The Influence of Fintech on Regional Financial Risk and Its Spatial Spillover Effect

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ABSTRACT: This paper uses data from 30 provinces in China from 2011 to 2018 as samples to analyze the impact of fintech on regional financial risks and its spatial spillover effects using spatial Dubin model. The analysis shows that fintech can restrain the accumulation of regional financial risks, but will accelerate the spillover of financial risks to neighboring regions. Therefore, the following suggestions are put forward: construct the fintech infrastructure system; perfect the construction of financial system and optimize the financial environment; attach importance to financial regulation.

KEYWORDS: Finance technology, digital finance, financial risk, spatial spillover effect, spatial Dubin model.

1. INTRODUCTION

In recent years, with the rapid progress of the fourth industrial Revolution, fintech, as a product of the fusion of technology and financial innovation, has been rising rapidly around the world. The widespread application of financial technologies such as blockchain, big data and artificial intelligence has made it possible to improve information transparency and transaction efficiency in financial markets, but it has also brought new risks. On the one hand, the widespread use of fintech in China enables financial institutions to provide financial services more efficiently and at lower cost, thus providing better financial security for high-quality economic growth. Since 2013, all kinds of new financial forms based on fintech have entered a period of accelerated development. Digital payment, Internet insurance, Internet consumer finance, Internet money fund, online lending and digital currency have all achieved rapid development. According to WIND data, the transaction volume of Internet funds increased from 2.2 trillion yuan to 13.3 trillion yuan between 2013 and 2016. From 2013 to 2017, the scale of digital payment market increased from 16.9 trillion yuan to 154.9 trillion yuan, the scale of Internet consumer finance surged from 6 billion yuan to 4.4 trillion yuan, and the scale of online lending increased from 97.5 billion yuan to 2.3 trillion yuan. On the other hand, due to the lack of fintech infrastructure, the public's lack of risk awareness, enterprises' lack of risk control ability, and lagging supervision, there have been frequent risk incidents in the fintech industry in recent years, and new financial forms have also brought new risks and hidden dangers. Take the online lending industry as an example. Since the emergence of P2P online lending platforms in China in 2007, there have been frequent incidents such as termination of operation, withdrawal difficulties, running away and fraud. These problems have not only cost investors significant money, but also severely damaged the industry's reputation. Once relevant risks are not properly handled and defused, they may spread to the formal financial system and make it more difficult to prevent systemic financial risks.

At present, the prevention and resolution of financial risks has become an important topic of the attention all over the world, especially after the outbreak of European debt crisis, unbalanced regional economic recovery and regional financial instability has very remarkable influence on the overall financial stability. Local financial risks accumulating to a certain degree and forming regional financial crisis may have a great impact on the overall economic and financial operation through various channels. As fintech becomes more prominent, the importance and ubiquity of complex networks and associated contagion effects will increase, including the systemic importance of centralization and interlinked issues. The development of fintech may exacerbate the market turmoil caused by financial friction. With the development of China's capital market and the growing maturity of financial institutions, the financial sector tends to be more mixed operation, and the business of each institution penetrates and crosses each other. In this case, once there is a risk in a certain region or industry, it will lead to the spread of the risk to the entire financial market through various channels, thus forming an economic crisis.

In the discussion of financial risks, scholars have conducted various theoretical discussions on the impact of fintech on regional financial risks, but few scholars have analyzed it based on empirical evidence. Existing research is mainly based on the financial system in

our country, aiming at the effects of the financial industry, financial science and technology to the traditional or internal financial risk transfer effect, not considering the regional heterogeneity of financial technology development and its spatial spillover effect, if the risk incurred will endanger the stability of the entire financial system rapidly. This paper will theoretically analyze the impact of the development of fintech on a single regional financial risk and its infectivity among different regions, and analyze the possible impact of fintech on regional financial risk and its spatial spillover effect through spatial econometric model, in order to provide useful reference for regional financial risk prevention and control.

2. LITERATURE REVIEW

The concept of fintech was formally proposed in 2011. The Financial Stability Board (FSB) defined it as technology-driven financial innovation, which is to innovate products and services provided by the traditional financial industry through the use of various technological means such as big data, blