10 How a FICO score breaks down

research teams to improve the traditional credit evaluation system by using big data analysis technology.

2.3.2.2 Online Shopping Platform

In the era of big data, online shopping platforms can use data mining technology to obtain a large amount of data from consumers' on-line activities, such as search keywords, browsing dwell time, consumption time preference. With those data, online shopping platforms can launch accurate products and carry out personalized

Fig. 2.11 The online shopping platforms in China

marketing activities. The accurate push of the online platform provides great convenience for consumers, which not only effectively reduces the searching time of offline consumption, but also effectively meets the shopping needs of consumers. In recent years, domestic online platforms have sprung up, such as Taobao, JD.com and Suning (as shown in Fig. 2.11).

The number of online shopping customers in China is increasing gradually. As shown in Fig. 2.12, by December 2020, the number of online shopping users in China had reached 782.41 million, accounting for 79.1% of the total Internet users. Compared with the data in December 2016, it increased by 315.71 million.

2.3.2.3 Internet of Things (IoT)

The Internet of things (IoT) is a product of big data. Literally, the Internet of things refers to connecting physical items through the Internet, which is both the extension and expansion of the Internet. On 17 November 2005, At the World Summit on the information society (WSIS) in Tunis, the International Telecommunication Union (ITU) released "ITU Internet Report 2005: Internet of Things", which formally put forward the concept of "Internet of Things". The report points out that the ubiquitous "Internet of Things" is coming, in which all objects in the world, from tires to

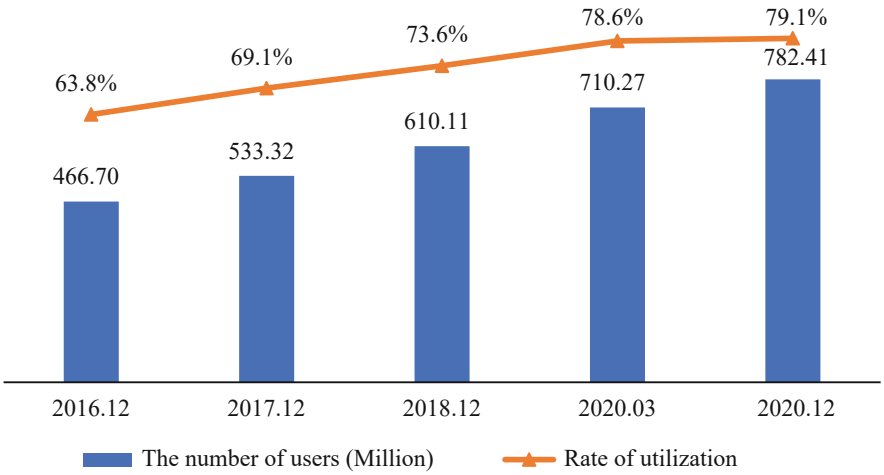


Fig. 2.12 The number of online shopping users and rate of utilization. Source: China Internet Network Information Center (CNNIC)

toothbrushes, from houses to paper towels, can be actively exchanged through the Internet. Radio frequency identification (RFID), sensor technology, nanotechnology and intelligent embedding technology will be more widely used and concerned. On July 13, 2021, the China Internet Association released the "2021 China Internet Development Report", which shows that the market scale of the Internet of things reached 1.7 trillion RMB. The IoT has many applications in life, such as smart wear, the Internet of vehicles, smart city, etc.

Typical examples of IoT include smart wearing devices include smart bracelets, smart watches, smart glasses (such as Google glasses), and smart clothing. The connection method of those devices is to connect the smart phone through Bluetooth, and the data is transmitted to the mobile phone through the sensor on the smart wearing device, and then transmitted to the server by the mobile phone. At present, such devices are widely used for medical purposes of monitoring patients' profile. The applications of Internet of vehicles mainly include intelligent transportation, unmanned driving, intelligent parking, and various on-board sensor applications. Intelligent transportation introduces the advantages of IoT technology, artificial intelligence technology, sensor technology and big data, which can effectively solve various traffic accidents in cities and play an important role in easing congestion.

Smart city is another example, which is a complex of many applications. For example, using IoT and electronic tags, the supermarket settlement system can realize rapid settlement. At the same time, the video monitoring technology at the settlement can effectively protect customers' rights and interests and avoid shopping disputes. The transportation detection equipment can detect the driving conditions of vehicles and goods transportation in real time, including the location and state environment of goods, as well as the driving behaviors of vehicles such as fuel

consumption, fuel volume, speed and braking times, which facilitates the urban traffic management and express transportation logistics inquiry.

2.4 The Ownership of Big Data

Although big data, together with development of artificial intelligence and machining learning technologies, can create significant business values for the economy, there are still some unsolved issues for the applications of data. One of the issues is customers' privacy. Nowadays, people's life is inseparable from the Internet. Every time they surf the Internet, they will produce data. People's purchase records, location information and language preferences are recorded as big data, which not only facilitates people's life, but also inevitably brings some dangers caused by the revelation of privacy. If something happens due to privacy disclosure, who should be responsible for it? To answer this question, the ownership of big data becomes important in the era of big data. In this section, we briefly discuss the issues of big data ownership.

2.4.1 The Potential Problems

2.4.1.1 The Security of Individual Data Privacy

In the era of data economy, data leakage has become a global problem. International Telecommunications Union defines privacy as the "right of individuals to control or influence what information related to them may be disclosed." Traditionally, private data is usually collected by the central government, and the credibility of the central government ensures that the data will not be leaked. In the big data environment, private data runs through the whole process of data production, processing, storage, publishing and use, and most of data are collected by certain platforms. For example, Facebook has about 2.7 billion of active users, which generates massive amount data. In addition, Edward Snowden, an American citizen, disclosed the truth of the National Security Agency (NSA) of the U.S. federal government's large-scale monitoring and seizing the communication information of U.S. citizens and non-U.S. citizens through the implementation of the prism plan through the Guardian and the Washington Post (as shown in Fig. 2.13). Therefore, the risk of platform data leakage is a significant concern by the public.

Even from the news media, we will often see some privacy leakage from major online trading platforms. For example, in March 2017, JD's internal employees were suspected of stealing 5 billion user data and selling them on the black market at prices ranging from 100,000 to 700,000 RMB. In November 2017, the data of millions of students in Qu Dian, including student loan amount, overdue fine, parents' telephone numbers, boyfriend's and girlfriend's telephone numbers and

The Washington Post

MONDAY, JUNE 10, 2013

Man who leaked NSA secrets steps forward

A REPORTER'S ACCOUNT

To leaker, personal risks were clear

BY BARTON GELLMAN

He called me ERASMSANNER, a code name in the double-barreled style of the National Security Agency, where he worked in the signals intelligence directorate.

Verax was the name he chose for himself, "truth teller" in Latin. I asked him early on, without reply, whether he intended to hint at the alternative fates that lay before him.

Two British dissenters had used the pseudonym. Clement Wilcher, a 17th-century detractor of Parliament, died in the brutal confines of the Tower of London. Two centuries later, social critic Henry Dunckley adopted "Verax" as his byline over weekly columns in the Manchester Examiner. He was showered with testimonials and an honorary degree.

Edward Joseph Snowden, 29, knew full well the risks he had undertaken and the awesome powers that would soon be arrayed to hunt for him. Pseudonyms were the least of his precautions as we corresponded from afar. Snowden was spilling some of the most sensitive secrets of a surveillance apparatus he had grown to detest, fly late last month, he believed he was already "on the X" — exposure imminent.

"I understand that I will be made to suffer for my actions, and that the return of this information to the public marks my end," he wrote in early May, before we had our first direct contact. He warned that even journalists who

SNOWDEN CONTINUED ON A4

Before the world knew his name, tech specialist Edward Snowden, 29, now in Hong Kong, drafted a note of explanation. STORY, A1

Risks of outsourcing

Government reliance on private spying contractors comes with costs as well as benefits. A2

A historic leak

Edward Snowden resolves praise and criticism as his name joins that of Daniel Ellsberg. A4

EDWARD SNOWDEN: 'I'M NOT GOING TO HIDE'

Booz Allen consultant could face prosecution

BY BARTON GELLMAN, AARON BLAKE AND GREG MILLER

A 29-year-old man who says he is a former undercover CIA employee said Sunday that he was the principal source of recent disclosures about top secret National Security Agency programs, exposing himself to possible prosecution in an acknowledgment that had little if any precedent in the long history of U.S. intelligence leaks.

Edward Snowden, a tech specialist who has contracted for the NSA and works for the consulting firm Booz Allen Hamilton, unmasked himself as a source after a string of stories in The Washington Post and the Guardian that detailed previously unknown U.S. surveillance programs. He said he disclosed secret documents in response to what he described as the systematic surveillance of innocent citizens.

In an interview Sunday, Snowden said he is willing to face the consequences of exposure.

"I'm not going to hide," Snowden told The Post from Hong Kong, where he has been staying. "Allowing the U.S. government to intimidate its people with threats of retaliation for revealing wrongdoing is contrary to the public interest."

Asked whether he believes that his disclosures will change anything, he said: "I think they already have. Everyone everywhere now understands how bad things

SURVEILLANCE CONTINUED ON A5

Fig. 2.13 The newspaper about Edward Snowden. Source: The Washington Post

other privacy information, have been leaked. In March 2018, Facebook was exposed that the data of more than 50 million users were illegally used by Cambridge Analytica to send political advertisements, which accounts for nearly one quarter of the number of voters in the United States. In April 2020, more than 500,000 zoom account login vouchers, including the data of financial institutions, banks, universities, and various organizations, were stolen and sold on the dark network crime forum.

Therefore, data privacy is under great threat in the era of big data. First, data leakage threatens the safety of personal property. For example, the user's personal information can be used by criminals to engage in illegal activities such as telecommunications fraud, kidnapping and extortion, illegal debt collection and so on. Second, data leakage threatens the personal safety. For example, the girl was murdered by the taxi driver from Di Di Taxi platform simply because of leakage of personal information.[4] Third, data leakage may threaten national and corporate security. For example, in July 2021, in order to prevent national data security risks, the National Network Security Review Office announced the implementation of network security review on "Di Di travel" and stopped the registration of new users during the review period. Fourth, data information can influence users' mind. For example, in 2018, Cambridge Analytica used Facebook user data to accurately launch push advertisement and add some information that could affect the presidential campaign, so as to potentially affect voters' thoughts and to some extent

[4] https://baijiahao.baidu.com/s?id=1609764586040795702&wfr=spider&for=pc.

manipulate the U.S. election. Therefore, in the era of big data, personal information security protection is facing major challenges.

2.4.1.2 Big Data-Enabled Price Discrimination Against Existing Customers

Big data-enabled price discrimination against existing customers means that for the same goods or services, the price seen by existing customers is much higher than that of new customers (as shown in Fig. 2.14). This phenomenon is normal due to information asymmetry and is difficult for consumers to find it out in advance. Moreover, there are many difficulties in obtaining evidence afterwards. On December 20, 2018, "big data-enabled price discrimination" was elected as the top ten buzzwords in social life of the year.[5]

On January 7, 2021, the China Consumer Association held a "Symposium on algorithm rules and consumer protection for online consumption". During the Symposium, four specific price discrimination algorithms based on big data were identified. First, different prices are set for new and existing customers. To be specific, the prices for the customers with membership, who may enjoy some "price discount", are more expensive than those for ordinary users. Second, different prices are set for consumers in different regions. Third, users who browse the

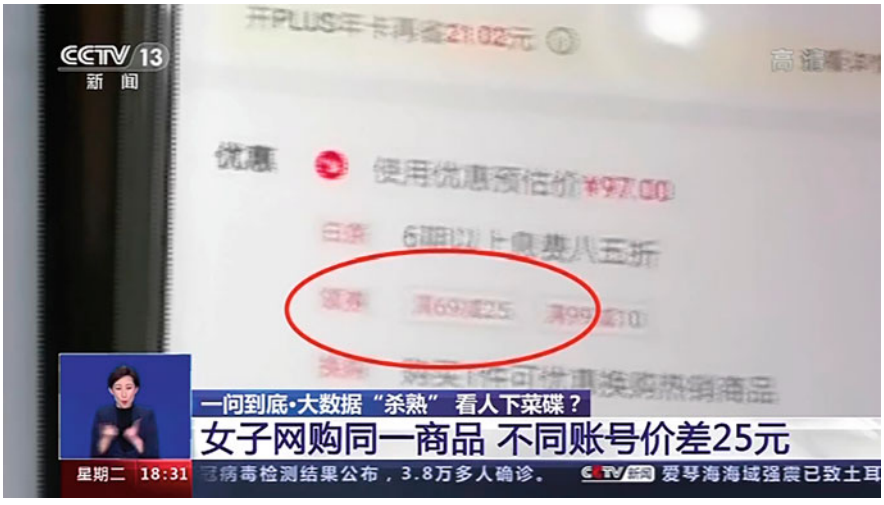


Fig. 2.14 The news about price discrimination. Source: CCTV

[5] https://baike.baidu.com/item/2018%E5%B9%B4%E5%BA%A6%E7%A4%BE%E4%BC%9A%E7%94%9F%E6%B4%BB%E7%B1%BB%E5%8D%81%E5%A4%A7%E6%B5%81%E8%A1%8C%E8%AF%AD/23215858.

webpage many times may face higher prices. Fourth, customers may face very complex promotion rules, which may confuse their calculation of real prices. Those four "price discriminations" are all driven by big data and certainly decrease consumers' welfare. Therefore, although big data can create significant values for the real economy, the revelation of consumers' real preferences may result in some dark side caused by "price discrimination".

2.4.2 The Opinions About Ownership of Big Data

The foundation of the market economy is the property right, which is normally defined as the ownership of the private property. In a data economy, the data ownership is surely important. Following the Oxford Dictionary of Law, the word "ownership" has the following meaning: "it is the exclusive right to use, possess, and dispose of property, subject only to the rights of persons having a superior interest and to any restrictions on the owner's rights imposed by agreement with or by act of third parties, or by operation of law." However, data may have different features in contrast to private properties, and the ownership of data is not easy to define. In some sense, defining the data ownership properly needs more research, and the solution may rely on the development of data technology. In the section, we briefly discuss the ownership of big data.

Each process of the generation of big data involves two participants: the data recorder and the data generator, respectively. Without the definition of data ownership, personal data is often improperly collected, stored, used, or even illegally traded in all links without authorization from the data generator. While the data ownership is truly important, there is no unified view in both industry and academia. Nonetheless, there three different opinions:

First, the big data belongs to the data generator. The information recorded in this piece of data is an objective and true record about the attributes of the recorded party, and its value depends on the recorded party. If the data is regarded as an asset and the recorded party's data is taken and used without permission, it should be a theft in law. In this sense, we have witnessed many improper collections of data by some platforms, which challenges the data ownership. If the citizen's privacy data is leaked, the citizen's personal privacy is violated. If national security related data is embezzled, it can be regarded as the disclosure of national intelligence.

Second, the big data belongs to the data recorder. Because the data recorder spends a lot of cost and technology to collect and sort out data, so as to create new business values. If no platforms record data, the value of data is difficult to realize. In addition, when collecting data, platforms have consulted Internet users for authorization opinions, which can be regarded as the transfer of data ownership. The platform legally obtains the original data, uses professional and technical means to analyze and utilize the data, realizing their maximum business value. Therefore, the ownership of the data should belong to the recorder of the data.

The holder of the third view believes that the ownership of data is not unique, and data should not be regarded as general goods.[6] Data are non-competitive and non-separable, and the data generation involves many parties in the process of production and use. On the one hand, the privacy of data generator should be protected in the use of data by law or advanced data technology. On the other hand, it is not 100% right to give data exclusive rights to data generator, because the data generator normally cannot use big data to create values. The right way to use big data should be based on a contract or an agreement between data generator and data recorder, so as to give full play to the value of data on the basis of privacy protection and fully benefit all parties.

2.5 The Potential Methods for Privacy Protection

Without properly defining the data ownership, it may be difficult to protect privacy of customers. However, there are several methods that have potential to solve or alleviate the problem of data privacy. We will have some discussion in the section.

2.5.1 Improve the Data Protection System and Introduce Relevant Laws

To avoid privacy revelation by big data, one way is to introduce the "the law for big data " from the legislative level. Data generation is a series of events, and every link may have information leakage. Therefore, regulators can clarify laws and regulations on the collection and processing of different types of data, safeguard the rights and interests of data generator. In addition, the boundary of the usage of big data should be clarified. For acts in violation of data legal norms, relevant legal subject responsibilities shall be investigated according to law. On June 10, 2021, the Data Security Law was adopted at the 29th meeting of the Standing Committee of the 13th National People's Congress and enter into force on September 1, 2021. On June 29, 2021, the Data Regulations of Shenzhen Special Economic Zone stipulates that data processors shall not refuse to provide relevant services to customers on the grounds that they do not agree to provide their personal data. Moreover, on November 1, 2021, the personal information protection law of the People's Republic of China officially came into force (as shown in Fig. 2.15). Such regulations and laws are expected to provide certain help to solve the problem of data security.

[6] In 2021, Luohan academy ("罗汉堂") release a report named "*Data and Privacy*" (*In Chinese,* 《数字时代的数据和隐私》), which talks about the ownership of big data.

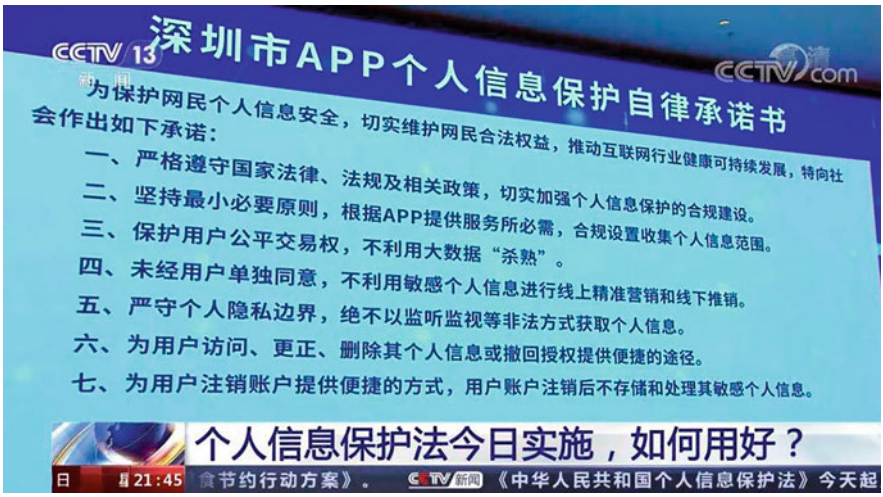


Fig. 2.15 The news about data protection regulations in China. Source: CCTV

2.5.2 Data Generators Have Rights to Choose Data Disclosure

Whether a data generator chooses to grant permission and upload personal information depends on her own willingness. Existing laws have made it clear that platforms shall not refuse to provide their services to customers because users do not agree to collect personal information. Application developers should disclosure information about data collection to their customers and clearly state the advantages and disadvantages of collecting relevant information. Figure 2.16 shows one example of information disclosure by one application developer. In addition, relevant rights protection hotlines and websites should be added, and measures were taken to encourage customers to expose illegal data utilization, so as to jointly promote the sound development of the big data industry.

2.5.3 Technology for Privacy Protection

Data technology is important for privacy protection. With the development of intelligent technologies such as cloud computing, blockchain and Privacy Enhancing Technology (PET), it is possible for the released big data not contain sensitive information. For example, we can use crypto technology to process the big data, so as to intelligently clean the sensitive information in the data. Thus, data recorder

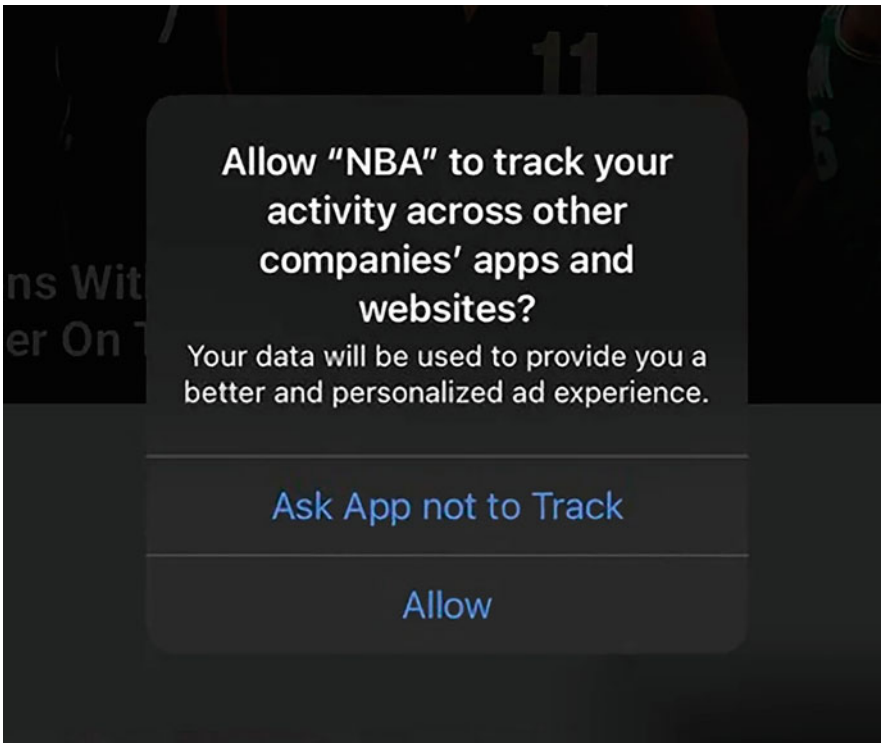


Fig. 2.16 IOS14.5 pop-up window asks whether the user is allowed to track private data

can make full use of the advantages of big data information and protect data generator's privacy as much as possible.

2.6 Summary

Big data is the core of the development of FinTech. In this chapter, we first briefly describe the development of big data, especially the development status of big data in China, in which the rise of third-party payment is one of the most important sources of big data. To make the discussion self-contained, we introduce the international and domestic development of third-party payment. Second, we introduce the industrial application of big data, and discuss the potential privacy infringement and property rights in big data. Finally, we show some possible data privacy protection methods.

Chapter 3
P2P Risk

As we discussed in Chap. 1, P2P lending is one of the main models of the development of Internet finance. However, P2P lending is well-known for the risk of frequent bankruptcy. How do we think about the risks in financial innovation? In this chapter, we give a comprehensive introduction to P2P lending, with a focus on its bankruptcy risk.

3.1 Introduction of P2P

In China, P2P platforms are well known for their risks, especially for the cases of E Zu Bao and Fan Ya in 2015, which involve billions of RMB and a large number of small investors.[1] In fact, the name "Internet finance" is no longer active after the bankruptcy of E Zu Bao in 2015. Before the case of E Zu Bao, P2P lending was regarded as one of the major innovations of Internet finance, but the risks of P2P platforms are unexpected. In this chapter, we will start with the definition and development of P2P industry, in which we discuss a well-known P2P platform in the U.S., the Lending Club. The development of the Lending Club shares some similarities to the development of the whole P2P industry. After that, we will talk about the risks from P2P platforms by analyzing several well-known cases of the bankruptcy of P2P platforms in China. Finally, we will discuss the link between P2P platforms and other financial markets.

[1] The Chinese name for E Zu Bao is "E租宝", and that for Fan Ya is"泛亚".

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_3

3.1.1 Definition and Overview of P2P Platforms

P2P is short for peer-to-peer lending, which serves as a third-party Internet platform that connects both borrowers and lenders. Based on the definition from the Regulations of Online Lending Information Intermediaries issued by China Banking and Insurance Regulatory Commission (CBIRC), P2P platforms are purely information intermediaries.[2] Based on this definition, P2P platforms should only provide borrowers' information to lenders online and should not be involved in any lending activities. The borrowers and lenders have a direct lending relationship only based on information provided by the P2P platforms. In other words, P2P platforms create an intermediary for information, which can be used for private lending. However, most P2P platforms do not meet the definition of information intermediary in reality.

According to the role those P2P platforms play in the lending process, the business models of P2P platforms can be divided into two categories: the revenue-based platforms and the zero revenue platforms. The revenue-based platforms can be further divided into simple intermediary and compound intermediaries. The simple intermediary is consistent with the information intermediary definition of P2P lending while the compound intermediary, in addition to providing the information intermediary service, also provides the services as debt collector, guarantor, joint debt collector and interest rate setter. For the example of simple intermediary, we can refer to the Pai Pai Dai in Shanghai, and for the example of compound intermediary, we can refer to Shenzhen Hong Ling Venture Capital. The zero revenue platforms mainly provide low-interest loan services for vulnerable groups, not for profits. China Yi Nong Dai is an example of this model. Next, we will give several typical examples of P2P platforms in China.

3.1.1.1 The Example of a Simple Intermediary: Pai Pai Dai

Pai Pai Dai was founded in August 2007, and the headquarter is located in Shanghai. Pai Pai Dai is a platform of simple intermediary, which only provides information to borrowers and lenders. In this sense, Pai Pai Dai is a pure information intermediary, and its model is consistent with the definition of P2P platforms. The operating model of Pai Pai Dai is like the Prosper, one of the largest P2P platforms in the world. The Pai Pai Dai posts various information on its website including loan and bidding information, data management and electronic vouchers. Pai Pai Dai covers various customers, including small and medium enterprises and high-net-worth individuals. Pai Pai Dai has a very low entry threshold for users, and any Chinese mainland citizen over 18 years old can apply to become a borrower or a lender, with a single transaction up to 200,000 RMB. After 5 years since its establishment, Pai Pai Dai accumulates more than 100,000 registered users.

[2]The Chinese name for the regulation is《网络借贷信息中介机构业务活动管理暂行办法》.

3.1.1.2 The Example of the Compound Intermediary: Hongling Venture Capital

Hong Ling Venture Capital was established in March 2009 and headquartered in Shenzhen. The business model of Hong Ling Venture Capital is a compound intermediary, which has the similar model as ZOPA, a leading British P2P platform. In the transaction ranking of P2P industry in the first three quarters of 2015, Hong Ling venture capital led with 62.6 billion RMB trading volume. While Hong Ling Venture Capital is a compound intermediary, it also covers financial e-commerce, consulting for domestic and foreign investment, industrial investment funds, investment and financing capital management, and other fields.

3.1.1.3 The Example of Zero Revenue Platforms: Yi Nong Dai

Yi Nong Dai is a platform launched by CreditEase in 2009. Through the Yi Nong Dai platform, loans can be made to rural borrowers in poor areas to support them in developing production and improving their lives. Lenders can subscribe to different shares according to their own willingness and ability, and the amount of each loan can be as small as 100 RMB. The borrowers need to be qualified and fall into the category of agriculture, rural areas and farmers. In general, the borrowers are poor people, or other rural low- and middle-income people recognized by cooperative lending institutions. Therefore, although classified as a P2P platform, Yi Nong Dai is more like a practitioner of solving the problems of "agriculture, rural areas and farmers" in China.[3]

3.1.2 Development of P2P Industry

The developments of P2P industry and Internet finance are in the same era. From 2012 to 2015, we observe a period of brutal growth for P2P platforms. Due to the lack of corresponding regulatory rules and unclear regulatory subjects, Chinese P2P industry is in the stage of trial and error, and there is no standard for the industry. As shown in Fig. 3.1, in November 2015, the overall transaction volume of P2P online loan industry reached 133.12 billion RMB and the cumulative historical transaction volume reached 1231.47 billion RMB. The rapid expansion of the scale brings about the continuous outbreak of various risks, resulting in the frequent bankruptcy of large platforms. The bankruptcy of the platforms is also called "P2P runaway" because the founders of the P2P platforms just disappear. The "P2P runaway" events occur more and more frequently, even for some very large platforms. Because large

[3] They are also called "three problems for rural areas"("三农")in China.

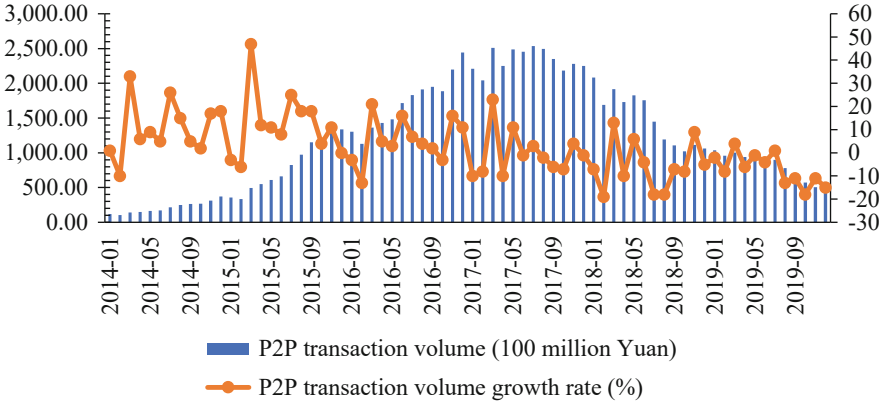


Fig. 3.1 P2P transaction volume. Source: WIND database

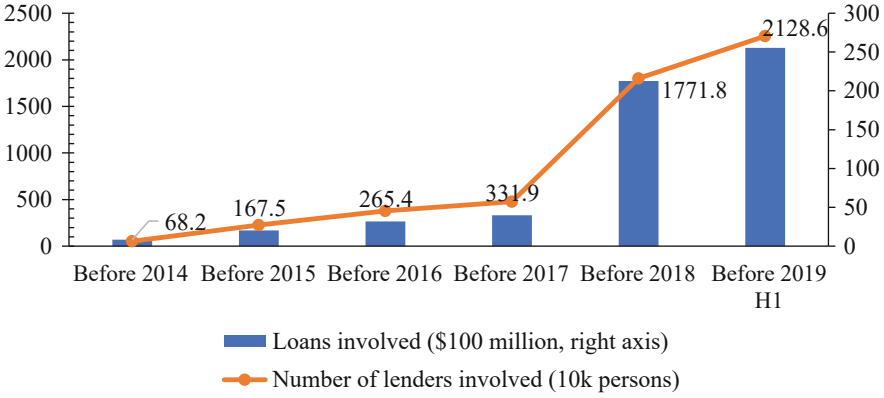


Fig. 3.2 Annual development of P2P industry

platforms usually have millions of investors, the "P2P runaway" brings huge losses to small and medium investors and even threatens financial stability.

The year 2015 is an important time point for the P2P industry, in which E Zu Bao platform is bankrupt. With this significant shock to the P2P industry, various regulation rules and policies are implemented in 2015. The development of the P2P industry has ended its brutal growth and entered the era of strict supervision. The development of the industry is gradually returning to a reasonable level. Some P2P platforms are forced to transform or exit, while some newer platforms are developing rapidly, forming a polarization trend. As shown in Fig. 3.2, the transaction volume maintained a stable growth in 2016 and nearly doubled in early 2017. However, although the transaction volume is increasing, the situation of the problematic platforms is still not optimistic. As shown in Fig. 3.3, from the end of 2015 to October 2017, the cumulative number of problematic platforms continued to rise, and the rate of "runaway" platforms reached 56.83%.

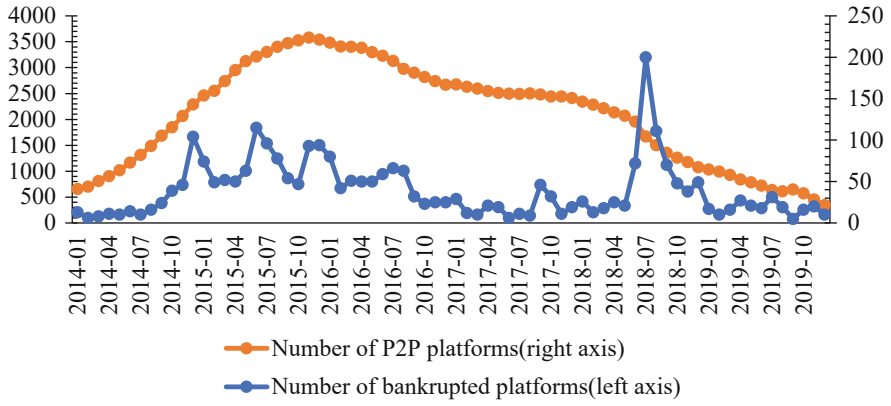


Fig. 3.3 Problematic P2P platforms. Source: WIND database

As shown in Fig. 3.3, the number of new platforms decreased significantly in 2017, and the number of new problematic platforms slowed down to about 100 per month. It is obvious from the comparison that the number of new problematic platforms far exceeds the number of new platforms. On the one hand, the P2P industry is facing greater exit pressure, and some platforms are facing restructuring. On the other hand, the whole P2P industry faces stricter regulations. P2P industry is in the period of rectification, so the number of platforms will further decline.

For loan interest rates, the comprehensive interest rates of P2P platforms continued to decline due to the impact of the new regulations. According to the 2017 Annual Report of China's Online Lending Industry, the industry yield reaches a peak of 22% in February 2014. It has since fallen for six straight months. In 2017, the overall comprehensive return rate of online lending industry is 9.45%. Figure 3.4 shows the distribution of problematic platforms in 2017. We can see that the proportion of the disconnected or "runaway" platforms is as high as 62.36%, and the proportion of withdrawal difficulties accounts for 20.86%.

The difficulty of the problematic platforms to exit brings huge risks to ordinary investors. Based on several discussions in the P2P conferences, two main regulatory directions were proposed to prevent risks. The first is ex-ante supervision. Regulators can increase barriers to entry to prevent inferior platforms from entering. The second is ex-post supervision. Regulators can strengthen the supervision of existing platforms, find problems in time and guide benign exit. Nonetheless, the risk of P2P platform is huge because it involves millions of investors. We will discuss more about P2P risk in Sect. 3.3.

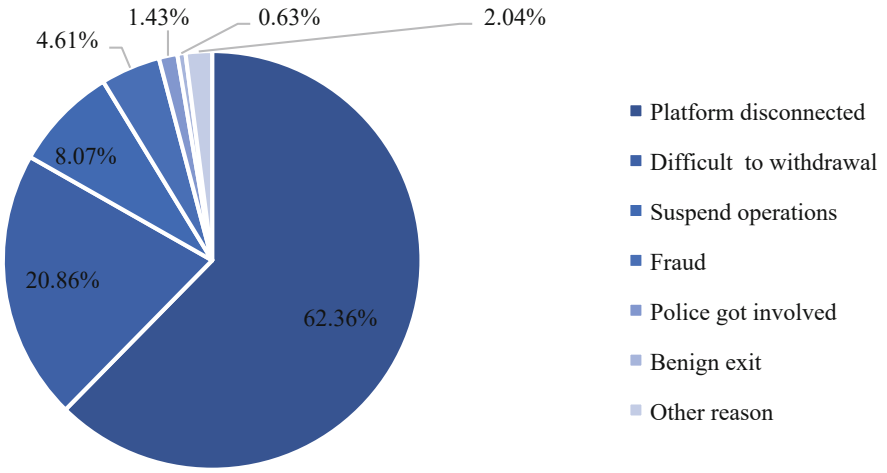


Fig. 3.4 The causes for platforms of being problematic in 2017. Source: WDZJ-OFFICIAL("网贷之家")

3.2 Lending Club

In this section, we use the Lending Club as an example to show how P2P platform operates. Lending Club, the largest P2P platform in the United States, was established in 2007. Lending Club occupies more than 65% of the P2P market share and thus is the largest P2P loan company in the United States. Like other leading American entrepreneurs, Renaud Laplanche, the founder Lending Club also had other entrepreneurial experiences before Lending Club was founded. Laplanche founded Matchpoint in 2000, which was later acquired by Oracle. Laplanche's early entrepreneurial experience laid the foundation for his success of the second venture, and the team of the investment company believes that this is an advantage. Figure 3.5 describes the historical business development of the Lending Club.

For investors, Lending Club can provide a return on investment ranging from 7.56% to 22.68%, with an average annual return of about 10%, which is relatively high among all the asset classes. Table 3.1 shows the return comparison between Lending Club and various asset classes. Moreover, investors can independently choose loans with different risks classified by Lending Club. The loans with rating A have the lowest credit risk and lower returns, and loans with rating G have the highest credit risk and thus with the highest returns.

Based on Internet technology, Lending Club, as an information intermediary, effectively connects borrowers and lenders together. Lending Club sells "certificates of debt" to investors and provides products with face value ranging from $25 to $35,000. For individual borrowers, they cannot borrow more than $35,000. By June 30, 2014, $5.04 billion had been lent, and a total amount $494 million of cumulative interests was paid to investors.

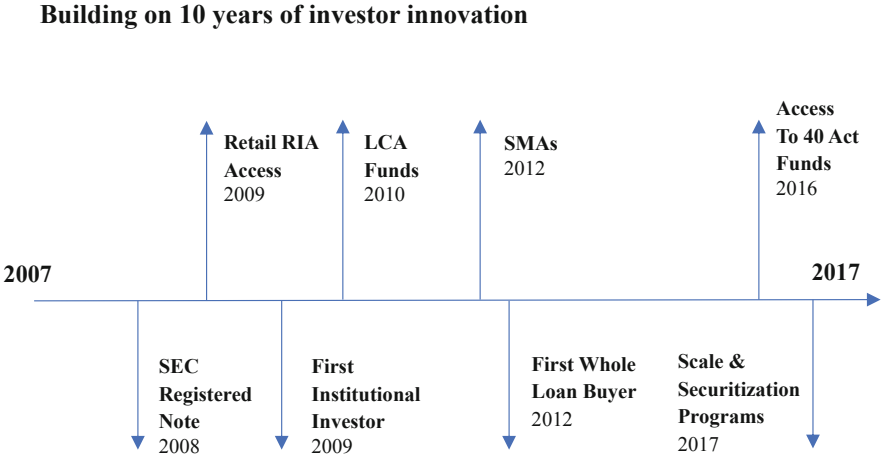


Fig. 3.5 Historical development of Lending Club. Source: Lending club 2017 investor day presentation

Table 3.1 Lending Club products with comparison to other normal investment products

Type	Interest rate
Investment product	
Lending Club	7.56% ~ 22.68%
1 year CD	0.15% ~ 1.05%
5 year CD	0.6% ~ 1.87%
S&P 500 5 year annual return	4.85%
Loans	
Lending club	6.78% ~ 27.99%
Credit card	10.29% ~ 23.64%

Source: Lending club webpage

3.2.1 The Development of the Lending Club

As shown in Fig. 3.6, Lending Club has had a high annual growth rate in loan transactions since it was founded in 2007. Until the first quarter of 2016, the Lending Club platform had $2.750 billion in loans in which transaction fees from borrowers are the main source of income.[4] Moreover, there are also another two revenue sources for the Lending Club. The first source is the fees that Lending Club charges investors for the services, which is 1% of the principal and interest that the investor receives from the borrower. The second is the administration fees, which come from the revenue and management fee of LCA (subsidiary corporation of Lending club), ranging from 0.75% to 1.25%.

[4]The fee ranges from 1% to 5% of the transaction value of the loans.

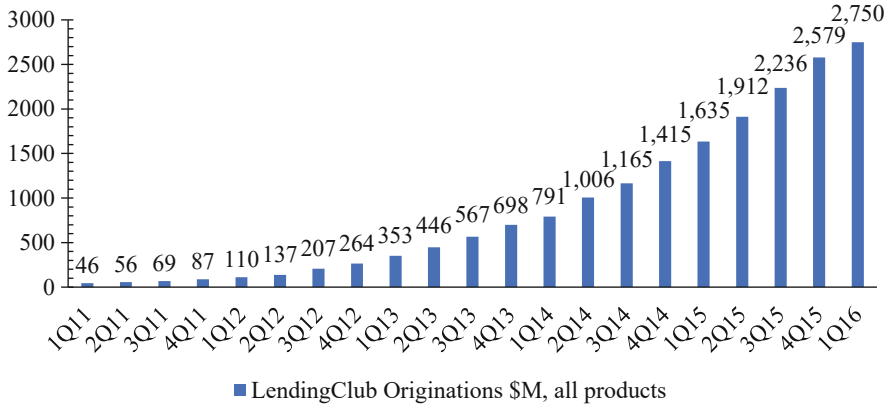


Fig. 3.6 Lending Club's debt originations. Source: Lending club 2017 investor day presentation

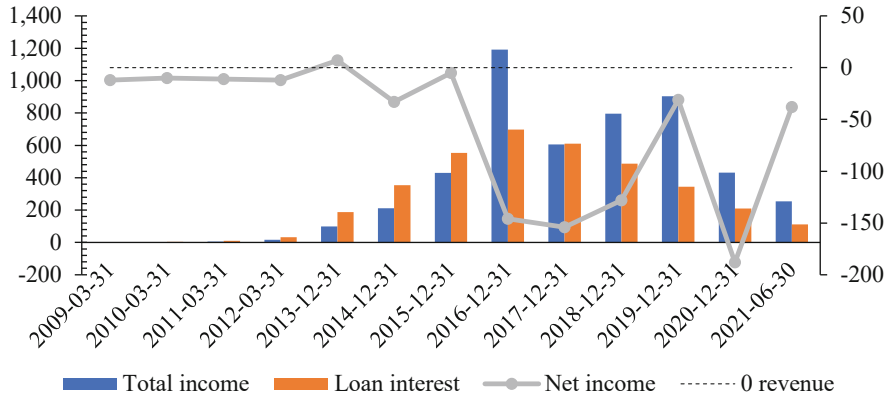


Fig. 3.7 Revenues of Lending Club. Source: Lending club financial statements

Lending Club is the first P2P platform listing in the stock exchange in the world. However, the financial situation of the Lending Club is not very good. Figure 3.7 shows the financial situation of Lending Club over years. The company achieved a positive profit for the first time in 2013, with an annual net profit of US $7.3 million. However, the company had a net loss of $16.49 million in the first half of 2014. The temporary loss in the first half of 2014 was due to the increase in costs caused by large-scale investments. Since then, the Lending Club has made no profit at all. To obtain a full picture of Lending Club, in the next subsection, we investigate the business model of Lending Club at different stages.

3.2.2 *Business Model of Lending Club*

The business model of Lending Club varies with the changes in the regulatory requirements. In particular, Lending Club has gone through three stages of its business models: information intermediary, semi-bank model and securitization model. With transformations of its business models and involvement of regulators, Lending Club has gradually transformed from a simple information intermediary into a "quasi-financial institution".

3.2.2.1 Business Model 1:Information Intermediary: 2007.6–2007.12

Between June and December 2007, Lending Club operates on an information intermediary model, which crucially depends on the promissory notes from borrowers. Figure 3.8 describes the procedure of the operation of information intermediary. Under this model, when the loan amount is fully subscribed, the borrowers issue their promissory notes to Lending Club, and then Lending Club transfers the borrowers' promissory notes to the corresponding investors. In the process, Lending Club effectively acts as an intermediary reseller of promissory notes for loans and provides follow-up services for loans. The key to information intermediary model is that investors directly buy the promissory notes from borrowers, so the borrowers and lenders have a direct lending relationship. This model is consistent with the P2P definition we discussed at the beginning of this chapter. In China, Pai Pai Dai is similar to the information intermediary model of Lending Club at this stage.

In this model, Lending Club makes money by charging fees and is responsible for any risks on the loans. However, from the relationship between Lending Club and the borrowers, Lending Club effectively makes loans to the borrowers and becomes the lender of money. That means Lending Club needs to obtain Lending licenses in

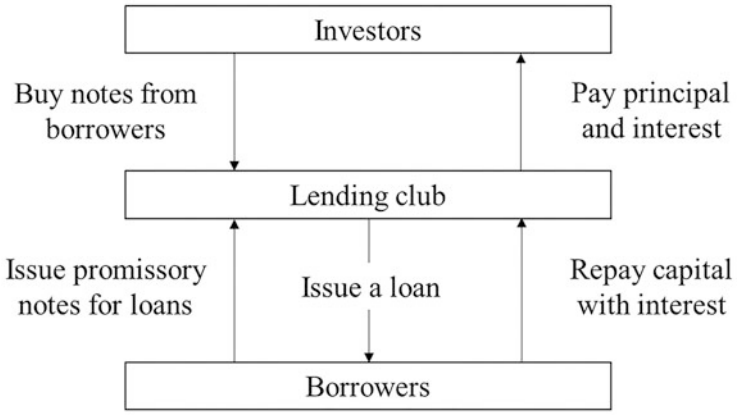


Fig. 3.8 Information intermediary mode of Lending Club

each state in the United States. Different states have different regulations, which greatly restricts Lending Club's ability to expand its business across the country with a uniform standard. For this reason, Lending Club changes its business model only after 6 months.

3.2.2.2 Business Model 2: Semi-Bank Model: 2008.1–2008.3

The second business model of Lending Club is the semi-bank model, which is adopted mainly to circumvent state licensing restrictions. In this model, Lending Club builds a partnership with WebBank. As shown in Fig. 3.9, when the loans are fully subscribed by investors, WebBank instead of Lending Club issues promissory notes. After that, the WebBank transfers promissory notes issued by borrowers to Lending Club at a nonrecourse price, and then calls back money that WebBank has lent. Finally, the promissory notes are transferred to investors through Lending Club.

The difference between the information intermediary and semi-bank models is that the WebBank plays the role of a lender instead of Lending Club. In this model, investors still buy the promissory notes from borrowers. Therefore, the two models are essentially the same, and the only purpose to change business model is to circumvent regulations. In this sense, Lending Club acts as the information intermediary for the borrowers' promissory notes and provides follow-up services for the loans. The second business model, however, only lasts for three months.

3.2.2.3 Business Model 3: Securitization Model: After 2008.10

The third business model of Lending Club is the securitization model, which is similar to the semi-bank model in most aspects. However, as shown in Fig. 3.10, the

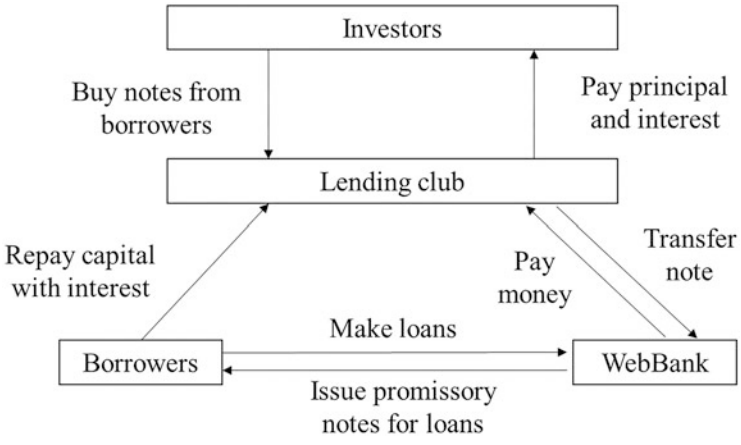


Fig. 3.9 Semi-bank mode of Lending Club

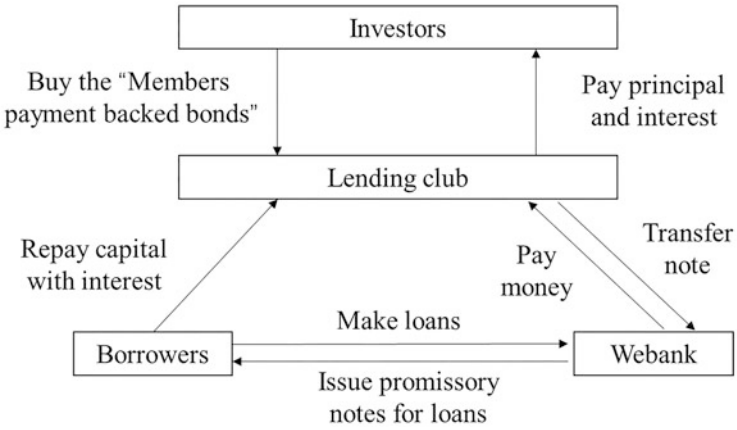


Fig. 3.10 Securitization mode of Lending Club

essential difference is that, under the securitization model, investors buy "member-repayment backed bonds" issued by Lending Club rather than borrowers. In other words, there is no direct lending relationship between borrowers and lenders, and investors are unsecured creditors of Lending Club. However, the returns of investors' investments are entirely dependent on the performance of the loans they invest in. In the first two business models, investors receive the loan promissory notes issued by the borrowers directly from Lending Club or through Lending Club from WebBank, and thus become the creditors of the borrowers. At this point, Lending Club is essentially a new kind of debt, but in the guise of P2P.

Based on the analysis of business models of Lending Club at different stages, although Lending Club belongs to the P2P industry, its main business somehow differs from the original definition of P2P lending. This phenomenon is not uncommon in the industry. In fact, in China, most P2P platforms are not doing "real" P2P business.

3.2.3 Regulation for P2P in the United States

At present, P2P platforms in the United States are regulated by multiple departments, states and federal governments, and various regulatory agencies rely on existing laws to supervise P2P lending businesses. At present, the SEC and state securities regulators are the main forces of investor protection, while FDIC, state financial institutions department and consumer financial protection bureau are the main forces of borrower protection. P2P lending, as a securitized lending model, is not only the issuer of securities, but also the link between borrowers and lenders. Moreover, the platforms also determine of lending interest rates. Therefore, P2P loans are regulated by three types of laws: Securities Supervision Act, Banking Supervision Act and

Consumer Credit Protection Act, which protect both lenders and borrowers. Overall, P2P loans face regulatory restrictions such as information disclosure, interest rate restrictions, privacy protection and fair treatment of all investors.

3.3 E Zu Bao ("E租宝")

The case of E Zu Bao has a significant impact on the whole P2P industry, even on the development of Internet finance. E Zu Bao platform is an on-line lending platform operated by Yucheng Group company. The platform was founded in 2014 by its founder, Ning Ding (the picture on the right), and was bankrupt at the end of 2015. Until its bankruptcy, E Zu Bao has attracted capital from approximately 900,000 investors, in a total amount of around 50 billion RMB (around $7.6 billion).

In December 2015 when E Zu Bao was shut down, the business model of the platform becomes a pure Ponzi scheme, raising new funds to repay the old debt. In fact, E Zu Bao also uses the fake investment projects for new financing. After the exposure, the public security and financial regulators launched an investigation into the operations of E Zu Bao, and the executives of the Yucheng group company and the E Zu Bao platform were arrested on suspicion. Finally, the founders and management team of the E Zu Bao platform were sued and imprisoned.

The case of E Zu Bao attracts a lot of public attention because it involves millions of small investors. According to an uncompleted statistic, there are more than 909,500 investors were cheated by E Zu Bao platform. Moreover, E Zu Bao is also the leader of P2P industry. Until December 8, 2015, the total volume of E Zu Bao products was 74.868 billion RMB, ranking the fourth in the industry. During 2015, the cumulative turnover of E Zu Bao increased rapidly, from 4.9 billion RMB in early May to more than 70 billion RMB in early December, with an increase of 1300% in 6 months. Both the magnitude and the number of investors cause the regulators to treat this case seriously.

After nearly 2 years of investigation, on September 12, 2017, the First Intermediate People's Court of Beijing Municipality made a legal judgment on the E Zu Bao case, which was defined as "fund-raising fraud and illegal absorption of public deposits". Therefore, the operation of E Zu Bao is classified as "illegal" activities.

3.3.1 Business Model of E Zu Bao

The business model E Zu Bao can be classified as an A2P (Asset to Peer) business model in which all products are designed with finance lease contract and credit assignment. Slightly different from the P2P models, the borrowing side of A2P model is the assets in the financing lease contract, which can generate certain cash flows. E Zu Bao sells the cash flows generated from the assets to investors through some internet finance products. Figure 3.11 shows the operation of E Zu Bao’s business model. The core business in the model is the cash flows generated by the underlying assets (or equipment) with the lease contract. The financing lease itself is not new, but the cash flows generated from the equipment can be securitized and sold as financial products through Internet finance platform, which is the essence of E Zu Bao.

E Zu Bao proposes a wide range of investment products with high rates of return and low investment threshold (or even none). Depending on the types (normally maturity) of investment products, the returns range from 9.0% to 14.6%, much higher than other common financial products in the same period.

3.3.2 The Scam of E Zu Bao

From the discussion of the business model of E Zu Bao, the securitization of the cash flows from financially leased assets is not so bad. The problem of E Zu Bao is that a large amount of capital flows into the platform rapidly. However, the capacity of E Zu Bao platform depends on the cash flows generated by the underlying assets (financially leased), which is somehow limited. In other words, E Zu Bao cannot infinitely securitize the cash flows.

Normally, when the capital flows into the platform, there should exist a third-party fund supervision platform such as commercial banks, which supervise the usage of the capital. However, due to the absence of legislative supervision, when the money goes in the E Zu Bao platform, there is no supervision, and the management teams can do whatever they want with the money. In fact, E Zu Bao should stop issuing more financial products if the cash flows from the financially leased assets hit

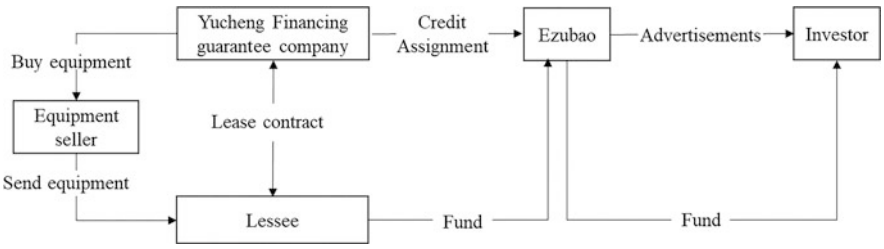


Fig. 3.11 Business model of E Zu Bao

the limit. However, it turns out that the financial products issued by E Zu Bao far exceed its capacity, so E Zu Bao has to find some other investment opportunities with good returns because investors nonetheless would ask for returns of their investment. High returns are normally associated with high risks, which is a hidden danger of bankruptcy for E Zu Bao.

It turns out that some risky investments finally fail, but E Zu Bao still has to pay back the investors. Because there is not enough money to return to investors, E Zu Bao starts counterfeiting. Based on the police investigation, the camouflages of E Zu Bao can be classified into three types. First, E Zu Bao uses fake financial leasing projects to sign false loan agreements with leasing companies, and then uses the fake loans to issue new products. Second, E Zu Bao illegally purchases enterprise data to form fake projects and publishes the information on its website. Third, Yucheng company falsely sets up a new company for the acquisition target and issued false projects. Based on the false information and projects, E Zu Bao can raise new funds to return investors.

In what follows, we will discuss the fake investment product, Ponzi scheme, and the misuse of investors' money in detail.

3.3.2.1 Fake Investment Products

E Zu Bao platform provides various products to investors with good returns, and the products are easily accessible for retail investors. Given that Chinese investors do not have enough finance service under the traditional financial system (as discussed in Chap. 1), E Zu Bao's products surely become attractive. Moreover, there also exists a third party who provides external guarantee for those products.[5] No doubt, billions of funds go to the E Zu Bao platform. However, statistics show that about 95% of E Zu Bao 's projects are "too good to be true". Not only is the third-party guarantee false, but the investment target itself is also fraudulent.

Moreover, most of the leasing contracts are fabricated by Yucheng Group company. According to the police report, only one of 207 related equipment companies had real businesses. Take Huadi Cast Steel Co., LTD. as an example, the company was initially registered as Huadi Cleaning Co., LTD., which changed its registration information and became an equipment seller, right before the day when it traded with Yucheng Group company. Until October 2015, 309 loan companies published loan targets on E Zu Bao platform, and 94.5% of them increased their registered capital before borrowing, making the information more reliable. The average registered capital of these enterprises was 1.54 million RMB before the trade, but they changed their registered capital into an average of 27.14 million RMB after the trade. Moreover, 97.7% of these related companies changed their legal representative before they borrow money from the E Zu Bao platform.

[5] It turns out that most of the external guarantees are also from subsidiaries of Yucheng Group company.

For the fake projects, E Zu Bao pays part of the investment to the “leasing company”. The founder of E Zu Bao, Ning Ding, instructed his employees to use 1.5% ~ 2% of the fund to buy enterprise data, which amounted to 800 million RMB. After that, E Zu Bao fills the information into the contract, forming a fake project and publishing it on the website.

3.3.2.2 Ponzi Scheme

Because the financial products issued by E Zu Bao far exceed its capacity, and investors ask for returns for their investment. Therefore, E Zu Bao raises new funds to return the old debt, which is a typical case of a Ponzi scheme. By using E Zu Bao’s funds, Yucheng Group company had built a capital pool of nearly 10 billion RMB. In fact, a capital pool is inconsistent with the information intermediary definition of P2P because the information intermediary should only provide information to borrowers and lenders. To avoid capital pool drying up, E Zu Bao had to keep rolling over their debt. New debts need new projects, so E Zu Bao had to constantly release fake projects to attract money inflows.

3.3.2.3 Misuse of Investors’ Funds

After a preliminary investigation by the police, it was found that only a small part of the capital pool was used to redeem investors’ principal and interest, while most of the funds were occupied illegally by the founder of E Zu Bao, Ning Ding, and the management team. In addition, Yucheng group company has been very active in expansion, employing many employees and paying high wages. For example, there are 80 executives in Yucheng Group company with extremely high salaries, and based on incomplete statistics, the average annual salary of those executives is one million RMB. In November 2015, Yucheng Group company paid 800 million RMB to its employees, and some of which were pretended to be used for project acquisition and bad debts to make up for its misuse of funds. To attract more investors, E Zu Bao also spent hundreds of millions of RMB on advertising on popular television channels, such as CCTV, Anhui Satellite TV, Beijing Satellite TV, etc.

3.3.3 Lessons from E Zu Bao Fraud

What can we learn from E Zu Bao? It seems that E Zu Bao is one type of financial innovation in P2P industry, but what is wrong with it? In this subsection, we will discuss various reasons for E Zu Bao, and in Chap. 6, we will further provide a theoretical framework for the analysis of P2P models.

3.3.3.1 Information Asymmetry

The first problem for E Zu Bao is information asymmetry. The credit investigation and disclosure regulation are unsatisfactory for E Zu Bao. Investors know little about the information of borrowers and can only make judgments based on the information provided by the E Zu Bao platform. In order to increase the volume of transactions, the platform may lower its screening criteria without informing the investors. When E Zu Bao does not have enough money to pay investors' interests, many fake projects are created, but investors have no ideas about it.

3.3.3.2 Lack of External Governance

The creditability of borrowers is not fully censored by the platform and supervised by the external regulators. Due to the imperfection of China's current credit investigation system, and the inability of P2P platforms to access the credit recording of the People's Bank of China, it is difficult for the platform and government to make sure of the qualifications of borrowers online. Also, P2P platforms can easily become the complicit in illegal fundraisings.

The use of investors' funds is also not properly regulated. The existence of P2P capital pools is not only inconsistent with the definition of information intermediary but also can bring huge risks to investors. First, the existence of the capital pool gives the platform the opportunity to take the money and run away. Second, through the manipulation of the funds in the capital pool, the platform can easily create fake projects and use the funds for self-financing or investment in other risky projects. Third, the existence of capital pools is conducive to P2P platforms to carry out maturity mismatch, which can bring hidden dangers for investors' asset safety.

3.3.3.3 Education for Investors

The expected annual return rate of E Zu Bao's products reaches 14.6% at the highest and 9.0% at the lowest, far exceeding that of other general investment products with the same maturity. It is common sense in finance that high returns are associated with high risks. However, for some reason, Chinese investors, especially elder investors, only care about high returns and selectively ignore high risks. When choosing investment products from P2P platforms, most investors care about returns and believe exactly what E Zu Bao advertises. E Zu Bao makes use of the investors' risk-taking mentality and gathers a large amount of funds. In addition, investors are not well informed about the credit of the borrowers and the risk behind them.

3.3.3.4 Media and Celebrity Effect

E Zu Bao strongly promotes its products in both online and offline channels, with the online advertisements mainly on TV, and offline mainly by so-called “financial planners” to attract customers. E Zu Bao spends hundreds of millions of RMB in the mainstream media (such as CCTV) for massive advertisements. At that time, there was no strict advertising censorship system, which made the advertisements of these fake products spread rapidly among the public. Most E Zu Bao’s investors are elder people, who were mostly the audiences of mainstream TV channels. Moreover, elder people are not good at obtaining and identifying information from multiple sources, which leads to their credulity of some mainstream media’s endorsement. In addition, the elder people are also the main customers of E Zu Bao’s offline promotion.

In fact, the E Zu Bao model has been challenged by some specialists. For example, in the 2015 Online Loan Rating Report jointly launched by the financial Risk Laboratory of International School of Renmin University of China and Finance 360 in May 2015, E Zu Bao was given a C grade of rating, indicating that E Zu Bao’s overall repayment ability is not sound.[6]

3.3.3.5 Celebrity Effect

E Zu Bao often organizes various seminars in which the participants are some celebrities in both industry and academia. In addition, E Zu Bao executives also go abroad to visit leaders of some countries. For ordinary people with little financial knowledge, the official endorsement plays an important role in their beliefs. Through the government, state media and other channels, E Zu Bao has gradually built up a “good” corporate image to deceive investors. In this way, the endorsement celebrities essentially serve as a collateral for E Zu Bao. We discuss this in more detail in Chap. 6.

[6]The Chinese name of Finance 360 is “融360”.

3.4 Fan Ya ("泛亚") Metal Exchange

3.4.1 Background of fan Ya Metal Exchange

In 2010, Kunming Fan Ya metal exchange (FYME) was established by Kunming municipal government, and the legal representative is Jiuliang Shan. The exchange is allowed to trade 12 varieties of rare metals, include indium, cobalt, tungsten, bismuth, gallium and germanium antimony, silver, vanadium and so on. At that time, the exchange was the world's largest exchange for rare metal, which attracts a lot of attention from public. Similar to the case of E Zu Bao, Fan Ya also issues a financial product through its on-line platform, which is called "Ri Jin Bao"("日金宝"). It is the financial product Ri Jin Bao that attracts investor's money to Fan Ya exchange, which is finally bankrupt due a Pinzi scheme.

In August 2015, due to the bankruptcy of the "Ri Jin Bao" platform, Fan Ya exchange announces restructuring and stops the entrusted business. In the case of Fan Ya, around 220,000 investors in 27 provinces are involved, and more than 43 billion RMB were irrecoverable. In addition to E Zu Bao, the case of Fan Ya also has a huge impact on the development of Internet finance industry.

3.4.2 Key Features of the Exchange

Fan Ya non-ferrous metal exchange trading market was established in 2011 in Kunming city, Yunnan province. In March 2011, the leaders of Kunming city attended the opening ceremony of Fan Ya metal exchange and signed a strategic

cooperation agreement with the exchange. Fan Ya describes its business model as “hoarding metal for the state”. The official media has repeatedly promoted Fan Ya exchange, which has increased its popularity and credibility for the public. In this subsection, we discuss some features of Fan Ya metal exchange.

3.4.2.1 Trading at a High Premium

According to no-arbitrage principle in finance theory, the same assets (or cash flows) should have the same prices. Suppose two assets have different prices, there would be an arbitrage opportunity for speculators by simultaneously selling the asset with higher price and buying the asset with lower price. If there are many arbitrageurs in the market, the selling and buying pressure would bring the asset prices back to the fundamental. However, for Fan Ya metal exchange, the no arbitrage principle no longer applies. Take the metal indium as an example, in April 2011, the price of indium in Fan Ya consecutively hit the trading limits. The highest price reached 857 RMB for every 100 grams while the spot price outside Fan Ya exchange during the same period was only around 500 RMB. For rational investors, they can buy indium in the spot market outside Fan Ya and sell the metal to the Fan Ya exchange for a sure profit, which can decrease the metal prices in Fan Ya exchange. However, even the arbitrage space obviously exists, there is no changes in prices. Why is the metal in the Fan Ya exchange so expensive? Why does the no-arbitrage theory not hold anymore? In fact, this phenomenon is related to the business model of Ri Jin Bao, and it is also due to the trading restrictions in the exchange.

First, only a limited number of traders can trade in Fan Ya exchange. According to the regulations of Fan Ya exchange, only the traders with Fan Ya membership can have trading desks to sell the metal. The explanation for this rule, from an insider of Fan Ya, is stated as “because the quality of the goods sold by other traders cannot be guaranteed, and the traders without a membership cannot afford the fees for quality tests”. Therefore, this rule excludes the short sellers in the exchange. Second, the prices and quantity of goods traded in exchange are limited. In normal exchanges, buyers and sellers submit the orders, and once their orders are matched, the trade happens. However, in Fan Ya exchange, the management team can refuse some of the orders without reasonable explanations, which also limits the arbitrage.

3.4.2.2 A Contrarian Trading Mechanism

Fan Ya has a unique trading rule, call “contrarian or reverse trading mechanism”. As said by a Fan Ya analyst: “ after the sellers receive the full payment, they need to take out 20% of the money in the electronic disk to submit a purchase order. By doing so, selling goods will not decrease the price.” The contrarian trading mechanism was designed to stabilize prices and prevent blowups. However, it provides cash flows for Fan Ya exchange to conduct the Ponzi scheme. We will discuss this in detail shortly.

Fig. 3.12 Business model of FYME

To sum up, the government's endorsement and Fan Ya's own propaganda attract many traders to trade in the exchange. Fan Ya's restrictions on seller qualification, transaction amount and trading restrictions on reverse operation prevent the price from falling. As a result, the metal prices are higher in the exchange than those outside the exchange. On the one hand, higher prices have thinned the already small volume of non-ferrous metals. On the other hand, high prices cause buyers unwilling to take delivery and have to pay a late delivery fee to sellers. In this case, Fan Ya management team urgently needs a measure to activate the trading market and stabilize the price trend.

3.4.3 Business Model of "Ri Jin Bao" in FYME

In the light market trading environment, Fan Ya launches the Ri Jin Bao platform, which is officially defined as Fan Ya's fund fiduciary business. The operation model of Ri Jin Bao is shown in the Fig. 3.12.

Before The launch of Ri Jin Bao platform, only metal suppliers and buyers were involved in transactions. The suppliers sell the goods and receive payment from buyers in the Fan Ya exchange. The buyers made the purchase with a 20% down payment, and an additional fee is required for a deferred delivery. After the launch of Ri Jin Bao platform, there are third parties who participate in original trading between suppliers and buyers. As shown by Fig. 3.12, with Ri Jin Bao platform, although metal suppliers still sell goods and buyers pay a 20% down payment, the suppliers receive the full payment from Ri Jin Bao investors. The metal suppliers receive payment and deliver the metal, so the metal becomes collateral to Ri Jin Bao investors. If the delivery is delayed, the buyers still have to pay an annual interest of 18.25% deferred settlement fee, of which 2/3, about 13%, will be paid as interest to Ri Jin Bao investors. Thus, Ri Jin Bao investors effectively lend money to the buyers and then receive the interests accordingly.

In addition, Ri Jin Bao also has several characteristics. First, the operation process is simple, and users only need to submit a copy of the front and back of ID card to open an account. Only some basic personal information about bank cards is needed.

Second, the purchase threshold is low. Investors can participate in the trading as long as they have 1000 RMB. Third, the investments to Ri Jin Bao have high and stable returns with flexible access. Ri Jin Bao operates in a similar way to Yu E Bao and theoretically can be withdrawn on the T + 0 basis. However, the yield is much higher than that of Yu E Bao, it is very attractive to ordinary investors. Fourth, the transaction seems to be secure because the exchange is regulated by the government, and the daily transaction data are being submitted to the State Council. At the same time, the margin accounts in the transaction are managed by the third-party bank that further ensuring the security of funds to a certain extent.[7] Nonetheless, Fan Ya exchange is bankrupt in 2015.

3.4.4 The Bankruptcy

In a normal trading market, the business model of Ri Jin Bao should not have too much trouble. However, in a market with low trading volume and high prices, Ri Jin Bao easily becomes a vehicle for Fan Ya to illegally raise funds from public. Because Ri Jin Bao investors effectively provide financing for buyers, the buyer's deferred delivery fee is the source of profits for Ri Jin Bao investors. However, when the transaction price is much higher than the price in other markets, buyers are unwilling to purchase even if they are financed through Ri Jin Bao investors. If no buyers buy the metal, there are no returns for Ri Jin Bao investors.

On May 9, 2013, for example, the sellers delivered 840,000 hands transactions, but the buyers delivered only 49,600 hands, which results in a significant order imbalance in the exchange. On some trading days, it is found that the buyers' orders are only 0.5% of the sellers' orders. Although buyers have no financing needs, Ri Jin Bao investors, lured by high-interest rates and flexible withdrawal, have grown rapidly. Similar to the case of E Zu Bao, billions of funds flow into Ri Jin Bao platform. For this reason, the interests payable to investors for Fan Ya increase rapidly. To repay investors, Fan Ya skips the buyers, and uses investors' money to trade directly with metal suppliers without investors' permission, as shown in Fig. 3.13. Because of the rule of contrarian trading mechanism for suppliers, the interest is repaid with the money from the suppliers' contrarian trading.

Figure 3.13 describes the whole procedure of business model of Ri Jin Bao platform. First, Fan Ya uses the money from Ri Jin Bao investors to buy goods from metal suppliers directly. Because the metal price in the Fan Ya exchange is higher than that in other markets, the suppliers can make an arbitrage in the exchange if they have membership. For example, if the spot precious metal price is 125 RMB in the exchange and is 100 RMB outside the exchange, the suppliers can buy the

[7] Fan Ya states that some commercial banks are the third-party banks for supervision, and investors can buy Ri Jin Bao products directly from commercial banks. However, no commercial banks acknowledge that they have sold Ri Jin Bao products.

Fig. 3.13 Business model of Ri Jin Bao

medal with a price of 100 RMB in other markets and sell it to Fan Ya exchange at a price of 125 RMB. As shown in Fig. 3.13, the Ri Jin Bao investors pay 125 RMB for a unit of rare metal and effectively buy the metal. Second, the suppliers conduct the contrarian trading and buy back 20% of metal they sell to Ri Jin Bao investors. For one unit of metal with a price of 125 RMB, suppliers need to pay 25 RMB ($125 \times 20\% = 25$ RMB) to theoretically buy back 20% of metal. Because there are no buyers in the exchange, the 25 RMB are usually used to pay the interests of Ri Jin Bao investors.

In the above numerical example, the suppliers do not lose money, and 25 RMB can cover the interests of Ri Jin Bao investors for a year. For suppliers, they just sell the metal to Fan Ya exchange, but why do they want to buy the metal back? The secret is that the metal price in Fan Ya exchange is extremely high, and even the suppliers buy back 20%, they still make a handful profit. In the numerical example, if the reverse trading is done, the suppliers can end up with 100 RMB (125–25 = 100 RMB), which means they do no lose any money. In April 2011, the indium price in Fan Ya exchange peaked at 857 RMB per 100 grams, but the spot price outside Fan Ya is only about 500 RMB. The premium in the exchange is 71.4% (857/500–1 = 71.4%). For this reason, the suppliers would certainly not lose money, and are happy to conduct a contrarian trading and still make an arbitrage profit.

However, 20% of contrarian trading from suppliers covers only interest payments for 1 year. In order to prevent the rupture of the capital chain, Fan Ya has taken three measures. First, Fan Ya maintains exchange prices more than 25% above the market price so that suppliers will not lose money. Second, Fan Ya maintains a 20% annual increase in transaction prices, which is designed to cover suppliers 18.25% annual deferred delivery fees. The two measures allow suppliers to sell at a premium while ignoring the 20% contrarian trading orders to Fan Ya. Third, Fan Ya continues to attract new investors. If the first two measures are aimed at appeasing producers, the third measure is to supplement cash flows for illegal fund-raising. Then Fan Ya platform essentially becomes a Ponzi scheme.

Fan Ya uses the fund from Ri Jin Bao investors to buy the metal directly, which leads to the false high demand in Fan Ya. From Fan Ya's perspective, the bulk purchase of rare metals is "stockpiling for a national reserve". However, for the

precious metal indium, the stocks in Fan Ya are as high as 3, 500 tons, while the demand of indium for China is just 20 tons a year. In fact, in the physical spot market, precious metal indium is heavily oversupplied, so the argument for “state storage” and competition for pricing power does not hold. As a result, the malicious bid up of rare metal prices is only a means for Fan Ya to maintain its illegal funds. Moreover, Ri Jin Bao investors suffer a huge loss because Fan Ya uses their money to buy indium directly. Finally, because the stock market went up sharply from 2014 to 2015, Ri Jin Bao investors want to withdraw their money and invest in the stock market, so the cash chain of Ri Jin Bao is broken, and Fan Ya goes bankrupt.

3.4.5 Lessons from Fan Ya

Based on the discussion above, the main model of operation of Fan Ya is also not a financial innovation. In fact, Fan Ya is also defined as illegal fund-raising. In this section, we summarize the lessons that we can learn from the case of Fan Ya exchange.

3.4.5.1 Irregular Operation of the Platform

The original transaction rules of Fan Ya are adjusted according to the matching ratio, the ratio of actual demand and supply of the investment. When the matching ratio is less than 1, it indicates that invested capital is greater than the that demanded in the exchange. If the matching ratio is greater than 1, the platform is underfunded. However, in order to maintain the platform’s popularity, Fan Ya conducted fraudulent buying orders of the metal. In this case, Ri Jin Bao investors became actual buyers of metals. The high-interest payments come from new money inflows, so Fan Ya gradually became a Ponzi scheme.

3.4.5.2 The Price Premium

Fan Ya limits the number of suppliers and their costs by increasing the entry costs for suppliers. Combined with the contrarian trading rules, Fan Ya easily controls the price and quantity of rare metals, which allows the Fan Ya exchange to consistently sell rare metals at a premium of more than 20%. The artificially high premium is obviously against the law of the market, which is bound to be unsustainable.

3.4.5.3 The Imbalance Between Metal Supply and Demand

In the Fan Ya exchange, the demand for metal is quite small relative to the supply. The high price premium of the Fan Ya platform has attracted a large number of

suppliers. As a result, Fan Ya has a stockpile of rare metals that could supply the entire country for hundreds of years. Moreover, as Fan Ya does not have a monopoly status on rare metals, the oversupply will inevitably lead to plummet of price and collapse of the exchange.

3.4.5.4 The Media and Celebrity Effect

Similar to E Zu Bao, Fan Ya also advertises in mainstream media, including CCTV and other mainstream TV channels for Yunnan province. During the opening ceremony of Fan Ya, the leaders of Yunnan province and Kunming city and some celebrities in both industry and academia all support the business model of Fan Ya. For common people, the support works as the collateral that promotes the borrowing and lending relationship to happen, which is also the reason behind the case of Fan Ya. We will discuss the economic theory behind this phenomenon in Chap. 6.

3.5 P2P Platforms and Other Financial Markets

P2P lending often works as a shadow banking system, which may have a link to other markets. In this section, we discuss the link between P2P platforms and stock markets, which is from a recent paper by me and other coauthors (e.g., Liu et al. 2021). In the paper, we show that stock market bubbles can exacerbate credit risks of P2P lending by analyzing more than 450,000 loans from Renrendai.com, a leading Chinese P2P lending platform. To be specific, we show that when the Shanghai Stock Exchange composite index exceeds 3500, both the default rate and the degree of delinquency rise disproportionately. The number 3500 of stock index can be seen as a threshold for investors' attention-grabbing. Once the number exceeds 3500, investors rush into the stock market, and P2P platforms provide channels of shadow banking for investors. Therefore, the risk from stock market can be transferred to the P2P platforms. In the following subsections, we first introduce the 2015 stock market turmoil in China and Ren Ren Dai platform, and then show the link between P2P and stock market.

3.5.1 The 2015 Stock Market Turmoil in China

China's stock market has experienced tremendous growth over the past two decades. In 2006, the total market capitalization of China's stock market did not surpass 1 trillion USD (Carpenter and Whitelaw 2017). However, by 2020, it had grown more than ten times to over 10 trillion USD, making it the world's second-largest.

Unlike the U.S. market, China's stock market is dominated by retail investors who contribute 85% of the daily trading volume (Jones et al. 2020).

However, such a high growth rate is often accompanied by extreme turbulence. One such example is the stock market run-up and crashes in the spring and summer of 2015. From June 2014 to June 2015, prices in the SSE increased more than doubled. In June 2014, the SSE composite index was only approximately 2000. The index experienced steady growth to approximately 3100 in January 2015, followed by a strong run-up, peaking at 5178 in mid-June. An unusually large part of this run-up was fueled by enthusiastic retail investors who borrowed to buy equities.

The market dropped dramatically starting on June 15. By July 9, the Shanghai stock market had fallen 30 percent, as 1400 companies, or more than half listed, filed for a trading halt in an attempt to prevent further losses. A third of the market capitalization of A-shares on the SSE was lost within 1 month (Bian et al. 2021). The episode continued with major aftershocks on July 27 and August 24. By the end of August 2015, the SSE composite index was approximately 2851, almost 50% less than its peak value immediately before the bubble burst. Excessive leverage and subsequent leverage-induced fire sales are considered the main contributing factors to this market turmoil instead of fundamental conditions related to the real economy. In response, the Chinese government aggressively purchased stocks to support prices, and the market eventually stabilized in mid-September 2015.

3.5.2 Ren Ren Dai

Founded in May 2010, Ren Ren Dai was one of the first peer-to-peer marketplaces in China, providing online credit and investment services to individual borrowers and investors. It mainly targeted white-collar employees and small business owners as its customers, profiting from management fees charged to borrowers. There was no requirement on the minimum level of wealth or historical records for borrowers on the platform. Instead, the company managed default risks by measuring borrowers' income, occupation, assets, and family connections. Lenders were compensated by a high-interest rate, which far exceeded the one-year deposit rate from commercial banks. The rise of the platform attracted significant attention from the industry and was considered a rising star for financial innovation. As a result, it was included in the list of the top 100 Internet companies in China and the Hu Run New Financial 100 list.[8] Ren Ren Dai was also widely considered a safe peer-to-peer platform with minimal credit risk. It was the only peer-to-peer company certified with a AAA credit rating by the Credit Rating Center of Internet Society of China.

Ren Ren Dai has experienced steady growth since 2013. In January 2013, the total number of loans from Ren Ren Dai was only approximately 5000. By June 2015, this number rose more than 80 times, reaching over 400,000. The growth of

[8]The Chinese name for Hu Run is "胡润".

Ren Ren Dai was accompanied by the run-up of China's stock market. This positive correlation between the two markets echoes our main hypothesis that stock market bubbles spur individuals' borrowing activities. The interaction between the stock market and the lending market was particularly relevant in China since the CSRC imposed very stringent rules to qualify for brokerage-financed margin trading. Instead, many retail investors turned to the online shadow-financing system for margin trading (Bian et al. 2021). Unlike the brokerage-financing system, the shadow-financing system was in a regulatory gray area that did not require a minimum level of wealth or trading history, providing, instead, a high-interest rate to lenders. Following the market turbulence, 2015 also witnessed a wave of bankruptcy in the peer-to-peer industry; by the end of 2015, more than one-third of peer-to-peer companies had become "problem platforms", and shadow financing was believed to be one of the major factors. Ren Ren Dai exhibited all the characteristics of a shadow-financing platform.

On June 12, 2015, the CSRC released a set of draft rules to regulate the shadow-financing system, aiming to tighten leverage constraints. From the following trading day, the market started to take a drastic plunge. The activities from Ren Ren Dai also took a hit. The accumulation in the total number of loans from Ren Ren Dai slowed down dramatically during the stock market turmoil, from over 40,000 loan applications per month to less than 10,000. This was likely driven by both the CSRC announcement and the bursting of the stock market bubble.

3.5.3 P2P Platforms and Stock Market

Anecdotal evidence suggests that Chinese retail investors borrow money through P2P platforms for equity investments. In late 2014, driven by bull market sentiment, many P2P platforms began to operate "equity allocation" businesses online. This so-called "equity allocation" stimulated investors to borrow money through online P2P platforms to trade in stock markets. The standard financing ratio is about five times. That is, if an individual has 100,000 RMB, he or she can borrow another 500,000 RMB for equity investments. The high leverage nature makes P2P lending very attractive since the maximum financing ratio for margin trading accounts with brokers is only 60%. To make matters worse, essential investor education and proper risk warnings are missing. For example, one P2P platform published a seductive slogan: "I pay, you invest, and all profits go to you". In June 2015, just before the stock market collapsed, borrowing from P2P lending peaked at approximately 200 billion RMB (Bian et al. 2021). Thus, the risk of P2P platforms depends on the behaviors of the borrowers. If the borrowers use the money to invest in the stock market, the risk of stock market can be transferred to the P2P platforms.

We first show that investors' attention is indeed grabbed by the threshold of stock index, 3500. Anecdotal evidence suggests that the 3500 threshold serves as an attention-grabbing event that lights up investors' enthusiasm. For example, on March 17, 2015, when the SSE composite index exceeded 3500 for the first time

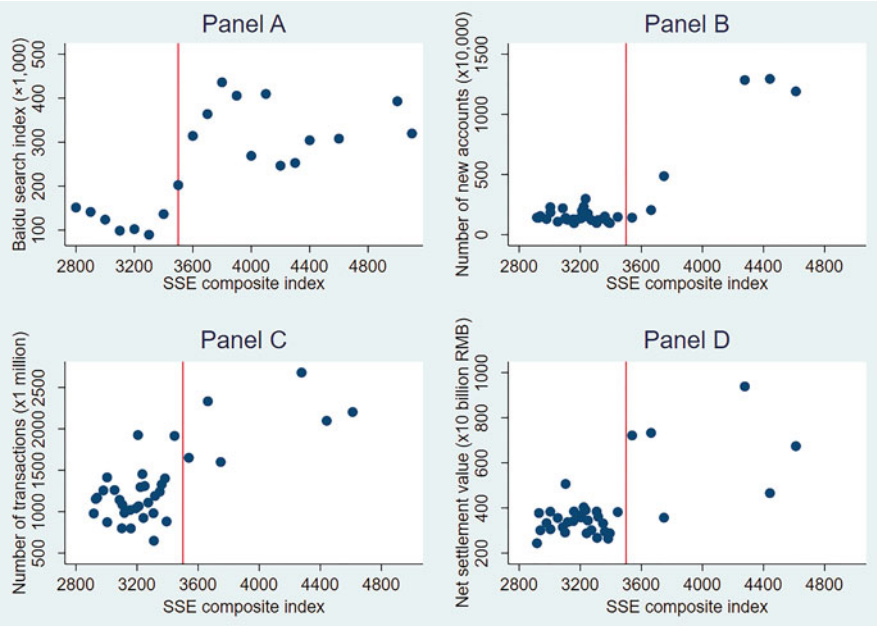


Fig. 3.14 Baidu search index, market participation, and the SSE composite index

in 7 years, the mainstream media described it as a sign of "a new round of the bull market". Figure 3.14 (Fig. 3.2 in Liu et al. (2021)) shows that investors' attention increases disproportionately after the stock index exceeds the 3500 threshold. In Panel A, the authors compare the relation between the SSE composite index and the subsequent search index provided by Baidu, i.e., the most important search engine in China. The Baidu search index is mainland China's version of the Google search index, calculated from search histories all over the country through its search engine. It provides a quantitative measure of internet search intensity through Baidu based on keywords (He and Li 2021).

In Panel A, the authors group the daily SSE composite index levels by a bandwidth of 100. Each dot represents the mean Baidu search index within each corresponding index bandwidth. For example, the dot at 3500 indicates that when the SSE composite index is within the range of 3500–3600, the average subsequent Baidu search intensity for the stock market is approximately 200,000. Panel A shows that the Baidu search index has a clear structural break with respect to the SSE composite index. When the index is below 3500, the search intensity is below 200,000, indicating relatively low attention from the public. However, after the index pumps over 3500, attention to the stock market intensifies; the search index doubles to a peak of over 400,000 and remains at a higher level.

As a result of such strong bull market sentiments, markets witnessed a record-breaking participation, as shown by increases in the number of new brokerage accounts and trading volumes. To show these trends, the authors collect monthly

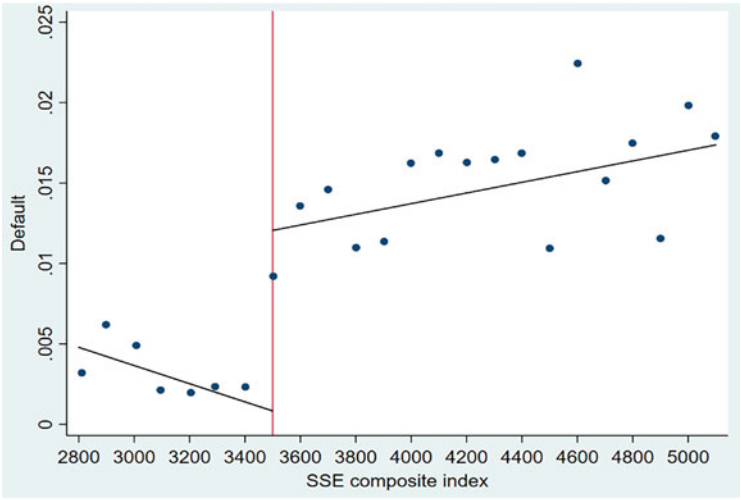
aggregate market data from China Securities Depository and Clearing Corporation (CSDC). CSDC is the exclusive clearing house for both Shanghai Stock Exchange and Shenzhen Stock Exchange, the two major stock exchanges in mainland China. Three proxies are used to capture market participation: (1) The number of new accounts, measured in 10,000, documents the number of new brokerage accounts created in each month. This is a direct proxy for retail participation as China's stock markets are dominated by retail investors; (2) The number of transactions, measured in millions; (3) The net settlement value, measured in 10 billion RMB, is the absolute RMB difference between buy and sell orders in each month.

Panels B-D of Fig. 3.14 shows the monthly measures against their corresponding month-end SSE composite indexes. Consistent with the pattern in Baidu search index, market participation and trading surged after the 3500 SSE index level. For example, when the SSE composite index exceeded 3500 in March, 2015, the number of new accounts increased from about 1.1 million in February, 2015 to roughly 4.9 million. Similarly, the number of transactions jumped from about 650 million to roughly 1.6 billion; the net settlement value rose from about 2.7 trillion RMB to roughly 3.6 trillion RMB.

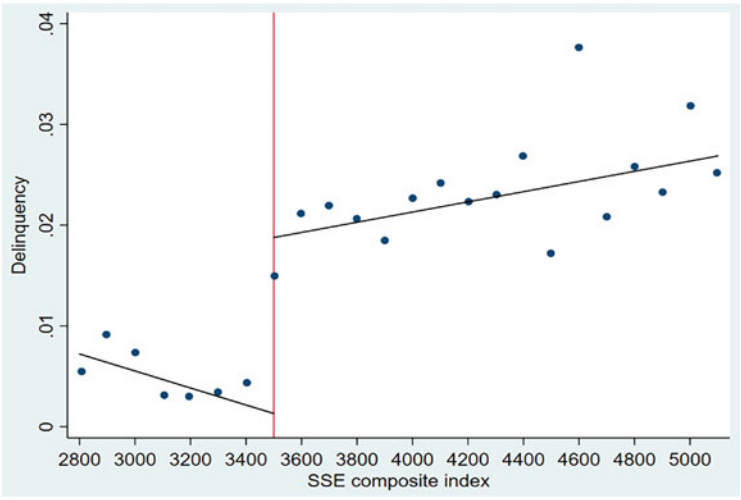
Next, we need to show that the credit risk of P2P platforms is indeed affected by the stock market, especially the threshold of 3500. Figure 3.15 (Fig. 3.2 in Liu et al. (2021)) presents the relation between credit risk from Ren Ren Dai and the SSE composite index. Similar to Fig. 3.14, the authors first group daily SSE composite index levels by a bandwidth of 100. Each dot in Panel A (Panel B) represents the mean Default (Delinquency) for all loans borrowed with a lagged index within the bandwidth. For example, in Panel A (Panel B), the average default rate (delinquency rate) for loans borrowed in the 3500–3600 bandwidth is approximately 0.009 (0.015). Both panels in Fig. 3.15 indicate the structural breaks in Default and Delinquency above the 3500 threshold. For example, Panel A of Fig. 3.15 shows that loans borrowed below the 3500 threshold have an average default rate of approximately 0.0029. However, for loans borrowed above the 3500 threshold, the average default rate increases to 0.0137 and can go as high as 2.3% for loans borrowed near the peak value of the index. Overall, Fig. 3.15 documents a strong contagion effect: stock market bubbles spur a disproportionate increase in credit risks in the P2P lending market.

3.6 Summary

The P2P industry appeared in 2007, reached the peak of industry development in 2016, and then shrank extremely in 2020. In the early stage, as an innovation of FinTech, the P2P industry grows rapidly, which is inseparable from the early loose regulatory attitude of the regulatory authorities. However, the failures of E Zu Bao and Fan Ya demonstrate the risks of the development of FinTech. The definition of P2P is just a combination of direct lending and Internet platform, which is not innovative at all. However, the unregulated industry is supported by mainstream



Panel A: Default



Panel B: Delinquency

Fig. 3.15 Credit risk from Ren Ren Dai and the SSE composite index

media and some celebrities, which attracts many ordinary investors, accumulating significant risks. In fact, some P2P platforms simply work as the shadow banking system in China and can sometimes exacerbate the risk of stock market.

References

Bian J, Da Z, He Z, Lou D, Shue K, Zhou H (2021) Margin trading and leverage management. University of Chicago, Becker Friedman Institute for Economics Working Paper (2021-29)

Carpenter JN, Whitelaw RF (2017) The development of China's stock market and stakes for the global economy. Annu Rev Financ Econ 9:233–257

He Q, Li X (2021) The failure of Chinese peer-to-peer lending platforms: finance and politics. J Corp Finan 66:101852

Jones CM, Shi D, Zhang X, Zhang X (2020) Heterogeneity in retail investors: evidence from comprehensive account-level trading and holdings data. Available at SSRN 3628809

Liu X, Ni X, Qiu Z et al (2021) Like a moth to a flame: does the stock market exacerbate credit risks of peer-to-peer (P2P) lending? Available at SSRN 3905453, 2021

Chapter 4
Development of FinTech in Academia

The development of FinTech is rapid, and its development in the industry is often faster than that of regulators and academia. However, as we discussed in Chap. 3, P2P platforms are risky, so proper regulations are needed. Moreover, we need to understand the essence of financial technology, so academic research in this field is essential. In this chapter, we discuss the development of FinTech in academia.

4.1 Introduction

It is estimated that the market value of global FinTech is about $7301.78 billion in 2020, and it is expected to maintain a compound annual growth rate of 26.87% until 2026.[1] With the expansion of FinTech's global influence, how FinTech would change the economy, such as financial market, has increasingly become a hot topic in academia. For example, the leading academic finance journal, the Reviews of Financial Studies (RFS), launches three special issues related to FinTech, which are the special issue for "2019 RFS-NBER Conference on Big Data: Long-Term Implications for Financial Markets and Firms" in 2019, the special issue for "To Fintech and Beyond" in 2019, and the special issue for "Big Data in Finance" in 2021, respectively. Such intensive special issues for one topic are rare for RFS, indicating the attitude of academia to the topic of FinTech.

In this chapter, we will focus on the top journals in the field of economics and finance, and briefly sort out the academic papers on FinTech and related topics emerging in recent years. We hope that we can help readers have a preliminary

[1] https://finance.yahoo.com/news/global-fintech-market-report-2021-130300659.html?guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS5oay8&guce_referrer_sig=AQAAALDMW6DCjFpYdhgwH_L_eWw72XhoUKaGUNzBael_cIkVf3eDcF36DCaIhGDNIWVQrZtQG5bqtKjxNzyCerNc_8cRrmT2ITQ9vWx2S3umv6X5XSjcaIypbt2NyaUzPD1pPnMBPH5k6zdvQWmxfWApESO-qX93XWFckQqq2tK8l_Nd&guccounter=2.

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_4

understanding of the history and current situation of the development of FinTech in academia. In the first part of this chapter, we will classify and count all the literature involved in this chapter, so as to facilitate readers to form a simple structure of the current academic FinTech development in their minds. Then, we will sort out the literature development based on each specific topic, with a particular focus on big data.

As Gang Yi, the governor of the People's Bank of China, said at the 2020 Financial Street Forum Annual Meeting on December 21, 2020, "what we call FinTech can be summarized according to five English letters: A (Artificial Intelligence), B (Big Data), C (Cloud Computing), D (Distributed bookkeeping or Blockchain) and E (E-commerce) in which big data is the most important because almost all science, technology as well as financial services are based on big data."

Big data is the foundation of the development of FinTech. Therefore, in the second part of this chapter, we will discuss the development of the literature of big data in economics and finance. Specifically, we will summarize the literature on the definition of big data in the economic and finance, the impact of big data, and the technologies used in the application of big data. Then, we will introduce other hot topics in FinTech, including blockchain, cryptocurrency and online lending. Finally, we will discuss the relationship between traditional finance and FinTech. The emergence of FinTech has brought a great impact on traditional finance system. Academia has been debating whether traditional finance system and FinTech are substitutes or complements to each other. We briefly discuss the development of the traditional finance system and FinTech and the challenges FinTech will face in the future development process.

4.2 Overview of the Literature in FinTech

In this section, we provide an overview of the literature development in FinTech, showing the statistics of the papers we will discuss in the chapter. Table 4.1 describes the quantity distribution of literature in top economics and finance journals that will be discussed in this chapter. There are about 75 papers in total.

Table 4.1 Research papers by journal in this chapter

Journal	Articles
Review of Financial Studies (RFS)	20
Management Science (MS)	16
National Bureau of Economic Research (NBER)	7
American Economic Review (AER)	5
Journal of Finance (JF)	3
Journal of Financial Economics (JFE)	3
Journal of Economic Literature (JEL)	3
Journal of Economic Perspectives (JEP)	3

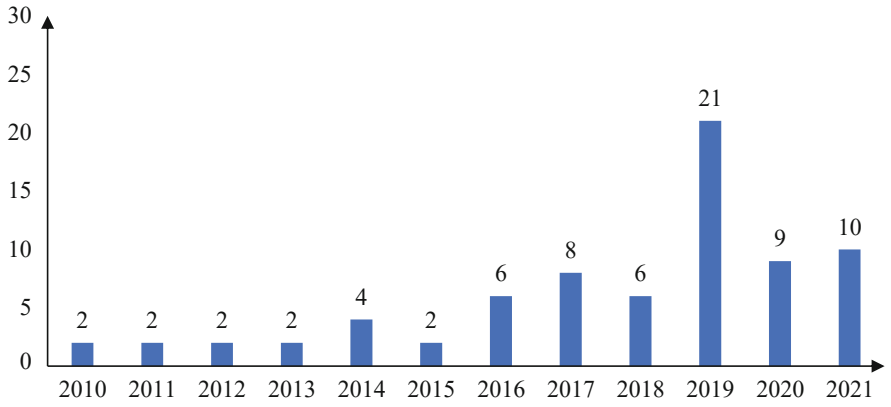


Fig. 4.1 Articles by year in this chapter (From 2010)

Among the top journals, Reviews of Financial Studies ranks the first and publishes 20 papers for the topic of FinTech. The reason is that Reviews of Financial Studies launched FinTech special issues in both 2019 and 2021. The second top journal is Management Science, which also has great interests in FinTech, Big data and other related topics, with a total number of 16 papers published. Moreover, there are many high-quality working papers in NBER, but due to the limited space of this paper, only seven articles are cited here. Other top journals such as AER, JF, JFE, JEL, JEP also focus on topics of FinTech to some extent. Moreover, in addition to the papers listed in Table 4.1, we also consider some working papers by well-known scholars in SSRN, and some related papers in the top finance journals, including Review of Finance, Journal of Quantitative and Financial Analysis. Because we only have a small number of those papers, and distribution is scattered, so they are not listed in Table 4.1.

Figure 4.1 describes the publications of the literature involved in this chapter over time, which shows the changes in the number of journals after 2010 (including 2010). We can see that since 2016, the number of papers in FinTech or related fields published in economics and finance has increased suddenly, reaching a peak of 21 in 2019. In 2020 and 2021, there are 9 and 10 papers published in top journals each year, representing enthusiasm of scholars in the field.

4.3 The Literature on Big Data

4.3.1 The Definition of Big Data in Finance and Economic

In the field of computer science and statistics, big data is normally described with characteristics of "3 Vs", namely volume, velocity and variety. However, in the field of economics and finance, big data is used to solve interesting economics and finance

problems. In the 2021 RFS special issues, Goldstein et al. (2021) argue that big data in the field of economics and finance should have at least one of the following three characteristics: large size, high dimension, and complex structure. Because researchers in finance and economics often use micro-level and transaction-level data, so they care about the three characteristics.

First, large size means that the volume of data is huge. For example, in the financial market, the trading data can often reach the daily frequency, even the higher frequency of hour and minute, and the orders for each market trader. Second, the high dimension can refer to transaction information (including time, price, transaction volume, currency type, etc.), trader information (including both parties), transaction market information, macro factors, etc. Third, the complex structure includes textual information (Loughran and McDonald 2011; Buehlmaier and Whited 2018; Ke et al. 2019; Gentzkow et al. 2019), pictures (Duarte et al. 2012), audio, video, and other unstructured data. Therefore, big data can make up for the shortcomings of traditional structured data (such as stock market trading data, macroeconomic data, etc.) and describe economic activities more accurately.

4.3.2 The Effects of Big Data

Big data is widely used for economics and finance (Tambe 2014; Brynjolfsson and McElheran 2016; Zhu 2019; Ichihashi 2020; Farboodi et al. 2020), and with the emergence of more and more big data, researchers start paying attention to the economic impact of big data (Varian 2014; Goldfarb and Tucker 2019; Goldstein et al. 2021). One positive impact of big data is that it can reduce economic costs. For example, Goldfarb and Tucker (2019) argue that with the popularization of digital technology, the search costs of consumers searching for high-quality products will be reduced. Therefore, geographical distance is no longer an obstacle between buyers and sellers, so transportation costs are reduced.

Moreover, the use of big data affects market efficiency. On the one hand, big data can enable investors to have more data and better predict asset returns, so as to improve market efficiency (Goldstein et al. 2021). Moreover, in the process of online lending, more voluntary and unverified information disclosure also reduces borrowing costs and improves market efficiency (Michels 2012). On the other hand, "big data" may induce traders to use information from others rather than doing fundamental research on the firms, which may decrease market efficiency (Farboodi et al. 2020). If the future price, which depends on future information, is difficult to predict today, there will be future information risk. The competition between static risk reduction and future information risk determines the long-term market efficiency.

Some scholars pay attention to the impact of big data on corporate finance (Bajari et al. 2018). Zhu (2019) shows that the use of big data can effectively reduce the opportunistic trading of managers and improve the investment efficiency of the company. The introduction of big data can reduce the cost of information acquisition and improve the price informativeness of the company's stock price. However, the

impact of big data is heterogeneous. Begenau et al. (2018) find that large companies in the financial market benefit more from big data than small companies. Large companies have more economic activities, longer company history and more data such as macro announcements, profit statements, performance indicators of competitors, export demand, etc. Those data can be processed and better predict the enterprise value and reduce the risk of investment, and therefore create more values. Moreover, in the financial market, Farboodi et al. (2020) find that with the progress of financial technology and richer data, the stock prices of large firms and growth firms increasingly reflect the information of the company's future profits, but the information content of small companies is somehow declining.

However, the use of big data also has some disadvantages. In some sense, the use of big data may exacerbate price discrimination. Ichihashi (2020) finds that the advantage of consumers' disclosure of personal information, such as browsing history, purchase status and personal characteristics, is that they can enjoy the seller's accurate push of target goods. However, sellers may use this information to distinguish prices, or directly use this information to estimate consumers' willingness to pay and redetermine the price on this basis. Such phenomena can be found on Amazon, Netfix, Spotify and other e-commerce platforms. From the perspective of personal privacy, the use of big data may cause concerns about privacy disclosure, which leads to negative externality at the social level (Horvitz and Mulligan 2015; Acemoglu et al. 2019). In addition, the use of big data may also inhibit market competition and aggravate the inequality between large-scale enterprises and small-scale enterprises (Begenau et al. 2018; Farboodi et al. 2020).

4.3.3 The Methodology for Big Data

How to effectively extract target information from big data is a hot topic debated in academia (Varian 2014; Mullainathan and Spiess 2017; Ait-Sahalia and Xiu 2017; Aït-Sahalia et al. 2020). As pointed out by Goldstein et al. (2021), big data has characteristics of large size, high dimension, and complex structure. Because big data is more complex than traditional structural data, there are many methods proposed for the analysis of big data, which provides good methodological support for the application of the industry.

Machine learning is a data dimensionality reduction method widely used in the field of economics and finance. As defined by Gu et al. (2020), researchers "use the term to describe (a) a diverse collection of high-dimensional models for statistical prediction, combined with (b) so-called "regularization" methods for model selection and mitigation of overfitting, and (c) efficient algorithms for searching among a vast number of potential model specifications". It should be noted that correct data mining methods are a kind of extremely useful tool. These tools allow researchers to choose variables and models more rigorously and can help analyze interesting economic and financial data. However, the misuse, especially in the

high-dimensional settings, the predictions by machine learning may result in severe over-fitting (Ait-Sahalia and Xiu 2017; Goldstein et al. 2021).

In recent years, machine learning methods are widely used in asset pricing for return forecasting and factor construction (Feng et al. 2020; Giglio et al. 2021a; Kozak et al. 2020; Giglio and Xiu 2021; Giglio and Xiu 2021), in corporate finance for executive screening and improvement of the level of corporate governance (Chen et al. 2019; Erel et al. 2021; Li et al. 2021) and in market microstructure for high-frequency trading (Easley et al. 2019). The common dimensionality reduction methods include LASSO (Feng et al. 2020; Kozak et al. 2020; Giglio and Xiu 2021), elastic net (Rapach et al. 2013; Kozak et al. 2020), and principal component analysis (Ait-Sahalia and Xiu 2017; Giglio and Xiu 2021; Giglio et al. 2021a; Giglio et al. 2021b).

Among many methodologies for unstructured data, textual analysis is one of the hottest topics in recent years (Bao and Datta 2014; Cheng et al. 2019; Gentzkow et al. 2019). Hoberg and Phillips (2010) use the product description in the 10-K files to study the impact of product differentiation on merger and acquisitions and the ability of product market synergies of the companies. Hoberg and Maksimovic (2015) use10-K text to construct the measures of the company's annual financial constraints, which can describe the company's equity and debt financing status, respectively. The measures describing the equity market constraint can better capture the impact of financing growth opportunities and unexpected negative shocks caused by information asymmetry. The measure for bond market constraints can better capture the impact of corporate default. Agarwal et al. (2016) find that the text with positive (negative) tone in the Standard & Poor's (S&P) credit rating reports can significantly predict the credit rating actions. Buehlmaier and Whited (2018) use the text information from the firms' annual reports to construct the measure of financial constraints and use them to predict stock returns. Ke et al. (2019) use the supervised learning structure to extract sentiment information from the new articles of Dow Jones Newswires and then use the information to predict asset returns.

4.3.4 The Economics in Data

In recent years, big data is widely used by computer technology such as machine learning, and the importance of data in economy has gradually attracted attention. The generation of big data has caused many new problems. For example, who should own the data? How can we protect citizens' privacy when using data? How is the abuse of data prevented?

4.3.4.1 The Ownership of Data

Data is the by-product of economic activities and the storage form of information (Veldkamp 2005). Data are generated through the existence human being and their

on-line behaviors. As information is stored in the form of data, data users can analyze and process the data to create business values. Because data is the key input of many FinTech companies, and those companies make huge profits from data generated by customers. In this sense, customers may not be paid enough from the data they generate (Pope and Sydnor 2011). With the separation of data producers and data users, the ownership of data property rights naturally arises.

Different from other commodities in economics, data are noncompetitive. That is, at the technical level, data can be used indefinitely. The existing data can be used by many companies and individuals at the same time without causing the loss of the data resources. However, most commodities in economics are competitive. For example, the consumption of food will lead to the reduction of food resources. Given that data are different from other commodities in nature, defining the ownership of data is not an easy task.

The property rights of data will determine the use of data in the economy, thus affecting output, privacy, and consumer welfare. From the perspective of economics, the most reasonable ownership of property rights should be in accordance with maximization of social welfare. Jones and Tonetti (2020) believe that if the property right is granted to data users (such as enterprises), enterprises are likely to abuse data, which will in turn cause privacy disclosure. If property rights are allocated to governments and regulators, they may be in consideration of privacy protection and strictly restrict the company's use of consumer data. Although this method successfully protects privacy, it may lead to a lack of competition among enterprises, resulting in low production efficiency. On the contrary, granting data property rights to consumers can produce near optimal results. The consumers weigh the concerns about their privacy and the economic benefits of selling data to all interested parties.

4.3.4.2 Data Privacy

The extensive use of data may bring huge social benefits, but enterprises may not fully respect consumers' personal privacy. In some cases, it is likely to cause negative effects such as personal privacy disclosure (Jones and Tonetti 2020). In fact, privacy can be invaded in various ways. For example, a large amount of historical data is stored in search engines (Chiou and Tucker 2017), personal genetic testing information in medical testing may also be published without permission (Miller and Tucker 2018), and personalized advertising push is based on our on-ling shopping habit (Goldfarb and Tucker 2011). Moreover, when each of us thinks that others are selling our data at a low price, we will also take the initiative to sell our personal data at a low price, which may lead to inefficient sale of data and the collapse of the data market (Acemoglu et al. 2019). In fact, many customers provide their personal data only for a small bonus.

Acquisti et al. (2016) summarize the theoretical and empirical research papers of privacy and pay attention to the economic value and consequences of protecting and disclosing personal information. They find that the protection of privacy can both improve and reduce personal and social welfare. In the digital economy, consumers'

ability to make informed decisions about their privacy has been seriously hindered, because consumers have imperfect or asymmetric information about when to collect data, what the purpose is and what the consequences are. Abowd and Schmutte (2019) believe that the society can choose the best use of data, so as to ensure full respect for privacy.

4.4 Blockchain and Cryptocurrencies

Blockchain technology is used by Nakamoto (2008) to build up the system of a decentralized currency, Bitcoin. As discussed by Nakamoto (2008), blockchain is a distributed ledger and database. The underlying technology for blockchain is the application of Hash function, which ensures the blockchain to have the characteristics of decentralization, tamper-proof, traceability, openness and transparency. Because of the unique features, it is generally believed that in the field of finance, the applications of blockchain technology can effectively improve transaction transparency, efficiency and security (Biais et al. 2019; Cheng et al. 2019; Chiu and Koeppl 2019; Cong and He 2019). While we will have a comprehensive discussion on blockchain in Chap. 5, we nonetheless provide some academic opinions about the blockchain in the section.

In recent years, the application of blockchain technology to commercial and financial fields is widely discussed in academia. For example, Chiou and Tucker (2017) think the advantage of applying blockchain technology to securities transaction settlements is to make the settlements faster and more flexible. The potential challenge is to avoid transaction failure when there is a forked chain. Harvey (2016) believes that cryptofinance has the characteristics of security, privacy and decentralization, which can trade with the least trust and greatly reduce the transaction cost. Thus, the advantages of cryptofinance and blockchain technology outweigh the disadvantages. Cong and He (2019) argue that decentralized ledger technologies such as blockchain have the characteristics of decentralized consensus and tamper-proof algorithm execution, resulting in changes in the information environment. On the one hand, the changes can improve social welfare and consumer surplus by strengthening competition. On the other hand, applications of blockchain technology may also lead to greater collusion and welfare destruction because participants can observe transaction information.

Moreover, Raskin and Yermack (2018) think that the central bank should learn from the blockchain technology behind digital currency, improve the central bank's payment and clearing system, and launch the central bank's own digital currency. Sovereign digital currency may have a far-reaching impact on the banking system. Yermack (2017) finds that stock exchanges and many other trading entities in the finance industry use blockchain as a new method to trade stocks and track their ownership changes, which provide lower cost, greater liquidity, more accurate records and transparency of ownership. Biais et al. (2019) find that the mining

process of blockchain consumes huge power, which may cause a waste of resources, and Biais et al. (2020) study the game played by different Bitcoin mining parties.

In recent years, the price of cryptocurrency has increased exponentially, which has aroused strong public concerns. Cheng et al. (2019) find that when the 8-K files of companies have information about blockchain, due to the Bitcoin price bubbles, investors overreact to the stock prices of the companies. The high volatility of the cryptocurrencies (e.g., Bitcoin and Ethereum) also affects the behaviors of miners because the rewards of miners are also cryptocurrencies (Biais et al. 2019). However, cryptocurrency is one of the largest unregulated markets in the world. Foley et al. (2019) estimate that about a quarter of Bitcoin users are involved in illegal activities, which may include drug trading through the black market. With the emergence of other cryptocurrencies, the illegal share in Bitcoin activities has decreased, but cryptocurrency still makes "black market transactions" more easily to execute.

4.5 On-line Lending

As we discussed in Chap. 3, P2P platform is not very successful in China because it brings huge risks. In academia, P2P on-line lending is still regarded as a remarkable feature of development of FinTech, which is different from the traditional banking models. In the on-line lending model, the loan platform appropriately pre-screens loan applications, while investors further screen and decide whether to finance the loans. This online lending model is extensively discussed in the literature (Paravisini et al. 2017; Vallee and Zeng 2019; Chemla and Tinn 2020; Hildebrand et al. 2017).

The most popular market mechanisms in P2P platforms include auction, in which participants determine the transaction price through the auction process, and posted prices, which are determined by platforms. Both mechanisms depend on the matching of capital supply and demand. Wei and Lin (2017) argue that in the case of posted prices, (1) borrowers have higher probability of obtaining financing, but the preset interest rate is higher than the interest rate in the auction; (2) Under the same conditions, the default rate of loans with posted prices is higher; (3) Posted prices make loans faster.

One of the advantages of the online lending is that it can provide convenient and rapid financial services, so as to improve consumer welfare. For example, Fuster et al. (2019) find that FinTech on-line loan companies have increased 20% of the loan speed and efficiency without increasing the default risk. The key is to find the borrowers with high default risk. For the low-quality borrowers, soft and nonstandard information is very important (Iyer et al. 2016; Butler et al. 2017). For example, friendship networks in the on-line P2P lending can be regarded as a signal for credit quality (Lin et al. 2013). The advantage of FinTech loan companies is that they can use their technical advantages to obtain soft information related to the borrowers' credit, especially for small and medium-sized enterprises and individual consumers with incomplete credit records (Fuster et al. 2019). At the same time, the popularity

of FinTech can reduce the impact of negative bias in credit markets, improving the inequality in the credit market (Philippon 2019). Although online lending has advantages in providing financial services, the loan repayment rate can only be guaranteed under the necessary platform and government supervision (Du et al. 2020). In Chap. 6, we will proved our view about online lending in a theoretical framework, and our opinion is that the current models of P2P are not very innovative, and the future development of online lending should depends on the development of technology.

4.6 FinTech and Traditional Finance

4.6.1 The Advantage of FinTech

FinTech is composed of a series of new business models, new technology applications, new products and new services that have a significant impact on the financial market and financial services. At present, the application of financial technology has involved many fields, such as blockchain (Chiu and Koeppl 2019; Cong and He 2019; Foley et al. 2019), on-line lending (Buchak et al. 2018; Chemla and Tinn 2020; Cornelius and Gokpinar 2020), and robo-advising (D'Acunto et al. 2019).

Driven by various emerging cutting-edge technologies, FinTech has attracted extensive attention with many advantages, which are not present in the traditional finance sector. First, FinTech can make it easier to collect and analyze data in financial markets, thus reducing information asymmetry (Fuster et al. 2019). Second, FinTech can effectively reduce economic costs, break the existing industry structure and further promote financial innovation. Third, trading strategies based on artificial intelligence and big data can redefine the price discovery mechanism of the financial market, improve the transaction speed, promote the liquidity of the financial market, and improve the efficiency and stability of the financial market. Forth, the development and application of FinTech can help small and medium enterprises and the poor to obtain financial services at a lower cost and in a more convenient way (Buchak et al. 2018; Philippon 2019), promoting the realization of inclusive finance. Fifth, FinTech innovations of enterprises can effectively increase the value of firms (Chen et al. 2019).

4.6.2 Substitute or Complement?

It is generally believed that disruptive technological changes will have an impact on traditional industries (Ferrari et al. 2010), so does finance industry. Chen et al. (2019) find that when the patent innovations involved in FinTech belong to destructive technological innovation, they have a strong negative impact on the formation of the traditional finance industry. Although Chen et al. (2019) provide some empirical

evidence, there is still a great controversy on whether FinTech and traditional finance are substitutes or complements.

There are basically three mainstream views in academia. First, FinTech will replace the traditional finance industry. FinTech has advantages based on the technologies used for financial services, which may have disruptive impact on traditional finance industry (Vallee and Zeng 2019; D'Acunto et al. 2019). Second, FinTech and traditional finance models are complementary to each other. For example, Buchak et al. (2018) find that, for the housing mortgage loans, FinTech loan company can lend at a lower cost, providing better products by the technical advantages. Therefore, compared with other shadow banking systems, FinTech lending institutions can serve borrowers with better reputations and become more active in the refinancing market, effectively filling the gap of traditional banks. Third, the effect of substitution and complementarity coexist. For instance, Tang (2019) uses the data from Lending Club and find that the borrowers from P2P platform are also the customers of banks, and the P2P lending only occurs to people who can obtain credit from banks. From this point of view, P2P platform is a substitute to banks. However, the loan amount of P2P platform is very small, and banks normally do not issue such small amount of loans. In this sense, P2P platform is complementary to banks.

4.6.3 Regulations of FinTech

The development of FinTech is irreversible (Goldstein et al. 2019), and the rapid development of FinTech is changing the industry structure for both economics and finance. In this sense, investors, government, regulators and financial institutions all face both opportunities and challenges (Buchak et al. 2018). It should be noted that institutional supervision plays a direct role in the development of FinTech, which may be as important as technological innovation itself. In principle, in order to promote the competition in the financial market, we should adopt a more flexible regulatory approach than traditional financial services. However, as FinTech is an emerging business, it seems that the regulatory authorities should adopt stricter regulations to maintain financial stability. On the one hand, the development of innovation requires flexibility. On the other hand, regulators need to find a balance between promoting financial innovation (or "enhancing competition") and dealing with financial stability. This balance is very important for realizing the value of FinTech and helps to avoid the stagnation of the development of FinTech. Otherwise, unregulated FinTech technology can cause a disastrous blow to the whole social welfare (Acemoglu 2021).

4.7 Summary

In this chapter, we sort out the literature related to FinTech in recent years. Because big data is the core of the development of FinTech, we have a special focus on big data. First, we summarize the definition, impact, methodology, data property rights and privacy of big data in the field of economics and finance. Second, we review the literature on blockchain and cryptocurrency, which are technologies related to big data and the hot topics in the field of FinTech. Third, because online lending based on FinTech can provide fast and convenient financial services, we summarize the views of online lending in academia. Finally, we discuss the unique advantages of FinTech and the relationship between traditional financial industry and FinTech.

Overall, we think the benefits of the development of FinTech can cause substantial changes in the finance industry. On the one hand, the technology development makes financial services more convenient and efficient. On the other hand, big data can provide more information which is unavailable in the traditional finance system. As a result, more people can enjoy the financial services with the development of FinTech, leading to the realization of inclusive finance. Although there are many arguments, difficulties for the future of FinTech, we are positive for its future development.

References

Abowd JM, Schmutte IM (2019) An economic analysis of privacy protection and statistical accuracy as social choices. Am Econ Rev 109(1):171–202

Acemoglu D (2021) Harms of AI (No. w29247). National Bureau of Economic Research, Cambridge

Acemoglu D, Makhdoumi A, Malekian A, Ozdaglar A (2019) Too much data: Prices and inefficiencies in data markets (No. w26296). National Bureau of Economic Research, Cambridge

Acquisti A, Taylor C, Wagman L (2016) The economics of privacy. J Econ Lit 54(2):442–492

Agarwal S, Chen VY, Zhang W (2016) The information value of credit rating action reports: a textual analysis. Manag Sci 62(8):2218–2240

Ait-Sahalia Y, Xiu D (2017) Using principal component analysis to estimate a high dimensional factor model with high-frequency data. J Econ 201(2):384–399

Aït-Sahalia Y, Kalnina I, Xiu D (2020) High-frequency factor models and regressions. J Econ 216(1):86–105

Bajari P, Chernozhukov V, Hortasu A, Suzuki J (2018) The impact of big data on firm performance: an empirical investigation (No. w24334). National Bureau of Economic Research Working Paper, Cambridge

Bao Y, Datta A (2014) Simultaneously discovering and quantifying risk types from textual risk disclosures. Manag Sci 60(6):1371–1391

Begenau J, Farboodi M, Veldkamp L (2018) Big data in finance and the growth of large firms. J Monet Econ 97:71–87

Biais B, Bisiere C, Bouvard M, Casamatta C (2019) The blockchain folk theorem. Rev Financ Stud 32(5):1662–1715

Biais B, Bisiere C, Bouvard M, Casamatta C, Menkveld AJ (2020) Equilibrium bitcoin pricing. Available at SSRN 3261063

Brynjolfsson E, McElheran K (2016) The rapid adoption of data-driven decision-making. Am Econ Rev 106(5):133–139
Buchak G, Matvos G, Piskorski T, Seru A (2018) Fintech, regulatory arbitrage, and the rise of shadow banks. J Financ Econ 130(3):453–483
Buehlmaier MM, Whited TM (2018) Are financial constraints priced? Evidence from textual analysis. Rev Financ Stud 31(7):2693–2728
Butler AW, Cornaggia J, Gurun UG (2017) Do local capital market conditions affect consumers' borrowing decisions? Manag Sci 63(12):4175–4187
Chemla G, Tinn K (2020) Learning through crowdfunding. Manag Sci 66(5):1783–1801
Chen MA, Wu Q, Yang B (2019) How valuable is FinTech innovation? Rev Financ Stud 32(5): 2062–2106
Cheng SF, De Franco G, Jiang H, Lin P (2019) Riding the blockchain mania: public firms' speculative 8-K disclosures. Manag Sci 65(12):5901–5913
Chiou L, Tucker C (2017) Search engines and data retention: Implications for privacy and antitrust (No. w23815). National Bureau of Economic Research, Cambridge
Chiu J, Koeppl TV (2019) Blockchain-based settlement for asset trading. Rev Financ Stud 32(5): 1716–1753
Cong LW, He Z (2019) Blockchain disruption and smart contracts. Rev Financ Stud 32(5): 1754–1797
Cornelius PB, Gokpinar B (2020) The role of customer investor involvement in crowdfunding success. Manag Sci 66(1):452–472
D'Acunto F, Prabhala N, Rossi AG (2019) The promises and pitfalls of robo-advising. Rev Financ Stud 32(5):1983–2020
Du N, Li L, Lu T, Lu X (2020) Prosocial compliance in P2P lending: a natural field experiment. Manag Sci 66(1):315–333
Duarte J, Siegel S, Young L (2012) Trust and credit: the role of appearance in peer-to-peer lending. Rev Financ Stud 25(8):2455–2484
Easley D, O'Hara M, Basu S (2019) From mining to markets: The evolution of bitcoin transaction fees. J Financ Econ 134:91–109
Erel I, Stern LH, Tan C, Weisbach MS (2021) Selecting directors using machine learning. Rev Financ Stud 34(7):3226–3264
Farboodi M, Matray A, Veldkamp L, Venkateswaran V (2020) Where has all the data gone? (No. w26927). National Bureau of Economic Research, Cambridge
Feng G, Giglio S, Xiu D (2020) Taming the factor zoo: a test of new factors. J Financ 75(3): 1327–1370
Ferrari S, Verboven F, Degryse H (2010) Investment and usage of new technologies: evidence from a shared ATM Network. Am Econ Rev 100(3):1046–1079
Foley S, Karlsen J, Putnins T (2019) Sex, drugs, and bitcoin: how much illegal activity is financed through cryptocurrencies? Rev Financ Stud 32:1798–1853
Fuster A, Plosser M, Schnabl P, Vickery J (2019) The role of technology in mortgage lending. Rev Financ Stud 32:1854–1899
Gentzkow M, Kelly B, Taddy M (2019) Text as data. J Econ Lit 57(3):535–574
Giglio S, Xiu D (2021) Asset pricing with omitted factors. J Polit Econ 129(7):000–000
Giglio S, Liao Y, Xiu D (2021a) Thousands of alpha tests. Rev Financ Stud 34(7):3456–3496
Giglio S, Xiu D, Zhang D (2021b) Test assets and weak factors. Chicago Booth Research Paper Forthcoming
Goldfarb A, Tucker CE (2011) Privacy regulation and online advertising. Manag Sci 57(1):57–71
Goldfarb A, Tucker C (2019) Digital economics. J Econ Lit 57(1):3–43
Goldstein I, Jiang W, Karolyi GA (2019) To FinTech and beyond. Rev Financ Stud 32(5): 1647–1661
Goldstein I, Spatt CS, Ye M (2021) Big data in finance. Rev Financ Stud 34(7):3213–3225
Gu S, Kelly B, Xiu D (2020) Empirical asset pricing via machine learning. Rev Financ Stud 33(5): 2223–2273

Harvey CR (2016) Cryptofinance. Available at SSRN 2438299
Hildebrand T, Puri M, Rocholl J (2017) Adverse incentives in crowdfunding. Manag Sci 63(3): 587–608
Hoberg G, Maksimovic V (2015) Redefining financial constraints: a text-based analysis. Rev Financ Stud 28(5):1312–1352
Hoberg G, Phillips G (2010) Product market synergies and competition in mergers and acquisitions: a text-based analysis. Rev Financ Stud 23(10):3773–3811
Horvitz E, Mulligan D (2015) Data, privacy, and the greater good. Science 349(6245):253–255
Ichihashi S (2020) Online privacy and information disclosure by consumers. Am Econ Rev 110(2): 569–595
Iyer R, Khwaja AI, Luttmer EF, Shue K (2016) Screening peers softly: inferring the quality of small borrowers. Manag Sci 62(6):1554–1577
Jones CI, Tonetti C (2020) Nonrivalry and the economics of data. Am Econ Rev 110(9):2819–2858
Ke ZT, Kelly BT, Xiu D (2019) Predicting returns with text data (No. w26186). National Bureau of Economic Research, Cambridge
Kozak S, Nagel S, Santosh S (2020) Shrinking the cross-section. J Financ Econ 135(2):271–292
Li K, Mai F, Shen R, Yan X (2021) Measuring corporate culture using machine learning. Rev Financ Stud 34(7):3265–3315
Lin M, Prabhala NR, Viswanathan S (2013) Judging borrowers by the company they keep: friendship networks and information asymmetry in online peer-to-peer lending. Manag Sci 59(1):17–35
Loughran T, McDonald B (2011) When is a liability not a liability? Textual analysis, dictionaries, and 10-Ks. J Financ 66(1):35–65
Michels J (2012) Do unverifiable disclosures matter? Evidence from peer-to-peer lending. Account Rev 87(4):1385–1413
Miller AR, Tucker C (2018) Privacy protection, personalized medicine, and genetic testing. Manag Sci 64(10):4648–4668
Mullainathan S, Spiess J (2017) Machine learning: an applied econometric approach. J Econ Perspect 31(2):87–106
Nakamoto S (2008) Bitcoin: a peer-to-peer electronic cash system. http://bitcoin.org/bitcoin.pdf
Paravisini D, Rappoport V, Ravina E (2017) Risk aversion and wealth: evidence from person-to-person lending portfolios. Manag Sci 63(2):279–297
Philippon T (2019) On fintech and financial inclusion (No. w26330). National Bureau of Economic Research, Cambridge
Pope DG, Sydnor JR (2011) What's in a picture? Evidence of discrimination from prosper. J Hum Resour 46(1):53–92
Rapach DE, Strauss JK, Zhou G (2013) International stock return predictability: what is the role of the United States? J Financ 68(4):1633–1662
Raskin M, Yermack D (2018) Digital currencies, decentralized ledgers and the future of central banking. In: Research handbook on central banking. Edward Elgar Publishing, Cheltenham
Tambe P (2014) Big data investment, skills, and firm value. Manag Sci 60(6):1452–1469
Tang H (2019) Peer-to-peer lenders versus banks: substitutes or complements? Rev Financ Stud 32(5):1900–1938
Vallee B, Zeng Y (2019) Marketplace lending: a new banking paradigm? Rev Financ Stud 32(5): 1939–1982
Varian HR (2014) Big data: new tricks for econometrics. J Econ Perspect 28(2):3–28
Veldkamp LL (2005) Slow boom, sudden crash. J Econ Theory 124(2):230–257
Wei Z, Lin M (2017) Market mechanisms in online peer-to-peer lending. Manag Sci 63(12): 4236–4257
Yermack D (2017) Corporate governance and blockchains. Rev Financ 21(1):7–31
Zhu C (2019) Big data as a governance mechanism. Rev Financ Stud 32:2021–2061

Chapter 5
FinTech Technology: Blockchain

In this chapter, we discuss one of the most important technologies of FinTech, the blockchain. We choose the blockchain because it is very related to the development of big data. As here are many technical books about blockchain, our focus is not on the technical part. We will first make a brief introduction and then discuss the various applications of blockchain technology, especially those related to big data.

5.1 Introduction

Blockchain is a traceable database with a structure of blocks and chains. Each block contains underlying data such as transactions (e.g., Bitcoin), and the chain connects the continuously generated blocks in chronological order. It is a distributed and tamper-proof ledger that ensures the security of data by means of cryptography. The first and currently most successful application of the blockchain is Bitcoin, which is created and promoted by Satoshi Nakamoto on 03 January 2009. Figure 5.1 shows the first or genesis block of Bitcoin.

Before the emergence of Bitcoin, it was the subprime mortgage crisis from which the world was full of doubts about the centralized financial system. It is believed that Satoshi Nakamoto is full of distrust of the central bank system, so the creation of Bitcoin is revolutionary. Figure 5.1 shows the sarcastic message by Nakamoto in the genesis block: "Chancellor on the brink of second bailout for banks" from the cover of the Times newspaper. Bitcoin is a decentralized currency, so the central banks do not play any roles in the system. Thus, the value of Bitcoin depends on the decentralized consensus on a distributed ledger, which has the block and chain data structure. The ledger contains all the transaction data in the Bitcoin system, and everyone in the system agrees with the ledger.

In the real world, not only currency, but also other institutions and businesses are centralized. Because most of businesses are governed by various contracts, in 2015, the concept of decentralized contract, smart contract, was introduced with the

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_5


```
00000000  f9 be b4 d9 1d 01 00 00  01 00 00 00 00 00 00 00  |................|
00000010  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000020  00 00 00 00 00 00 00 00  00 00 00 00 3b a3 ed fd  |............;...|
00000030  7a 7b 12 b2 7a c7 2c 3e  67 76 8f 61 7f c8 1b c3  |z{..z.,>gv.a....|
00000040  88 8a 51 32 3a 9f b8 aa  4b 1e 5e 4a 29 ab 5f 49  |..Q2:...K.^J).._I|
00000050  ff ff 00 1d 1d ac 2b 7c  01 01 00 00 00 01 00 00  |......+|........|
00000060  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000070  00 00 00 00 00 00 00 00  00 00 00 00 00 00 ff ff  |................|
00000080  ff ff 4d 04 ff ff 00 1d  01 04 45 54 68 65 20 54  |..M.......EThe T|
00000090  69 6d 65 73 20 30 33 2f  4a 61 6e 2f 32 30 30 39  |imes 03/Jan/2009|
000000a0  20 43 68 61 6e 63 65 6c  6c 6f 72 20 6f 6e 20 62  | Chancellor on b|
000000b0  72 69 6e 6b 20 6f 66 20  73 65 63 6f 6e 64 20 62  |rink of second b|
000000c0  61 69 6c 6f 75 74 20 66  6f 72 20 62 61 6e 6b 73  |ailout for banks|
000000d0  ff ff ff ff 01 00 f2 05  2a 01 00 00 00 43 41 04  |........*....CA.|
000000e0  67 8a fd b0 fe 55 48 27  19 67 f1 a6 71 30 b7 10  |g....UH'.g..q0..|
000000f0  5c d6 a8 28 e0 39 09 a6  79 62 e0 ea 1f 61 de     |\..(.9..yb...a.|
000000ff
```

Fig. 5.1 The first (genesis) block of Bitcoin and the Times newspaper

emergence of Ethereum. The founder of Ethereum is Vitalik Buterin, a 19 years old boy in 2015. The smart contracts are some Turing Complete programming codes on the decentralized platform, the Ethereum, which can be used as a decentralized application (Dapp). Moreover, the concepts of NFT and Defi have also developed

on the platform of Ethereum and are considered to have a great impact on human society. Our purpose in this book is not to cover everything about blockchain, so we only provide some non-technical introduction.

By using the cryptographic algorithms and distributed consensus, blockchain establishes a "trust" network between machines and creates new credit through technical endorsement. It turns out that the blockchain has become the key to supporting the transmission of trust and values in the digital economy. The success of Bitcoin makes blockchain technology popular in the world, and people believe that the function of Bitcoin to deliver values through the Internet is the key to realize the concept of "value Internet".

Then what does Bitcoin do? It essentially transfers one dollar from Alice to Bob, without relying on any central parties. What behind this one dollar is just some programming codes! Those programming codes can represent one dollar, what else can they represent? The blockchain realizes the value Internet, which gives us unlimited space of imagination. Therefore, governments all over the world generally attach great importance to the strategic role of blockchain. China, in particular, has successively formulated a number of top-level designs and policies and specifications to promote the development of blockchain technology. As said by President Jinping Xi: "We should take blockchain as an important breakthrough, strive to overcome a number of key core technologies, and accelerate the innovation and development of blockchain technology and industry".

5.2 Core Technology of Blockchain

In this section, we use Bitcoin as an example to briefly discuss the technologies of blockchain. In fact, there is no consensus about the definition of blockchain technology. Consider the Bitcoin as an example, its technologies include cryptography, block and chain database, and distributed consensus. Each of them could be an application of blockchain technology.

Bitcoin is a decentralized currency that achieves the fact that Alice sends Bob one dollar without any central parties. The secret in the Bitcoin system is that there exists a ledger recording the fact that Alice sends Bob one dollar, and everyone in the system agrees with the ledger. As a result, the transfer of one dollar is realized. Because there are many transactions, we need a block and chain database, and the agreement is called distributed consensus. Everyone keeps the ledger in the local computer but has to make sure that all the ledgers are identical. Therefore, the ledger has to be public so that everyone can check whether her ledger is the same as others. The ledger essentially is the blockchain database, and the underlying technology is cryptography. Moreover, a distributed consensus has to be made on the public ledger.

5.2.1 Cryptography

The key technology of blockchain or Bitcoin is the Hash function, which transforms the input of any length into the output of fixed length through Hash algorithm. Hash function has properties of collision resistance and hiding.[1] The two properties of Hash function make the ledger of Bitcoin tamper-proof and public without privacy disclosure. Collison resistance means that it is unlikely to find the same output in the Hash function with two different inputs. With this property, we can build a tamper-proof ledger. The underlying data of Bitcoin are various transactions, which are calculated by the Hash function and recorded in the ledger. Because of the property of collision resistance, any changes can easily be checked by looking at the output of Hash function. The other property is hiding, which means that Hash function is one-way calculation. If we look at the outputs, it is no way to calculate the inputs. Therefore, if a ledger is constructed by Hash function, it can be made public for everyone.

5.2.2 Distributed Consensus on Block and Chain Database

The ledger of Bitcoin is essentially a blockchain database, which is constructed by both blocks and chains. The data in each block are the underlying transactions, which are grouped in pairs and calculated with Hash values layer by layer. As shown in Fig. 5.2, all transactions are summarized by one hash value that is called the root.[2] Each block has its own Hash value, which contains both the root value of all transactions and the Hash value of the previous block. Thus, the block summarizes the transactions at each time stamp, and the chain summarizes the trading history. Based on the properties of Hash function, the root value makes sure current transactions are tamper-proof, and the chain ensures the trading history is tamper-proof. Moreover, given the hiding property of Hash function, the ledger is public to everyone in the system.

Everyone in the Bitcoin economy has to agree with the blockchain database or the ledger. Because this is a point to point (also called P2P) network with many independent nodes, Bitcoin achieves a distributed consensus. Every node in the system can verify the transactions and record the transactions into a block. Moreover, this node needs to add the new block to the chain so that new transactions can be added into the database. Nakamoto (2008) uses a mechanism of mining to achieve the decentralized consensus. In short, each node (or miner) competes with mathematical puzzle, and the winner has the right to wrap the transactions in the block and

[1] There is another property called "puzzle friendly", which is related to the mining activity of Bitcoin. Our focus is not on mining, so we only discuss collision resistance and hiding.

[2] The block has a databased of a Merkle tree, so the root is also called Merkle root. We will not discuss the technical part of Bitcoin, and simply use the root in this book.

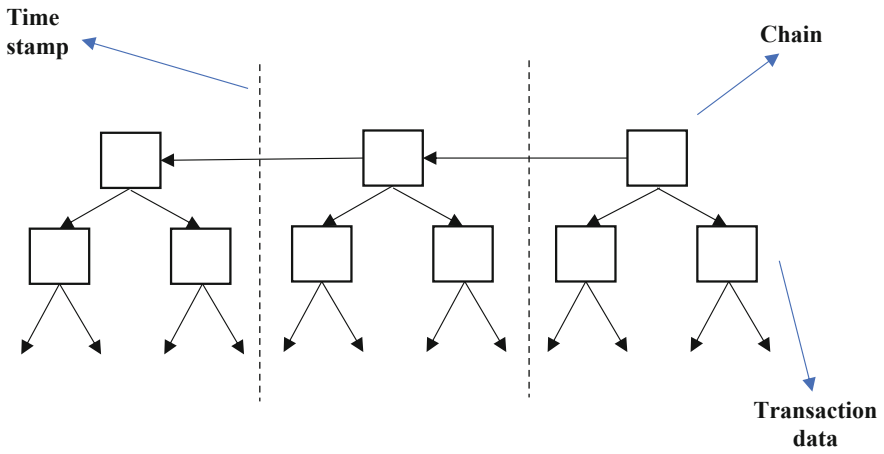


Fig. 5.2 Block and chain database

add the block on the chain, resulting in a blockchain database. Solving the puzzle depends on the computing power of each node, and once succeeds, the note can also receive some rewards from maintaining the blockchain database (block reward). Therefore, Bitcoin system achieves the goal of currency-issuing, which is usually done by central banks, by rewarding the databased recorders.

To sum up, Bitcoin uses the Hash function to construct the blockchain database, which is served as a public ledger in the system. Moreover, Bitcoin uses an incentive scheme to motivate every node in the network to voluntarily maintain the ledger, and maintaining the ledger can receive some rewards, which plays the role of the central bank to issue money. Therefore, the transaction of Bitcoin is essentially the consensus of all nodes on the ledgers.

5.3 Development of Blockchain

This section briefly reviews the development of blockchain technology both from stages and from different countries.

5.3.1 Different Stages of Development

5.3.1.1 The Stage of Digital Asset

Digital assets refer to digital cryptocurrency and its payment system. In this regard, the main function of blockchain is to realize the decentralization of currency issuance and payment means. Bitcoin was born in 2009, which is a typical example

of the earliest application of blockchain to digital assets. Later, large financial institutions such as New York Stock Exchange, Chicago Stock Exchange, Goldman Sachs and Nasdaq have also applied the blockchain to the fields of cross-border transfer, remittance and digital payment. With the rise and development of digital RMB, blockchain is expected to realize the application and development at the payment level in China.

5.3.1.2 The Stage of Smart Contract

The core concept of smart contract application is to take the blockchain as a programmable infrastructure to assist in the execution of relevant transactions or projects by some Tuning complete programming codes, which are called smart contracts. The smart contract is mainly used in the public chain of Ethereum and the alliance chain between enterprises. Based on the concept of smart contract, we can achieve the goal that "Alice sends one dollar to Bob, if condition C is satisfied". In contrast to Bitcoin, the smart contract realizes one more condition beyond the transaction. The condition can be an auction process, which will execute automatically by the programming codes in the public chain. Therefore, many applications, such as crowding funding, can be achieved by the smart contract in a decentralized way.

5.3.1.3 The Stage of Intelligent Society

This stage of intelligent society somehow goes beyond the economic fields such as currency and financial services. Its coverage is very broad, including the fields such as municipal administration, medical treatment, science, education, and art. The advantages of blockchain technology will reshape the original human society and social relations and become a universal technology of globalization.

5.3.2 Global Development of Blockchain

At the global level, the growth rate of blockchain applications is stable, and major blockchain manufacturers are gradually maturing after 2–3 years of exploration. At the same time, many innovative enterprises provide technology and solutions to the business scenarios in many industries such as supply chain, manufacturing, energy and so on. Figure 5.3 shows that there is a gradually increasing trend in the market size of blockchain applications.

After 2010, blockchain-related technologies have gradually emerged in China. In 2015, the concept of Internet finance rose, and the blockchain industry also developed rapidly in China. However, with the tightening of Chinese regulators' policies on digital currency after 2018, as shown in Fig. 5.4, blockchain-related enterprises

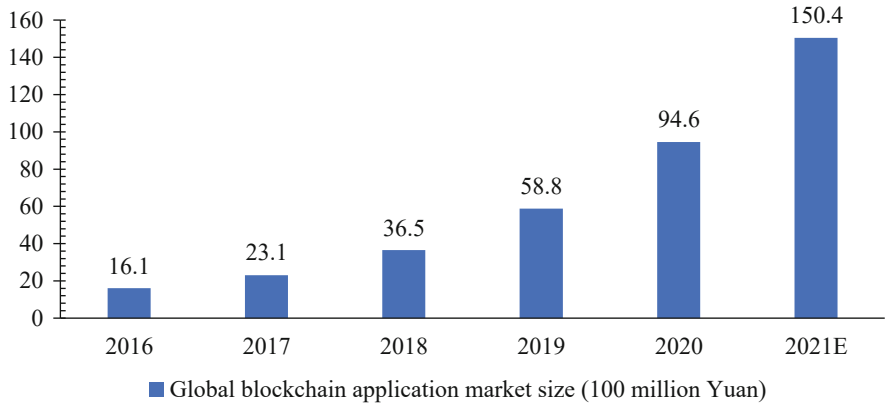


Fig. 5.3 Global blockchain application market size. Source: Frost and Sullivan (2018)

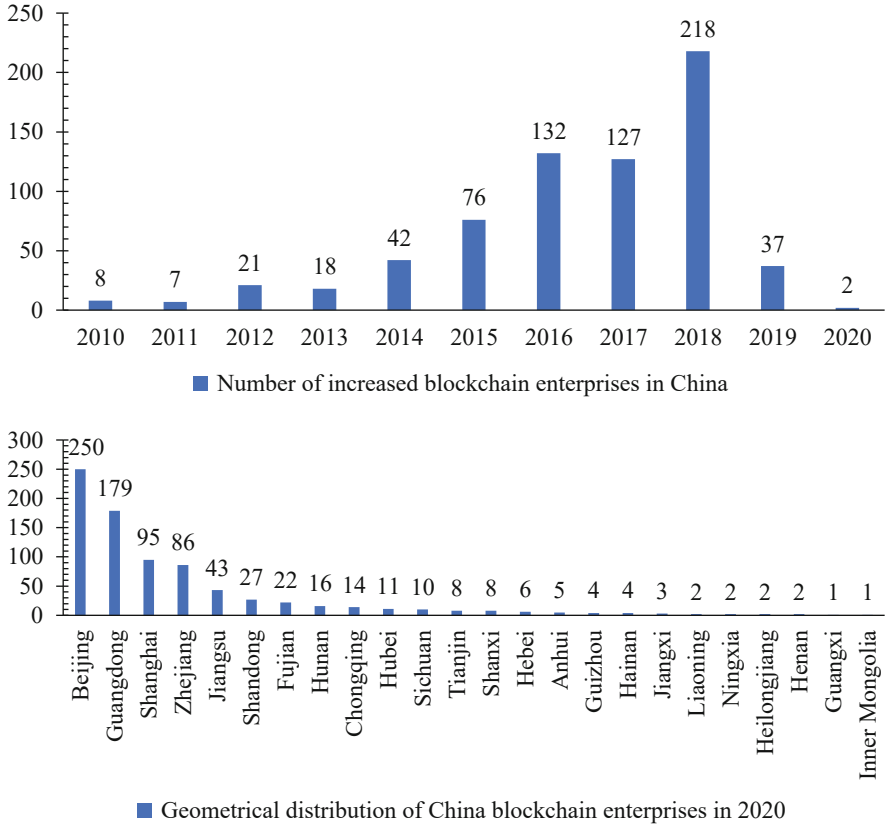


Fig. 5.4 Trend and geometrical distribution of blockchain in China. Source: China Internet Network Information Center (CNNIC)

(most of them are cryptocurrency-related) have decreased sharply. From the perspective of regional distribution, as shown in Fig. 5.4, by the end of 2020, first-tier cities such as Beijing, Shanghai and Guangdong Province and coastal cities are still important areas for the development of blockchain.

5.4 The Business Application of Blockchain

Blockchain has a wide range of business applications, including token economy, blockchain as a service (baas), decentralized application development platform, blockchain-based software products, network services, blockchain professional services, P2P blockchain business model, and applications of cryptography and distributed consensus. Because there are many books about blockchain business applications, in this section, we only briefly discuss ICO (the initial coin offering) and the NFT (non-fungible tocken). On the one hand, we choose ICO because it often brings various risks, which is consistent with the theme of this book. On the other hand, we choose the NFT because it is applicable to the establishment of patents and intellectual property rights, which can help us think about the establishment of data property rights.

5.4.1 ICO

5.4.1.1 The Definition of ICO

ICO (Initial Coin Offering) generally means that a project is publicized and disclosed through a designated issuance platform, agreed to issue tokens on a specific date and in a specific way, and granted special rights and interests (product use right, equity, option, income distribution right, etc.). Based on the prospect of the issuance project, investors invest in projects with the mainstream convertible digital cryptocurrencies (such as Bitcoin and Ether) to support the development of the project and obtain newly issued project tokens. After the issuance of new tokens, they can also circulate freely on the designated platform. Investors can sell cash out for legal currency (such as RMB) after the agreed date to seek exit or continue to increase their holdings. Some projects are just smart contracts on the Ethereum, which is the largest ICO platform in the world.

In short, ICO is a way for financiers to obtain digital cryptocurrency (e.g., Ether in the Ethereum) by issuing their own tokens of the project. It is a behavior of exchanging new tokens for widely accepted cryptocurrencies. The token issued by ICO can be regarded as a special security with only earning right and no voting right. Theoretically, because the number of project tokens is fixed, the increase of project value will be reflected in the token price, and the change of token price can almost

completely reflect the change of project value. Therefore, the risk-return structure of tokens issued by enterprises through ICO is almost the same as that of equity.

5.4.1.2 The Process of ICO

The name of ICO is like IPO (initial public offering). However, IPO is highly regulated in the secondary market, while ICO is decentralized and unrelated. Although ICO is very popular, it brings certain risks to the economy. In the subsection, we briefly discuss the process of ICO.

Project Preparation: The White Paper

Before ICO, the project founder needs to have a detailed and complete plan for the project, including how to use blockchain technology, project business model, innovation, technical route, etc. After the planning is completed, the sponsor needs to write a project white paper, similar to the prospectus when the company makes an initial public offering. The white paper is the only public document in the whole ICO process, and it is also an important way for investors to understand ICO projects.

Fund Raising

Investors attracted by the project of the ICO need to exchange the cryptocurrency for ICO project token in accordance with the provisions of the white paper. Tokens can be used as a voucher for investors to obtain products or services, or as a voucher for the expected income of the project. Generally speaking, the cryptocurrency raised by ICO projects is mainly the mainstream digital cryptocurrency with good liquidity, such as Bitcoin and Ether.[3] Not all the tokens generated by the new project will be issued to investors, and some of them will be reserved for project development team, like the original shares before the IPO. Fund raising can be completed at one time or in stages. In the multi-round fund-raising model, in order to encourage investors to actively participate, ICO projects often adopt the pricing principle of "early participation with preferential price".

Project Operation

After the stage of fund raising, the project founder will develop and operate the project according to the plan in the white paper. If the project progresses well, the value of the token will increase, and investors can also share the values of the project

[3] The Bitcoin and Ether are accounting for more than 90% of the ICO transactions.

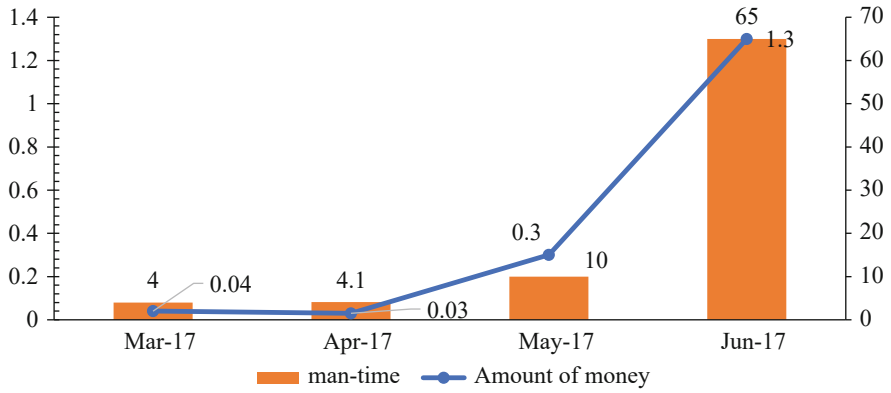


Fig. 5.5 ICO financing amount and time trend of participants. Source: National Internet Financial Security Technical Expert Committee

or obtain the products or services of the project according to the agreement in the white paper. However, if the project operation fails or the project team runs away after getting the money, investors will suffer heavy losses.

Token Circulation

After the success of ICO, if some investors are still optimistic about the invested ICO project, they will choose to hold the tokens for a long time. However, most investors are speculators who use ICO for short-term speculation. Once the project is successful, speculators will throw out all the tokens in the secondary market, withdraw from the project by transferring tokens to other investors. In the end, speculators obtain cryptocurrencies such as Bitcoin and Ether and sometimes even directly exchange fiat currency. For speculators, they essentially earn profits from the market price fluctuations of tokens.

5.4.1.3 The Popularity of ICO

ICO was very popular before 2017, and the total amount of financing has exceeded that of early PE or VC investments. According to the report on the development of domestic ICO in the first half of 2017 issued by the Chinese Internet financial security technical expert committee, since 2017, the cumulative financing scale of ICO projects completed through the ICO platform has reached RMB 2.616 billion, and the cumulative number of participants has reached 105,000. Figure 5.5 shows the trends of the total amount of financing and the number ICO participants. Clearly, an increasing trend is observed. What makes the ICO project so attractive? We will have a discussion in the subsection.

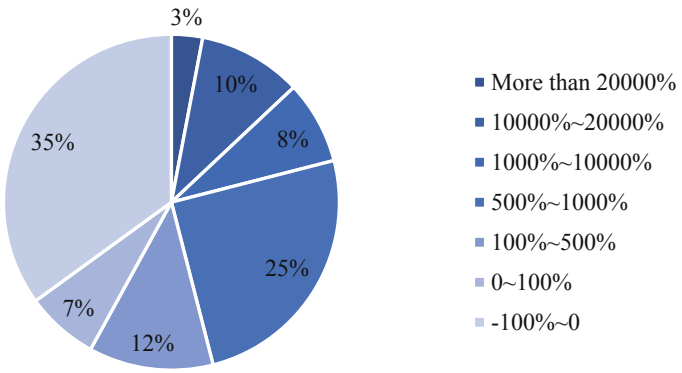


Fig. 5.6 Distribution of returns for ICOs over $100,000 from 2013 to 2017. Source: CBInsights

From the perspective of the project funder, ICO is convenient and fast, and the financing cost is very low. Compared with traditional financing methods such as IPO and VC, ICO does not need to spend a lot of time looking for investors, consulting, negotiation, and defense. The project founder does not need to register and review with the regulatory authorities, does not need to accept due diligence, and does not need to regularly announce the specific situation and financial status of the project operation to the investors.

ICO only needs a white paper, and then through QQ group, Wechat group, or industry website, it can trigger investors to rush and raise a large amount of funds in a very short run by making use investors' freshness and excitement about blockchain. Moreover, the white paper may exaggerate the technical means and future income of the project. If some well-known investors can be found as its platform, ICO projects can also quickly get a lot of attention. In some sense, it is similar to the celebrity effect of E Zu Bao case we discussed in Chap. 3. Many firms that are not qualified to obtain bank loans can easily get funds through ICO. For most investors, the attraction of ICO projects lies in low threshold and high return in a short period. Therefore, some potential risk of ICO is accumulating.

In China, the wealth of the public is accumulating in the last forty years, but there are not many sound investment opportunities. The housing market is strictly regulated, and the stock market is depressed, investors need channels to allocate their wealth. As a result, ICO provides such an investment channel. According to the statistics of CBInsights, from 2013 to February 2017, among the ICO projects that raised more than $100,000, the projects with a return of more than 200 times accounted for 3%, and the projects with a return rate of more than 5 times accounted for 46% (as shown in Fig. 5.6). The lottery property of ICO creates the myth of making wealth, which successfully attracted attention of many investors. Some investors even know that the ICO projects are very risky and apparently bubbles, but with a hope to transfer the tokens to the other investors. Therefore, they actively join the ICO trading, which is also called "currency circle" in Chinese. In addition, unlike project investment, equity investment and derivative investment that require

high thresholds and strong investment knowledge, the threshold of ICO is very low, and anyone can participate, resulting in a rush buying boom of ICO projects.

Nonetheless, there are also some investors who invest in ICO because they are optimistic about blockchain technology. Those investors expect long-term appreciation of ICO projects. As a subversive innovative technology, blockchain has high application value in finance, sharing economy, Internet of things and other applications. In recent years, the central bank has paid more attention to the blockchain, and some developed countries are also actively deploying the blockchain industry. If investors can participate in the early investments of blockchain, those investments may bring ultra-high returns when the market matures.

5.4.1.4 ICO Risk

While ICO becomes popular with the development of blockchain industry, it nonetheless brings huge risks. In fact, there are many problems in ICO projects, such as unclear definition of assets and serious lack of information disclosure (Holmstrom and Tirole 1997). Even worse, some start-ups are suspected of engaging in illegal financial activities such as fraud and illegal fund-raising in the name of ICO, which has seriously disturbed the normal financial order. Specifically, ICO project has the risks of misleading publicity, contract fraud, technology risk, the volatile values of tokens, and externality to enterprises.

The Risk of Misleading Publicity

The white papers of ICO often contain various professional words that are unfamiliar to ordinary investors, including blockchain, decentralized network, POW, DPOS, distributed ledger, asymmetric encryption and so on. It is precisely by taking advantage of the characteristics of high technical threshold and unclear assets of ICO projects that some ICO projects often exaggerate the technology application in publicity. However, the challenges and problems that may be faced in the process of technology realization are often not mentioned in the white papers. Through various channels of publicity and personnel search platforms, investors often receive very positive information about the projects and expect the project prospect with excessive optimality.

Contract Fraud

Many ICO projects, in the guise of FinTech and blockchain, make up concepts to investors and prepare false project white papers. As the white papers of ICO project are not legal documents, the authenticity and reliability of its contents cannot be guaranteed. Some ICO projects change the purpose of funds agreed in the white papers after successful financing, and investors are not legally protected. Even

worse, some ICO projects even do not have white papers, and they can defraud investors of tens of millions or even hundreds of millions of dollars. The irrationality of investors' interests and the vacuum of supervision give fraudsters an opportunity. Similar to the P2P cases, after the successful financing, the project founders immediately lost contact and ran away, taking away the funds of investors.

Technology Risk

All network systems are subjected to various attacks, and the security of ICO projects is facing great challenges. In 2016, the DAO, a crowdfunding smart contract in Ethereum, raised more than US $150 million, becoming the largest crowdfunding project in history. At that time, the DAO is believed to be even more successful than Ethereum. However, due to hacker attacks, more than 3.6 million Ethers that worth US $60 million were hijacked, resulting in the final failure of the project only three months after its establishment. The development team of Ethereum finally close the smart contract and return Ethers to investors. However, some participants think that the hacker is nothing wrong but following the rules of the smart contract. Since "code is law", then "bug is also law! There is finally a disagreement in the society of Ethereum, resulting a hard fork of the blockchain. Finally, those who do not agree with the development team choose a chain and become an independent cryptocurrency, the Ethereum Classic (ETC). The incident reflects that the blockchain technology is not mature, decentralization cannot guarantee the absolute safety of funds and cannot avoid problems such as technical operational risk and subjective moral hazard.

Volatility and Risk of the Token Values

The value of the token comes from the future income of the ICO projects. The uncertainty of technical means and the high opacity of the project make it impossible to accurately evaluate the ICO projects. Thus, there is a lot of uncertainty about the value of the token, resulting in volatile prices. Moreover, unlike stocks, token trading is less regulated, so the prices may rise or fall dozens of times in a day, resulting in great value risk. At the same time, due to the lack of supervision of the ICO market, it is easy to manipulate the market. ICO projects often show a high concentration of token shares in investment accounts. The tokens held by the top ten accounts exceed 50% of the total number of projects, making it easier for large investors to encroach on the interests of small investors through price manipulation such as buying low and selling high.

Externality of ICO on Credit Risk

Pan et al. (2020) find that the use of token financing has a significant negative externality on China's small and medium enterprises. Compared with equity financing, although ICO is fast and low threshold, it is not conducive to the accumulation of human capital of enterprises in the long run. ICO can aggravate the problems of low level of information disclosure, lack of attention and lack of media supervision of small and medium-sized enterprises, and finally lead to a significant shortening of the life of start-ups. From the macroeconomic consequences of token issuance financing, the adverse effects caused by ICO have worsened the regional credit environment and significantly increased the regional financing cost.

5.4.1.5 Global ICO Regulation

Due to the lack of credible endorsement, less constraints on the project, and low information transparency, the regulatory attitude of governments at all levels around the world is becoming increasingly stringent, especially after 2017. Moreover, it is easy for ICO projects to involve illegal fund-raising and other illegal acts. Therefore, as shown in Fig. 5.7, the overall number of global ICO has also shrunk significantly since 2018.

China strictly prohibits ICO. In September 2017, the People's Bank of China and other seven ministries and commissions issued the announcement on preventing the financing risk of ICO, which explicitly prohibited the financing activities of token issuance. The ICO was clearly defined as illegal financing. Some countries choose to incorporate ICO into the existing regulatory system. The United States regards ICO as a financial instrument, while Japan regards ICO as a payment method and allows token issuance in accordance with the existing regulatory rules. Some countries

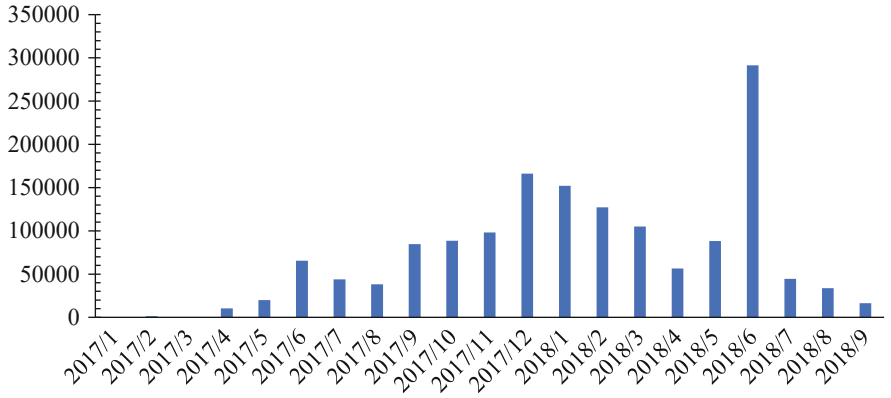


Fig. 5.7 2017–2018 Global ICO financing volume. Source: China Internet Network Information Center (CNNIC)

consider building a new and specific token issuance framework for ICO, such as France.

5.4.2 NFT

5.4.2.1 Introduction of NFT

On March 11, 2021, an NFT (non-fungible tokens) representing the ownership of digital paintings was sold at Christie's for more than $69 million, which successfully attracts attention from the public. The painting consists of 5000 smaller images created by artist Beeple, as shown in Fig. 5.8. In the same period, digital avatars worth $160,000 were sold in the form of NFT. The emergence of these high price paintings indicates that blockchain encrypted assets have opened a new era in the field of digital collections.

The full name of NFT is non-fungible tokens, which is often translated into "non-homogenous tokens or non-replaceable tokens" in Chinese. In short, NFT is an entry of the blockchain, which is a decentralized digital ledger technology similar to cryptocurrencies such as Bitcoin. The key difference is that one Bitcoin from Alice is the same as one Bitcoin from Bob, but for NFT, each token has its unique feature, distinguishable from others. Because NFT has irreplaceable characteristics, it can be used to represent unique things, such as the original Mona Lisa painting in the museum, or the ownership of a piece of land.

The prototype of NFT can be traced back to a P2P network protocol improved based on Bitcoin in 2012, which can realize decentralized virtual asset trading. Later, a P2P financial platform, Counterparty, was born in 2014. The platform supports

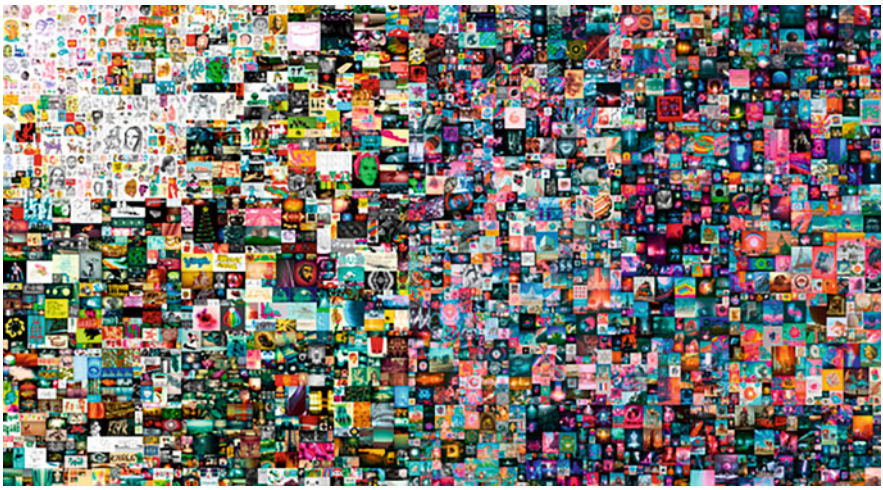


Fig. 5.8 NFT painting by Beeple

card games and virtual asset transactions and attracts many game developers. Many game projects such as Spells of Genesis, Force of Will and Rare Pepes are released on the counterparty platform. In March 2017, with the rapid rise of Ethereum, game projects such as Cryptochunks and Cryptokitties were born one after another. Cryptokitties is the first project to adopt NFT, which allows players to adopt, feed and trade virtual cats on the blockchain, and track the ownership and the transfer of a single token in the blockchain database. The emergence of Cryptokitties makes NFT popular. From 2018 to 2019, NFT received extensive attention in the art world, and the trading volume of NFT market reached US $250 million in 2020. With the high price sale of Beeple's NFT work "every day: the first 5000 days" on March 11, 2021, NFT received more and more attention and showed an unprecedented explosive growth trend.

5.4.2.2 Technology of NFT

The essence of NFT is a unique digital asset on the blockchain with scarcity. Its ownership can be transferred through smart contracts, and the whole process of ownership transfer is recorded through blockchain database. Based on the features of blockchain, any node can view all transaction records of an NFT, and one NFT cannot be exchanged with the other NFT in the same category. Therefore, each NFT is unique, so the ownership of digital assets can be marked.

The uniqueness of NFT coincides with the natural attributes of works of art. NFT has traceability and can be well applied to art auctions. In the traditional art auction, the opacity of information and the imbalance between supply and demand lead to the increasingly prominent problem of art forgery, which can be solved by the transparency of the blockchain. In addition, the transaction records of traditional works of art are usually paper-based, which is subject to the risk of being tampered with or lost. The art auction based on NFT can record the ownership and circulation process of works of art on the blockchain, which is difficult to tamper with and can be viewed by everyone. When there is a forgery problem, it is easy to trace the problems through encrypted signature and timestamp.

NFT is a concept in contrast to fungible token (FT). Broadly speaking, NFT is a kind of digital asset ownership based on blockchain, which is indivisible, irreplaceable, and unique. At present, NFT mainly has three underlying standards in Ethereum: ERC-721, ERC-1155 and ERC-998, respectively. In what follows, we will briefly discuss those underlying standards in a non-technical way.

ERC-721

ERC-721 is the first standard of NFT, which was proposed by Ethereum in 2017 and is the commonly used underlying standard at present. The first and well-known application of ERC-721 is Cryptokitties, which essentially is a blockchain game on Ethereum platform. ERC-721 is different from the original standard of Ethereum in

which all the tokens are identical.[4] For the original standard, all tokens can be arbitrarily divided and exchanged, so it is impossible to track the transaction and circulation records of each token. Under this standard, any token has no difference and cannot be distinguished, which cannot meet the needs of assets with unique attributes. ERC-721 standard is proposed for the needs of assets with unique attributes and represents the ownership of digital assets. Under this standard, each token is unique and indivisible, so each token has different values, and its complete circulation and transaction process will be recorded on the blockchain, which is public to everyone. Therefore, the ownership transfer process of each NFT based on ERC-721 standard can be fully tracked and verified.

ERC-1155

ERC-1155 is a semi fungible token. Under the ERC-721 standard, each NFT transaction needs to call a smart contract, so when multiple NFTs need to be traded at the same time, the smart contract needs to be called many times, resulting in low transaction efficiency. ERC-1155 standard can effectively solve this problem. Under this standard, a smart contract can transfer multiple NFTs and FTs at the same time, which greatly improves the transaction efficiency and reduces the transaction cost.

ERC-998

ERC-998 is a composable non-fungible token (CNFT). This standard allows multiple NFTs and FTs to be packaged into one portfolio for trading, which makes it possible to realize the packaging transactions of all NFTs and FTs related to the CNFT through one transaction.

5.4.2.3 Business Models of NFT

Trading Market

The top three NFT trading markets on the Ethereum platform include OpenSea, Rarible and Axie Marketplace. Opensea is the first NFT trading market on Ethereum, mainly for encrypted collections, and users can buy, sell and auction NFT point-to-point on the Opensea platform. Rarible is an NFT open-source market established in early 2020, in which users can cast, sell and buy collections in this application market. Axie Marketplace is the internal trading market of Axie Infinity, where game players can buy, sell or auction NFT game assets.

[4]The original standard of Ethereum is called ERC-20.

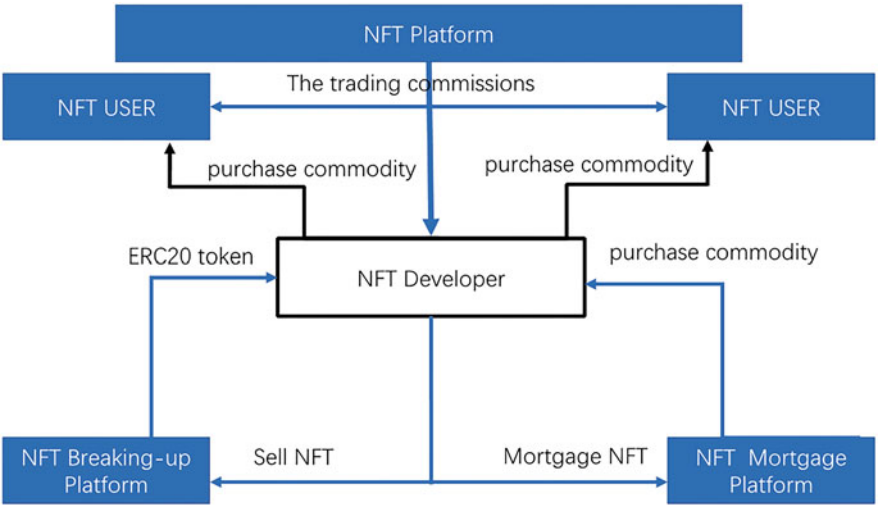


Fig. 5.9 Business mode of NFT

Profit Model

The most common way to make profit in the NFT ecosystem is to sell NFT directly. Based on the models of direct sales of NFT, secondary markets of transaction fees, fees in the game internal economy and other revenue models can also be developed. When NFT is used for games in blockchain, the game developers can charge from the secondary market transactions of the items they develop. For example, Opensea platform developers can set a secondary market sales bonus of 0–99%. Moreover, developers can also charge from NFT transactions generated by users. For example, in Cryptovoxels virtual world, users can create NFT accessories by themselves, and Cryptovoxels developers can charge users a small amount of fees for trading NFT products from the original market of such games.

In addition, NIFTEX, NFTFI and other platforms have created a new business model for NFT. NIFTEX, an NFT splitting platform, allows users to invest in high-value NFT and then split it into 10,000 Ethereum tokens. Such Ethereum tokens can also be used for trading in the NIFTEX market. NFTFI is an NFT mortgage platform, in which developers can quickly obtain loans by using the NFT assets they create as collateral. Therefore, NFT developers do not need to obtain short-term loans through the traditional banking system. Figure 5.9 show the overview of business models of NFT.

5.4.2.4 NFT and Copyright Protection

The emerging NFT technology is expected to provide an effective solution for copyright protection. At present, NFT technology has been widely adopted by artists

and music publishers. Using the characteristics of blockchain technology, the created works are stored in the blockchain as NFT, and the only digital ownership certificate corresponding to the works is generated, so as to achieve the purpose of copyright protection.

However, NFT still needs to be improved to fully provide copyright and property protection. Similar to the traditional art and collection transactions, NFT also faces the problem of “who is the real creator of the work”. NFT can only prove “token provenance”, that is, the transaction exists and has a source to follow, but cannot prove the origin of the work itself, that is, "artwork provenance". Many artists' works are cast into NFT by others and sold without their permission. For example, someone pretended to be Derek Laufman, a famous cartoonist, and sold his works in the form of NFT on Rarible as an author. In addition, NFT and art itself are separable, which makes it possible for NFT to be artificially changed, resulting in damage to the NFT owners. For example, a crypto artist named “Neitherconfirm” found that even if his NFT has been sold in the Opensea market, he can still replace the pictures originally corresponding to the NFT with other unrelated pictures.

5.4.2.5 NFT Bubbles

NFT is a virtual asset based on blockchain. For the price of NFT, it is necessary to consider the supply and demand under the chain and on the chain at the same time. Under the chain, NFT benchmarking digital art market involves rich product types, complex identification means and unstable value evaluation standards, which virtually raises the threshold for buyers. On the chain, blockchain, smart contracts and other technology applications also affect the value of NFT. Meanwhile, we have to consider the corresponding relationship between physical collections and NFT virtual collections. The value of NFT is comprehensively determined by relevant market factors, and the security, existence, and other characteristics of blockchain.

With the popularization of the concept of NFT, various NFT assets continue to emerge. At present, most NFTs are traded by auction in the trading market. The involvement of speculative capital has led to the blowout of the NFT market and to a certain extent created the NFT market bubbles. At the same time, in the absence of identification and supervision, blindly trading NFT on the chain also brings a certain risk of fraud. With the improvement of NFT ecology and the decline of market passion, some projects are bound to be eliminated by the market, which will lead to the loss of the value of some NFTs.

At present, there is no regulatory authority for NFT, which leads to the dilemma that the rights and obligations of both parties to NFT transactions cannot be clarified and guaranteed. Most NFTs are digital assets created on the blockchain, but with the development of NFT market, there are more mappings of physical assets under the chain, and regulators may launch corresponding policies for management. There may be criminal acts such as money laundering, illegal fund-raising, illegal network trading. Therefore, risks such as engaging in illegal and criminal activities by using

new technologies and applications bring difficulties to the government's supervision of NFT.

Overall, NFT has broad application prospects and is naturally suitable for art sales and copyright protection of works. Moreover, as we discussed in the previous chapters, the data ownership is also a problem for the development of big data. With the concept of NFT, blockchain technology can possibly be the solution to solve the problem of data ownership. However, before this technology matures, there are still many technical and institutional problems, which may be exploited by criminals and speculators, making it a tool to harm society. So far, the development and application of the NFT technology still need joint efforts at the technical and regulatory levels.

5.5 Problems of Blockchain

Blockchain technology has great application prospects and practical values, but at this stage, blockchain technology still has great risks and challenges. In order to make better use of blockchain technology and seize the opportunity to gain an advantageous position, we have to clearly identify these risks and challenges to find effective solutions.

5.5.1 Technology Restrictions

5.5.1.1 "Triangular Constraints" of Accuracy, Decentralization, and Cost-Efficiency

Abadi and Brunnermeier (2018) point out that the centralized ledger has accuracy and cost efficiency because its maintainers can obtain monopoly rent and the franchise values, which encourage them to keep accurate records. Distributed ledger gives recording nodes rewards to encourage them to record accurately, and the nature of distributed consensus helps to eliminate the monopoly rent enjoyed by a single blockchain system. However, the distributed ledger may bring instability and disharmony. Therefore, no blockchain system can have the characteristics of accuracy, decentralization, and cost-efficiency at the same time. There is a paradox in the performance and security of the blockchain system.

5.5.1.2 Information Island

At present, many organizations and institutions are trying to use blockchain on a small scale, resulting in the diversification of blockchain technologies and platforms. There are more than 6500 active blockchain projects on GitHub, the world's largest

open-source code hosting platform. These projects use different platforms, different development languages, different protocols, consensus mechanisms and privacy protection schemes. To realize the trustworthiness of blockchain, it is necessary to connect these heterogeneous blockchain platforms, which leads to another major challenge facing the blockchain. In the Internet era, we have suffered from "information island, heterogeneous data fusion and heterogeneous protocol interoperability", and the cross-chain challenges of different blockchains will be even greater.

5.5.1.3 The Bug for Smart Contract

The emergence of blockchain abstracts financial transactions as smart contracts and completes the execution of contracts on the blockchain in a decentralized manner. Smart contracts are programming codes, which face bug problems. First, smart contracts should be trusted, so we must prevent the embedded problems from the programmers. Second, when there are technical loopholes in smart contracts, how should they be saved and repaired? Since the smart contract is built on a decentralized and tamper-proof blockchain, the contract cannot be modified or withdrawn even if there are problems in the code running. Who should bear the relevant responsibilities and consequences?

5.5.1.4 Decentralization

The traditional supervision model is centralized. After the emergence of the decentralized organizational form of blockchain, it undoubtedly challenges the traditional supervision model. However, the boundary of centralization and decentralization is hard to identify. For example, the cryptocurrency distribution center with the slogan of decentralization is a "re-centralization". The newly issued cryptocurrency is free from the financial system and has not been subject to effective financial supervision. However, most of the cryptocurrencies are traded in a centralized exchange.

5.5.1.5 Cryptographic Algorithm Security

At present, most of the algorithms used in blockchain projects are traditional algorithms, which have security defects, such as potential "back door" risk. Thus, the algorithm strength needs to be further strengthened. While actively seeking and innovating algorithms, we should also guard against the risk of subversion of traditional algorithms by new technologies.

5.5.2 Regulation Limitation

Blockchain technology was born among a group of anarchists called "network punks". The earliest and most successful application of blockchain is Bitcoin, but it is undeniable that Bitcoin is widely used in the "dark net", as a way of money laundering and illegal transactions. The blockchain-based ICO has been maliciously exploited as a means of financial fraud. From this perspective, on the premise of maintaining the "autonomy" advantage of blockchain, integration into the real-world regulatory system is the only way for blockchain to achieve wide applications. From the concept of blockchain, the decentralized blockchain contract does have regulatory restrictions. However, if regulators can be allowed to intervene, it naturally has the advantage of easy supervision due to the tamper-proof feature of blockchain. Therefore, in the future, we hope to see the application of blockchain technology at the regulatory level.

5.6 The Development of Blockchain in China

5.6.1 Policy Support

Since 2016, China's policy documents on blockchain have been implemented one after another. More and more industry and technology development plans mention the need to accelerate the development of blockchain. At the same time, local governments followed the call of the central government and introduced blockchain support policies. The frequent releases of policy documents show that China attaches great importance to the development of blockchain technology. Under the influence of local favorable policies, China's blockchain industry has obtained a good development opportunity.

The year of 2016 can be seen as the starting point that the Chinese government officially supports the blockchain technology. The central government has ushered in the first official guidance document on blockchain technology, which summarizes the development status of blockchain and proposes to accelerate the development of blockchain technology and industry in China. In the same year, blockchain technology was written into the "13th five-year plan" as a strategic technology. From 2017 to 2020, China's attention to blockchain has become increasingly prominent, and various substantive support policies for blockchain have sprung up. In the research and implementation of blockchain technology support systems, China has gradually explored the "China model" from reality and made significant achievements. In 2021, in the "14th five-year plan" and the long-term goal outline of 2035, China positioned the blockchain as one of the seven key industries of the digital economy.

5.6.2 Typical Application Scenarios of Blockchain in China

Given the strong support from the central government, blockchain technology has been applied for many scenarios. In this section, we discuss several important applications of blockchain in China.

5.6.2.1 Blockchain and Digital Currency

The first successful application of blockchain is Bitcoin, which is essentially the decentralized digital currency. Therefore, the obvious blockchain application is digital currency, and China spends a lot of effort on the development of digital RMB (DC/EP).[5] Digital RMB is a legal fiat currency in digital form issued by the People's Bank of China. It is operated by designated operating institutions and is not bound to specific bank accounts. Digital RMB is equivalent to cash, with legal value and compensation, and supports anonymity and controllability.

The Background of Digital RMB

At present, many central banks are actively laying out digital currencies. According to the survey data of the Bank for International Settlements (BIS), by the end of 2020, the proportion of central banks actively engaged in digital currency research and development was as high as 86%, an increase of 1/3 over four years ago, 60% of central banks were testing their technology for digital currency, and 14% of central banks were deploying relevant pilot projects. Some countries such as Ecuador, Bahamas and Cambodia have completed the issuance of digital currency, and countries such as Sweden, Singapore and Ukraine have also entered the digital pilot stage. At the same time, many countries are in the research and development stage of digital currency, such as the United States, Japan, Russia and the United Kingdom.

In contrast to the developed countries, the People's Bank of China has attached great importance to the research and development of digital RMB, and China's research and development of digital RMB is at the forefront of the world. In fact, China's research and development of legal digital currency has long been laid out. As early as 2014, the central bank-led the establishment of a legal digital currency research group to start special research on the issuance framework, key technologies, issuance and circulation environment and relevant international experience. In 2016, the digital currency Research Institute was established to complete the construction of the first-generation prototype system of legal digital currency. By 2017, with the approval of the State Council, the People's Bank of China officially began to

[5]The full name of DC/EP is digital currency electronic payment.

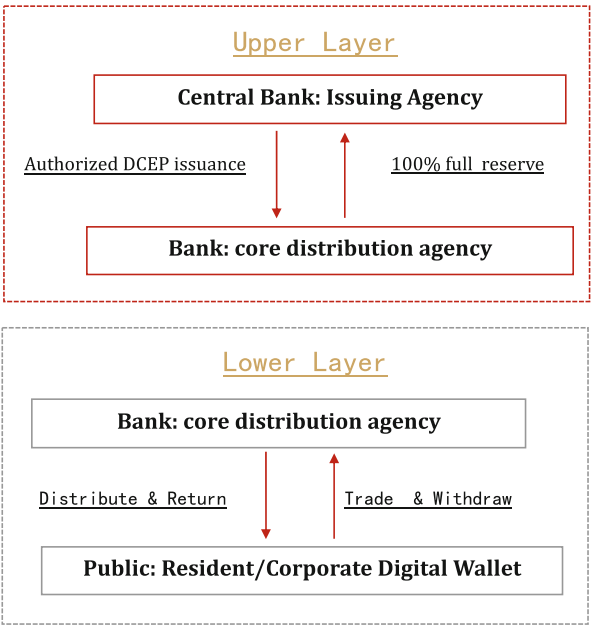


Fig. 5.10 The two-tier operation mode of digital RMB

organize commercial institutions to jointly carry out the research and development pilot of legal digital currency. In 2020, the pilot project of digital RMB began.

According to the white paper on the research and development progress of China's digital RMB issued by the People's Bank of China in July 2021, by the mid of 2021, China has more than 1.32 million pilot scenarios. In particular, more than 20.87 million personal wallets and more than 3.51 million corporate wallets are created, and there are more than 70.75 million cumulative transactions with an amount of about 34.5 billion RMB. In terms of progress, although the coverage and user activity of digital RMB wallet still need to be improved, the People's Bank of China has a clear attitude to vigorously promote the pilot work. It is expected that the pilot work will be further accelerated during the 2022 Winter Olympic Games.

Technical Framework of Digital RMB

Digital RMB adopts a two-layer operation model. The upper layer is the People's Bank of China, and the lower layer is commercial banks, telecom operators and third-party payment platforms. Specifically, at the upper level, the People's Bank of China is responsible for digital RMB issuance, cancellation, and wallet ecological management. At the lower level, commercial banks licensed by People's Bank of China act as designated operating institutions to provide digital RMB exchange services. Figure 5.10 shows that how the digital RMB operates.

According to the white paper of digital RMB: "the technical route selection of digital RMB is a process of long-term evolution, continuous iteration and dynamic

upgrading. . .". Because there are many other popular third-party payment systems in the market, such as Ali pay and Tencent pay, the development of the digital RMB needs continuous improvement. In the initial stage, the central bank digital currency research institute does not exclude the blockchain framework but considering the alternative positioning of RMB as M0 (cash in circulation). Moreover, it is not easy for a simple blockchain framework to meet the requirements of high concurrency in the small retail scenario.

The digital RMB is mainly based on the hybrid architecture of traditional encryption and blockchain, and the encryption will dominate. In fact, the banking system and third-party payment system will take the main payment functions. Each operation organization has its own independent development of digital currency, so the specific path of the blockchain in each route is unknown. According to the researchers from Dong Fang securities company, the application of digital RMB to blockchain technology focuses on three aspects:

1. The digital signature of the digital RMB wallet uses blockchain technology of encryption.
2. The digital RMB has the functions of smart contract. In the future, smart contracts with currency-related functions can be loaded to promote business model innovation.
3. Using the tamper-proof property of Hash function, the blockchain ledger uses Hash summary instead of transaction sensitive information to protect the privacy and security of personal data.

In general, digital RMB uses the blockchain technologies of Hash function, digital signature and smart contracts, but in a centralized way. Moreover, if the future blockchain-related applications are mature enough to meet the concurrency and regulatory requirements, blockchain technology is likely to be widely used in the whole system. It is worth noting that smart contracts closely related to the blockchain may become an important application. According to Changchun Mu, the director of the Monetary Research Institute of the People's Bank of China, the central bank may load smart contracts conducive to the monetary function.

Prospect of Digital RMB

As we mentioned in Chap. 1, the third-party payment such as Tencent pay and Ali pay are widely used in China. Although the digital RMB is not in the same dimension of the third-party payment system, for customers, they have similar payment experiences for digital RMB and third-party payment systems. Chinese customers have already got used to Tencent pay and Ali pay, so it is not easy for most of them to change to digital RMB. In the certain time horizon, digital RMB may coexist with Tencent pay and Ali pay.

Ali pay relies on the Taobao platform to establish the first-mover advantage in the field of third-party payment, and has created a diversified "pay+" ecosystem in the late stage, covering almost all segments of vertical industries such as finance,

education, health care, transportation. Tencent pay relies on WeChat, a powerful national social App, and leads to payment by virtue of user stickiness. Tencent pay and Ali pay form duopoly market, and other means of payment are difficult to compete with them. Take the "cloud flash payment" as an example, since its launch, it has attracted customers through consumption Festival and red envelope subsidies, and the number of users exceeds 300 million by August 2020. Although "cloud flash payment" makes some achievements in the short term, there is still a big gap between Tencent pay and Ali pay. At present, digital RMB is still in the pilot stage. The marketing and promotion of digital RMB are still preliminary, and it should pay attention to how to link resources from all walks of life to build their own ecological scenarios, so as to cultivate users' habits. The wide application of digital currency is an inevitable trend in the digital era, and digital RMB will be popularized in the future.

5.6.2.2 Blockchain and Supply Chain Finance

Traditional Supply Chain Finance

Supply chain finance refers to the financing model of looking for the core enterprises in this field, which can provide financial support for the upstream and downstream from the whole supply chain industry. Through supply chain finance, financial institutions can effectively inject capital into small and medium enterprises in a relatively weak position in the supply chain, so as to solve the problems of difficult and expensive financing of small and medium enterprises. At the same time, supply chain finance integrates bank credit into the purchase and sales behavior of upstream and downstream enterprises, enhancing their commercial credit.

The history of China's attempt to develop supply chain finance can be traced back to 1999. At that time, Shenzhen Development Bank initially tried supply chain finance and launched movable property and survival financing business. Then, in 2006, Shenzhen Development Bank put forward the concept of supply chain finance. After that, several policies and measures are developed to promote the healthy development and to encourage financial institutions to carry out pilot business of supply chain finance. The market scale of China's supply chain finance reached 22 trillion in 2019. In 2020, the incoming COVID-19 epidemic has pressed the pause button for the world, which is a significant shock for small and medium enterprises. The role of supply chain finance in the development of small and medium enterprises and the real economy has become more and more important. However, although supply chain finance is developing rapidly, there are still many problems. We summarize them as follows:

1. Supply chain finance is highly dependent on core enterprises. In supply chain finance, small and medium enterprises and third-party financial institutions are highly dependent on core enterprises. The normal operation of core enterprises will directly affect the stability of supply chain finance.

2. It is difficult to confirm the business accounts receivable and to manage quality of assets, so there exist credit verification problems. Supply chain finance cannot be separated from credit verification, so high-quality core enterprise credit cannot be transmitted to the upstream and downstream of the supply chain.

In the process of development, supply chain finance has gradually evolved into four transaction forms: accounts receivable financing, inventory financing, prepayment financing and strategic relationship financing, respectively. The problem is that for small and medium enterprises, the credit system is not perfect, so it is difficult to confirm the right of core enterprises.

Blockchain Application for Supply Chain Finance

Based on the features of blockchain technology, several problems in the supply chain finance can be solved.

1. Blockchain records the business activities of all trading entities in the database, so as to get rid of dependence on core enterprises. The real transactions can be transformed into digital assets, and all related parties can use the digital signature to verify their identity, realizing the trust on the chain.
2. Blockchain ensures that the information cannot be tampered with, which improves the transaction security and data reliability. Through multi-level signature mechanism, blockchain records data and information on each distributed node to ensure transaction traceability, preventing information from being tampered and ensuring the security of blockchain asset transactions.

The main technical framework of the blockchain-based supply chain financial system is shown in Fig. 5.11. The platform nodes include core enterprises and

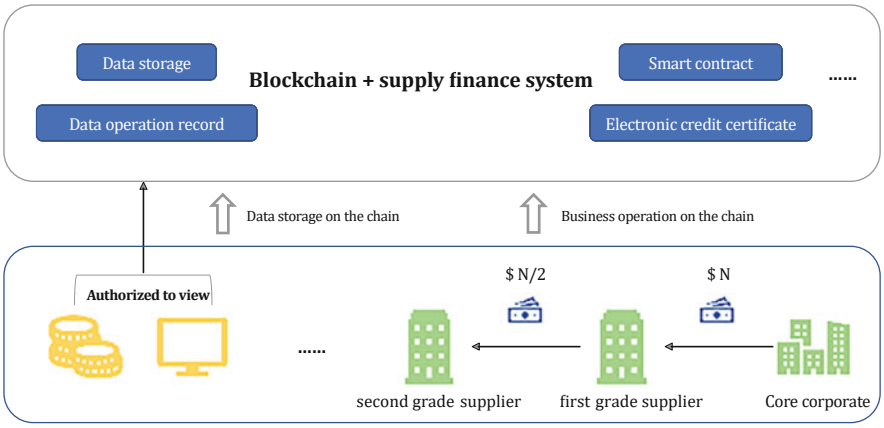


Fig. 5.11 "Supply chain finance + blockchain"

suppliers at all levels. They share transaction and financing data on the database, and blockchain technology ensures that the data is not tampered with. With the authorization of the regulatory authorities, the data of enterprises on the chain can be extracted and analyzed, so as to provide credit ratings, reduce the difficulty of bank risk control, and solve the problems of difficult and expensive financing of small and medium enterprises.

Example of Supply Chain Finance

In this subsection, we use the trade finance blockchain platform of the People's Bank of China as an example to illustrate China's exploration of supply chain finance based on blockchain. The trade finance blockchain platform of the People's Bank of China is a financial technology infrastructure initiated by the central bank and constructed and operated by its Shenzhen central branch. The goal of the project is to create an open, credible, safe, and shared platform for financial asset registration, custody, and transaction.

Since the first phase of the project was officially launched for trial operation on September 4, 2018, it has successively launched application scenarios such as multi-level financing of supply chain receivables, cross-border financing, international trade account supervision, foreign payment tax filing. On the platform, if the information is complete, the operation time from the customer submitting the loan application to the bank completing the loan is only about 20 min, which greatly shortens the financing time, improves the financing efficiency, and reduces the financing cost of small and medium enterprises. By the end of 2019, the business volume of the platform has exceeded 90 billion RMB. In terms of cross-border business, in November 2021, the platform links to the Hong Kong trade linkage platform and realizes the trading process online with Hong Kong export enterprises, significantly increasing the trading efficiency.

Compared with the traditional business platform, the central bank's trade finance blockchain platform has several advantages: (1) it is a general platform for various institutions and regions, with multi-point common maintenance to facilitate information flow; (2) The transaction adopts the form of smart contract to realize the process automation on the chain and effectively solve the problems of trust in the traditional circulation process. During the promotion process of the central bank's trade finance blockchain platform, there are also some problems. The core enterprises are unwilling to cooperate, and the small and medium enterprises have some difficulty being on the chain. Although the future development of supply chain finance based on blockchain is full of challenges, the trade finance platform is still a practical and persuasive application of blockchain technology in the field of supply chain finance.

5.7 Summary

Blockchain has broad application prospects in the real economy, especially for finance. Many features of blockchain such as cryptographic algorism, distributed consensus, and smart contracts can be applied to many scenarios, solving the problems of information asymmetry and providing trust for participants. Moreover, the ownership of digital assets can be properly defined by NFT, which gives us unlimited space of imagination for defining the ownership of data. However, although the development is rapid, there are nonetheless some risks from the ICO processes and NFT bubbles. Therefore, not only do we observe the development of blockchain technology in the FinTech era but also observe risks related to those financial innovations.

References

Abadi J, Brunnermeier M (2018) Blockchain economics (No. w25407). National Bureau of Economic Research, Cambridge

Frost and Sullivan (2018) China's P2P lending industry market research report. Available at http://www.frostchina.com/wp-content/uploads/2019/05/P2Pjiedai.pdf

Holmstrom B, Tirole J (1997) Financial intermediation, loanable funds, and the real sector. Q J Econ 112(3):663–691

Nakamoto S (2008) Bitcoin: a peer-to-peer electronic cash system. http://bitcoin.org/bitcoin.pdf

Pan Y, Xie Y, Pan J (2020) The study of initial coin offerings: from the perspective of firm lifespan. J Financ Res 480(6):133–151

Chapter 6
FinTech and Financial Risk

In the previous chapters, we discussed the development of FinTech, big data, P2P risk and blockchain technology. In the chapter, we would like to build up a unified framework to connect the topics in the previous chapter together. This chapter is based on an academic paper by me and my coauthors (e.g., Qiu et al. 2021), which analyzes the risk and technology in the development of FinTech. Therefore, this chapter is named "FinTech and Financial Risk", which is consistent with the title of the book.

6.1 Introduction of FinTech and Financial Risk

In recent years, as an innovation of the finance industry, FinTech has developed rapidly in China and has become an effective supplement to China's traditional financial system. On the one hand, the third-party payment platforms of Internet giants, Alibaba and Tencent, become the starting points of online business activities and the infrastructure of big data collection. Massive online transactions have accumulated a large amount of data, which provides some new information that is unobservable under the traditional finance system. The big data generates new finance models with which the new credit investigation based on big data has provided financing channels for many small and medium enterprises and individuals, achieving great success of digital inclusive finance. Moreover, data-based technology, such as blockchain, has also been successfully applied to many scenarios, as discussed in Chap. 5.

On the other hand, in the process of development of FinTech, new types of risks represented by P2P platforms also emerge. As discussed in Chap. 3, E Zu Bao, Fan Ya and other platforms illegally raise billions of funds from hundreds of thousands of small investors, which significantly threatens the financial stability. Therefore, in the development of FinTech, we both observe that technology development and associated risks together. How can we make better use of the new opportunities

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_6

brought by new technology? How can we better defend against new types of risks? To answer those questions, we need to conduct more research to understand the core of the development of FinTech and the causes of new types of the risks.

As discussed in Chap. 1, in the early stage of development, FinTech appeared in the model of Internet finance, which in some sense played a positive role in the development of China's financial system. However, as discussed in Chap. 3, due to the frequent bankruptcy of P2P platforms, the word of Internet Finance almost slowly disappeared. Then the concept of FinTech represented by technology, such as blockchain, big data and artificial intelligence, becomes widely known by the public. Today, the concept of Internet finance is no longer popular, which is inseparable from the frequent bankruptcy of P2P platforms.

Although Internet finance is rarely mentioned today, it is still an important part of FinTech or the early stage of FinTech development. As discussed in Chap. 2, big data is the core of the development, and the third-party payment system represented by Ali pay and Tencent pay can be regarded as the infrastructure of big data, which is the key driver for the development of FinTech. The rapid development of third-party payment has accumulated a large amount of data, which has laid a foundation for the FinTech development. The emergence of big data allows people to observe new information that cannot be observed under the traditional financial system, thus providing a basis for credit investigation for small and medium enterprises and individuals who cannot obtain financial services under the traditional financial system. In fact, small and medium enterprises and individuals account for the majority of the population and are very eager for financial services. Therefore, the emergence of big data essentially provides collateral of financial service, which promotes the fast development of FinTech in China.

The application scenarios of popular technologies currently included in FinTech, such as blockchain and federated learning, are developed based on big data. The development of new technology needs “try and trial”, which may generate new risks. Therefore, we should not only accelerate the development of technology, but also prevent risks, so it is important to understand the essence of FinTech innovations. Although FinTech is mainly brought by the development of technology, the core of finance remains unchanged. The understanding of FinTech should be from the perspective of finance. This chapter first makes a general discussion on financial risk and technology, and then takes big data credit as an example to analyze the core of FinTech.

6.2 Big Data Finance and P2P Risk

As we discussed in Chap. 1, FinTech first appeared in the form of Internet finance, mainly in business models of third-party payment and P2P platforms. Facing the rapid development of Internet finance, especially the third-party payment system, one question we need to ask is: why is the Internet developing so fast in China? Nowadays, we can go out almost without cash, take a taxi, pay for the subway, or

even buy fruit at a roadside stall with Ali Pay or Tencent pay. This is unimaginable in the United States, Europe, and other developed countries!

At present, China's third-party payment industry has ranked first in the world. However, looking back on the development process, many innovative models have already appeared in U.S. or Europe, but they have not really developed. Taking Alibaba as an example, the model of Taobao has long appeared in the United States, which is the platform of E-bay. The prototype of Ali pay is also in the United States, which is called Pay-Pal (PayPal). Moreover, Pay-Pal has even developed the US version of Yu E Bao.[1] However, in the United States, the development of Internet finance is far less rapid than that of China. Why do we observe those phenomena? In this chapter, we try to build a framework to understand the development of FinTech in China.

The infrastructure of FinTech is the terminal (third party payment) of big data accumulation. It can be said that if there is no third-party payment as an intermediary to collect financial big data, there will be no prosperity of today's development of FinTech. The third-party payment system solves problems of information asymmetry. Take the business model of Ali pay as an example. When the transaction starts, the buyer sends the money into the Ali pay account (virtual account), and the seller does not receive the payment. When the transaction is completed, that is, when the buyer is satisfied with the product, Ali pay will give the money to the seller. Although it seems that Ali pay is just postponed the payment process, it solves the problem of asymmetric information between buyers and sellers and promotes the prosperity of online transactions. Moreover, a complete transaction via Ali pay means that the buyer is satisfied with the seller's product, which gives some information about the quality of the seller's product. It turns out that this piece of information is very useful to solve the moral hazard problem in the traditional finance system. Therefore, another derivative of third-party payment is big data, which is the core of the development of FinTech.

The traditional financial system in China is leading by commercial banks, and the deposit and loan interest rate is strictly controlled by the government. In some sense, the commercial banks in China do not care too much about the payment services. The controlled interest rates make sure that banks can make stable profits from saving and loan services without any risks. Therefore, when Alibaba applies for the business of third-party payment system to support Taobao, the commercial banks do not regard it as a business grab. In fact, the payment services only account for about 5% of the total business of commercial banks, and the number in U.S and Europe is about 25%. Under the traditional finance system, individual investors lack investment channels and can only deposit a large amount of idle funds in banks. As we discussed in Chap. 1, Yu E Bao provides a simple way of wealth management for individual investors, leading to a transfer of bank deposits from bank account to Y E Bao accounts.

[1] Pay-Pal also links its account to the money market, and the business is almost identical to Yu E Bao.

Moreover, small and medium enterprises also lack financing channels under the traditional finance system. The reason is that they do not have enough collateral for the loans. The small loan company by Alibaba provides new financing channels for small and medium enterprises based on the massive transaction data. As one of the most successful FinTech companies, Alibaba has attracted the attention of the media and the public. Alibaba obtains the transaction information of online merchants from the transaction records and can provide them with a certain amount of loans. This process is the operation model of Alibaba small loans. On the one hand, given the business model of Ali pay, sellers cannot get money immediately when they sell goods, so there is a demand for money. On the other hand, the on-line stores are mainly small and medium enterprises, so it is difficult for them to finance from banks under the traditional financial system.

In the Internet age, everyone leaves a lot of information of their online activities on the Internet, so it also forms personal related big data. In this context, personal credit investigation based on personal big data has also developed very rapidly. As shown in Chap. 2, Alibaba developed the sesame credit for personal credit based on the personal behaviors of Taobao and Ali pay. The sesame credit does not only rely on the credit information, but also relies on other non-credit information.

Moreover, together with the technology development, we also observe huge P2P risks. P2P platforms are normally packaged with financial technology, but many cases of bankruptcy make people have doubt on the development of FinTech. In fact, we need some theoretical analysis to find out what the real core of financial technology is. In a recent paper by me and coauthors (Qiu et al. 2021), we explain the rationales of P2P platforms and big data credit in economics, which is an attempt to understand the core of FinTech. In the next section, we will briefly discuss the paper and take big data credit as an example to analyze the development of FinTech.

6.3 The Economic Explanations of the Credit Based on Big Data

The development of Internet technology provides an opportunity for the development of financial innovations, and the difference between FinTech and traditional finance model also lies in the wide application of data technology. With the popularization of computers and smart phones, we have obtained a large amount of network transaction data, which provides us with an unprecedented amount of information. According to Merton (1992), one of the six functions of the financial system is to solve the problems caused by asymmetric information. New data brings new information and new information processing methods, which leads to different financial innovation models. Since 2013, the strong rise of Internet Finance/FinTech significantly affects in China's financial industry. After the sudden rise of Internet finance, many people have great confidence in its development prospects. For

example, Xie et al. (2015) believes that Internet finance is a subversion of traditional finance.

When facing the current development momentum of FinTech, both industry and academia are very concerned about whether FinTech subverts traditional finance. Qiu et al. (2021) develop a theoretical framework to understand the relationship between FinTech and traditional finance. In the paper, Qiu et al. (2021) choose the big data credit as an example and analyze advantages the credit model transformed by FinTech technology based on big data. Comparing with the traditional bank credit model, big data can provide some new information, which effectively solves the moral hazard problem. In this sense, Qiu et al. (2021) make an economic explanation for the differences between traditional finance models and FinTech, which essentially lays in the big data. In this subsection, we discuss Qiu et al. (2021) in a nontechnical way.

6.3.1 Background

In the development of finance system in China in the past few decades, the traditional credit intermediary represented by commercial banks has always played a leading role in financing. However, in the early stage of the development of Internet finance, many people believe that P2P online loan, as one of the representatives of Internet finance, is likely to replace traditional bank credit in the future. Facing the prosperity and development of P2P, commercial banks also feel pressure, so some commercial banks have also established P2P platform companies. In fact, bank credit and P2P lending are very different things. The former is indirect financing, but the latter is direct financing. In recent years, the problems of P2P online loan platforms have been exposed, and regulations of P2P become stricter. As a result, the development of P2P falls significantly.

At the same time, FinTech companies represented by Ant Financial and Webank focus on the development of big data credit, realizing the artificial intelligent credit approval process online, which significantly increases the financing efficiency. The online model of big data credit is more effective than the traditional bank credit model, which also causes high pressure on commercial banks. In fact, even the state-owned commercial banks are trying to cooperate with Internet companies. In the past several years, the application of big data credit by Chinese traditional banking industry is rather successful. As pointed out by Shuqing Guo, the chairman of China Banking and Insurance Regulatory Commission, the China's banking industry makes a lot of exploration in using big data to reduce the non-performing rate to a very low level, about 1%.

Although some papers discuss the basic theory of Internet Finance/FinTech (e.g., Xie et al. 2015), they do not focus on big data. Some empirical studies point out that big data can help solve the moral hazard and adverse selection problems caused by information asymmetry, but they rely on data analysis rather than a theoretical framework.

Qiu et al. (2021) apply the model of information economics to discuss the "subversion" of FinTech to traditional finance. Some financial technologies mainly conduct the traditional financial business model by simply using the Internet, which cannot be regarded as financial innovation. For example, a considerable number of P2P platforms and financial management platforms just move the traditional finance model to on-line platforms. Some FinTech models, such as big data credit, apply the new technology to the big data, which significantly improve the problem of information asymmetry and is regarded as financial innovation.

The greatest improvement of FinTech on credit business should not lie in on the difference of on-line and off-line models, but in its transformation of the core of financial risk management. Based on big data, lenders of funds can obtain better information to identify and control credit risk and reduce information asymmetry. The advantage of big data credit is that it can collect and process information that cannot be obtained in the traditional credit models, so as to better identify the qualifications of borrowers. Moreover, big data can solve the moral hazard and adverse selection problems perplexing the financial industry and objectively expand the boundary of financial services, realizing the inclusive benefits of finance.

Qiu et al. (2021) construct a model with asymmetric information and deduce in detail how financial technology can help solve some problems that cannot be solved by the traditional credit model. The paper mainly focuses on the two most important problems in finance, moral hazard and adverse selection. Moreover, in the operation of most P2P network loan platforms, the core of offline traditional risk control methods has not changed, so P2P is essentially not a financial innovation. Credit-based on big data has advantages because it generates new and useful information for credit review through big data analysis.

Qiu et al. (2021) demonstrated the mechanism of big data credit through a model of optimal contracting. They compare the differences between direct lending model, traditional bank credit model and big data credit model, revealing the advantages of big data credit from the theoretical level. Moreover, Qiu et al. (2021) believe that the big data credit model is an upgrade of the traditional bank credit model and poses a certain challenge to the survival of traditional banks. Banks need to keep pace with the times and make rational use of big data to carry out credit. For the P2P online loan model, however, it is lack of big data support and cannot effectively improve the problem of information asymmetry. Compared with traditional banks, P2P has no advantage in risk control.

6.3.2 Description of the Model

Qiu et al. (2021) build a model for borrowers and lenders with asymmetric information as the benchmark, in which the model of P2P lending can be analyzed. Our discussion will be qualitative, so we will not solve the model in the section. However, to better illustrate our idea, we still need to make a reasonable description of our model. Figure 6.1 shows the graphical description of the model.

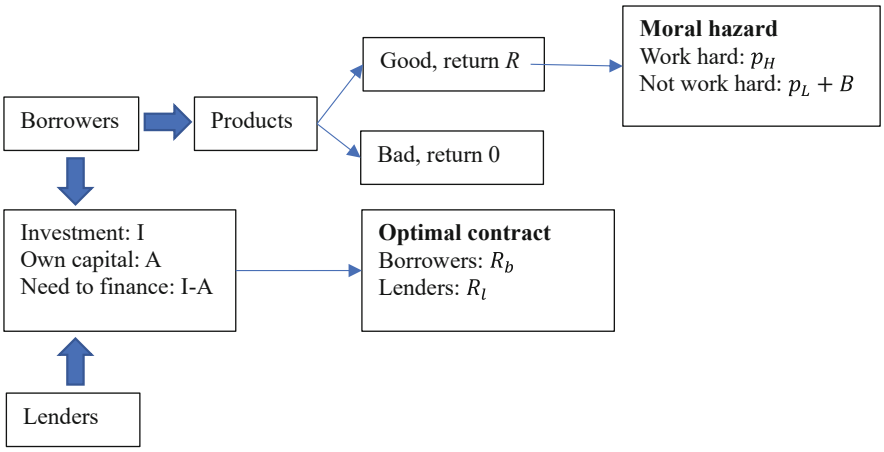


Fig. 6.1 Model description

We consider a direct lending economy with both borrowers and lenders. First, the borrowers need funds for some investment, and we can imagine borrowers as entrepreneurs who have good projects but no funds to operate. Second, the lenders have money and need to make an investment for good returns. They can be imagined as investors with some spare money. As shown in Fig. 6.1, the borrowers have their own capital A, but the project investment needs the total amount of I, which is higher than the capital owned by borrowers ($I > A$). Therefore, the entrepreneurs need to raise a total amount of I-A capital from the investors. The investors can invest their money in the project, and then receive some returns for their investment.

Entrepreneurs can produce some product with either good or bad quality. If the product is good, it will generate good returns (in the model, the return is R) with a certain probability. If the product return is realized, the entrepreneurs and investors will share the profit based on a prespecified contract. However, there is a certain possibility that the product is unqualified. If this is the case, the entrepreneurs will not get any income, the enterprise will go bankrupt, and the investors will not get any return.

There is information asymmetry between the entrepreneurs and the investors. One type of information asymmetry is moral hazard, which means that the investors cannot observe whether entrepreneurs work hard or not. If the entrepreneurs work hard, the probability of producing qualified product will be high (p_H in Fig. 6.1). If they do not work hard, the probability of producing qualified product will be low (p_L in Fig. 6.1). However, entrepreneurs can obtain some private benefit (B) by enjoying personal life or travelling with money raised from lenders.

To solve the problem of moral hazard, investors and entrepreneurs can sign a contract to determine how to share future profits, and the contract can also provide enough incentive to let entrepreneurs work hard. As shown in Fig. 6.1, the optimal contract specifies the returns to borrowers (R_b) and lenders (R_l). Note that the form of R_l can be various forms. If R_l is a fixed principal and some interests, then it is an

optimal debt contract. If borrowers and lenders share the profits generated by the product, then it is an optimal equity contract.

Therefore, the definitions of the contract can be very broad, including equity, debt, ABS, or other financial instruments. Moreover, we can also add financial intermediaries, such as commercial banks or equity markets, between the entrepreneurs and the investors. Therefore, although Qiu et al. (2021) only consider a model with direct financing, the model can be modified to incorporate most of the financing channels in reality. Moreover, the model links finance with the real economy, which shows that a good real economy needs financial support.

The basic idea of this model is from Holmstrom and Tirole (1997) in which they consider the role of financial intermediation. There are several conclusions by Holmstrom and Tirole (1997), which are mainly due to the existence of information asymmetry. First, if the borrowers do not have enough assets as collateral, they will not be able to borrow money, which is also called credit rationing. In other words, lending without collateral does not exist. Second, commercial banks can play the role of a monitor, which can improve the problem of moral hazard. However, commercial banks also face moral hazard problems, so we go for a question: Who monitors the monitor? Therefore, even with the existence of commercial banks, credit rationing still exists. In China, one observation is that it is difficult for small and medium enterprises to obtain financing from commercial banks. As we discussed in Chap. 1, due to the prevalence of commercial banks in the traditional finance system in China, the problem of credit rationing (or information asymmetry) is the reason for the present situation of small and medium enterprises!

Qiu et al. (2021) introduce big data into the basic model by Holmstrom and Tirole (1997). When big data is very detailed, technologies such as machine learning or artificial intelligence can obtain some useful information that cannot be observed by traditional commercial banks, and the information can be used as the basis for credit investigation of small, medium-sized enterprises. Therefore, big data can cover some customer groups that commercial banks cannot cover, which increases the boundary of credit rationing. At the same time, big data can also solve the problem of moral hazard.

Moreover, Qiu et al. (2021) develop a two-period dynamic model with moral hazard, in which the borrowers have to raise money for two rounds of production. Whether the borrowers can raise enough money for production in the second round depends on their performance in the first round of production. The lenders can use big data generated in the first round of production to extract information about quality of the product. Thus, to obtain the second round of financing, the borrowers have incentive to work hard to increase the quality of the product. We can use the real-life example, Alibaba small loans, to illustrate this idea. The borrower can be thought of as online store on the Tao Bao platform, and the lenders can be thought of as Alibaba small loans. Based on the big data from Ali pay, Alibaba issues some loans to those on-line stores. The mechanism is shown in Fig. 6.2.

Figure 6.2 shows case of Alibaba small loans, which is the example of how big data can be used to solve the moral hazard problem. In this example, the big data is the successful rate of transactions. The third-party payment platform represented by

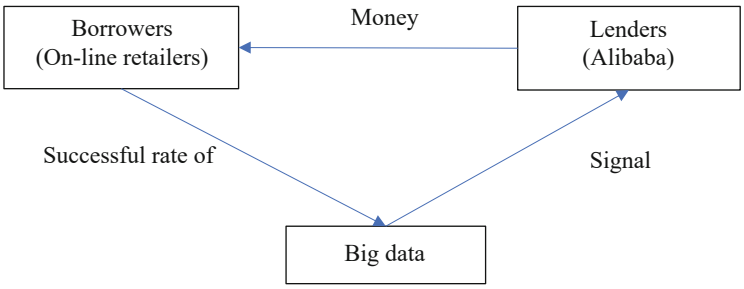


Fig. 6.2 How big data solve moral hazard

Ali pay is a key link in the operation of Alibaba small loans and online stores. Alipay can generate a large amount of transaction data from online stores, and Alibaba small loans provide loans to online stores based on those data. As shown in Fig. 6.2, when an enterprise sells its products to consumers, the transaction is not completed immediately. A transaction is completed only after consumers receive the products and are satisfied with the product. Therefore, the successful rate of transactions can be regarded as some signal about the quality of the product. Alibaba extracts information from the successful rate of transactions, so as to decide whether to provide financing for enterprises in the next round. Obviously, the more successful transactions, the easier it is for enterprises to get funds. Therefore, in order to obtain funds, enterprises will work hard to improve the quality of products and improve the probability of transaction success, so the problem of moral hazard can be solved.

On the website of Alibaba, we can various conditional for the applications of Alibaba small loans. One important condition for the loans to be issued is "continuous and effective operation", which is effectively the number of transactions. It is with these massive data that Alibaba small loans can develop a new model of big data credit. In fact, big data can also supervise enterprises during and after loans. After the loans are issued, Tao Bao platform itself is a kind of collateral. During the lending process, Alibaba can also use big data to supervise borrowers. For example, if an enterprise claims that the loan is for advertising, big data can play a supervisory role by observing whether webpage views increase or not through Tao Bao platform.

6.4 Some Discussion on Collateral

One implication of our benchmark model (e.g., Holmstrom and Tirole 1997) is that credit rationing, which basically means that non-existence of financing without collateral. If we find some lending without collateral, it must be the case that something works as the collateral. For example, Qiu et al. (2021) show that big data work as collateral. While the well-known Grameen Bank is normally recognized as a non-collateral financing, issuing loans from the Grameen Bank needs a guarantee from a group of well-known local people. In this case, the trust of those

well-known local people works as collateral. In the P2P cases such as E Zu Bao and Fan Ya we discussed in Chap. 3, the mainstream media and celebrity effectively work as collateral.

A large number of empirical literature attempts to demonstrate that the non-traditional information can affect success rate of lending, such as appearance (Duarte et al. 2012), race and gender (Pope and Sydnor 2011), financial status (Iyer et al. 2009), social relations (Freedman and Jin 2008), social networks (Lin et al. 2013), loan statement (Li et al. 2014) and investor rationality (Li et al. 2014). These pieces of non-traditional information are alternative to credit information, which is usually regarded as "soft" credit information. In fact, the soft credit information also works as collateral. However, in addition to the necessary identity and other information, P2P borrowers usually voluntarily release information that helps them obtain loans, which is generally unverifiable. Both lenders and platforms lack the ability to distinguish the authenticity of information, so they cannot be used as a reliable source of information. However, empirical research shows that lenders are vulnerable to this information, and making decisions that may be wrong (Michels 2012).

6.5 Takeaways

In this chapter, we provide some discussion on P2P risk and big data credit, which are important for the development of FinTech. However, FinTech covers a wide range, and big data credit is only a small branch. At the end of this chapter, we discuss some of takeaways from our discussion.

1. In the paper by Holmstrom and Tirole (1997), the most basic credit model is P2P (direct lending and internet platform), and under normal circumstances, the P2P platform also needs collateral to complete the loan. Therefore, P2P lending is not really a financial innovation, and the mainstream media and celebrities play the role of collateral for P2P lending. As we discussed in Chap. 1, the investment opportunities are limited for ordinary investors, so common people cannot enjoy enough finance services under the traditional finance system in China. Therefore, investors have trust in mainstream media and celebrities, and the trust works as collateral, so the P2P lending happens.
2. The collateral mentioned in the previous point of view actually plays an alternative role to credit. If the trust between people can be replaced by the trust in technology, such as blockchain, P2P lending may become a viable way for financing, which may be the direction of big data technology in future development.
3. In big data credit, all we mentioned are the good aspects of big data, but is big data always good? The answer to this question is not necessarily yes. Personal privacy issues related to big data are difficult to solve at present, Moreover, it is often estimated that some useless big data will be created to mislead consumers

(such as false comments). The solution to these problems may require the confirmation of data ownership! If the ownership of data can be confirmed, rights and obligations can be completely distinguished, then the use of big data to infringe on others' privacy can be prosecuted.

For the development of FinTech, we believe that big data is the core of its development, and we will finally be in the era of data economy. A deep understanding of the real impact of big data on economics and finance is important for us to understand the development of FinTech. Although FinTech is a combination of finance and technology, we believe that its core is still finance!

References

Duarte J, Siegel S, Young L (2012) Trust and credit: the role of appearance in peer-to-peer lending. Rev Financ Stud 25(8):2455–2484

Freedman S, Jin GZ (2008) Do social networks solve information problems for peer-to-peer lending? Evidence from Prosper. com. SSRN working paper

Holmstrom B, Tirole J (1997) Financial intermediation, loanable funds, and the real sector. Q J Econ 112(3):663–691

Iyer R, Khwaja AI, Luttmer EF, Shue K (2009) Screening in new credit markets: can individual lenders infer borrower creditworthiness in peer-to-peer lending? In AFA 2011 Denver meetings paper

Li Y, Gao Y, Li Z, Cai Z, Wang B, Yang Y (2014) The influence of borrower's description on investors' decision—analyze based on P2P online lending. Econ Res J 49(S1):143–155

Lin M, Prabhala NR, Viswanathan S (2013) Judging borrowers by the company they keep: friendship networks and information asymmetry in online peer-to-peer lending. Manag Sci 59(1):17–35

Merton RC (1992) Financial innovation and economic performance. J Appl Corp Financ 4(4): 12–22

Michels J (2012) Do unverifiable disclosures matter? Evidence from peer-to-peer lending. Account Rev 87(4):1385–1413

Pope DG, Sydnor JR (2011) What's in a picture? Evidence of discrimination from prosper. J Hum Resour 46(1):53–92

Qiu Z, Luo Y, Jiang Y, Wu C (2021) Is Fintech the gravedigger of traditional credit intermediaries? An economic analysis of credit based on big data. Stud Int Financ 8:35–45

Xie P, Zou C, Liu H (2015) The fundamental theory of internet finance. J Financ Res 422(8):1–12

Chapter 7
Summary and Future Development

The theme of this book is about the development of FinTech and related risks, with a special focus on China. Although China is one of the countries with the fastest development of FinTech in the world, it is also well known for the speculative and unregulated industry with high risks. Therefore, China is suitable for us to understand both the technology development and risks of FinTech. On the one hand, we observe innovations and development of technologies, which lead China to become the world leader in the field of FinTech, especially the third payment system. On the other hand, the bankruptcy tide of the P2P industry brings huge risks to the financial system, which involves millions of ordinary small investors, significantly threatening the financial stability of the country. In this book, we try to link those topics together and to get a sense of key drivers and economic explanations about both the fast development and risks about FinTech.

By describing the history of China's "Internet finance", we understand the different stages of the development of FinTech. The system of the third-party payment becomes the infrastructure for big data collection, and the big data drives the almost whole development of FinTech. Moreover, some innovations turn out to be non-innovative at all, especially P2P platforms, which bring huge risks to the society. Based on the P2P definition and case analysis in Chap. 3, we show that if the P2P platform is consistent with the definition of information intermediary, it is just a combination of the traditional private lending and the Internet platforms, which cannot be the innovations for finance. The big data, however, provide some additional information that cannot be observed in the traditional finance system, thus can be regarded as the collateral of small and medium borrowers for financing. Moreover, big data can also solve moral hazard problems caused by asymmetric information.

In this book, we use both cases and economic analysis to show that big data is the core for the development of FinTech. For the future development, we also believe big data is the key driver, which can finally guide us into a data economy. However, although big data is promising, there are nonetheless some problems with the applications of big data. As we discussed in both Chaps. 2 and 6, we not only

Z. Qiu et al., *Fintech and Financial Risk in China*, Contributions to Finance and Accounting, https://doi.org/10.1007/978-981-19-0288-8_7

need to solve the problems of personal privacy and data ownership, but also need to understand the real impact of big data on economics and finance.

For future development of FinTech, we may rely on the development of technology. In Chap. 5, we discuss one technology, the blockchain, in the book. The blockchain originates from the decentralized currency such as Bitcoin, but it gives us a huge space of imagination for data application. Although cryptocurrency is illegal for many countries, the blockchain technology is widely supported by governments. For Bitcoin, the decentralized one dollar is essentially some programming code. If the programming codes can represent one dollar, they can represent the ownership of assets in the digital world. Take NFT as an example, it can represent the ownership of an artwork in a digital world. Then can we use NFT to represent the ownership of data?

In general, we believe that we will finally enter a data economy in which data is the key production factor. However, there are still some remaining issues for the future development of data. Some of them can be solved by technology, but others may need legislation. Nonetheless, we have a long way to go about the development of data economy, and more thinking and research are needed in this field. Here, we summarize some of the important points in this chapter at the end of this book.

7.1 The Boundary of Data Usage

Nowadays, we see data everywhere, and anyone can leave footprints by their online activities. Therefore, huge amounts of data are collected, and even some businesses for data collection and analysis are rapidly developed. However, not all the data are properly analyzed, and some data collections are even not legal. Take Facebook and Cambridge Analytica as an example, data are illegally used and analyzed for political purposes.

On the one hand, we can extract values from big data by using advanced technology such as machine learning and artificial intelligence. On the other hand, the misuse of data may damage personal privacy. For example, if some application developers use the trading volume to analyze some trading strategy, there should not be any problems. However, if they disclose the stock holdings of each investor, it clearly violates personal privacy. Therefore, in the era of big data, it is important to make clear about the boundary of data usage.

7.2 Data Ownership

Defining the property rights is the most important factor for the success of market economy. However, in the data economy, how can we define the data ownership? As we discussed in Chap. 2, data may belong to data collectors or data generators, and there is no unified opinion. However, although data ownership is not properly

defined at the moment, the punishment of data misuse, especially violation of personal privacy, should be regulated at the legislation level. Tragedies in the past remind us of the importance of personal privacy. In August 2018, a girl in Zhejiang province was deliberately murdered by a Di Di (a taxi-hailing app) driver, as a result of illegal information leakage. The data leakage allows drivers to get information about their passengers, which greatly harms the passengers' safety.

7.3 The Pricing of Data

There are many data markets in China, but the pricing rules are not clear. If we treat data as an important production factor, then the development of data market or exchange is important. However, there are several issues with the pricing of data. First, the same data can generate different values for different users, so different users may pay different prices for the same data. Second, the sellers can sell the same data many times and set different prices for different buyers. Third, if a buyer has just purchased data, she can resell the data to others after using the data, just competing with the sellers. Therefore, unlike other commodities with physical states, data needs more in-depth research for the pricing and trading.

7.4 Noise in Big Data

In the data world, we can obtain the additional information provided by big data to generate business value, which is one of the biggest advantages of the data application. However, big data can not only provide more information, but also generate more noise, and some of which are deliberately generated. For example, on the Tao Bao platform, the online stores can hire someone to leave messages to exaggerate their goods and services. Although those messages are also regarded as big data, they certainly do not provide any useful information. Even worse, they can cause the original information extracted from big data to be less precise.

7.5 Price Discrimination of Big Data

This is also a widely discussed topic for the application of data. In general, some data collectors may have better knowledge about customers' preferences, so they can set the price based on customers' marginal utility. For example, different customers may see different prices for the same product or service, and one customer may obtain different prices for the same service at different times. As we discussed in Chap. 2, this issue also needs to be solved.

In general, our understanding of the development of FinTech or the application of data is rather limited, and we may rely more on the development of technology. For example, the blockchain database can be used as a shared ledger for several parties, which can generate more business value by cooperation. The more detailed the shared data, the higher the business value can be generated. However, the drawback of detailed data is the leakage of information. To solve this problem, the shared data can be encrypted by some cryptographic algorism for privacy protection, and technology such as federal learning can be applied for encrypted data. Therefore, although users share the data on the blockchain database, what they use is encrypted data, which will not threaten privacy disclosure. We expect more advanced technological developments of data applications in the future.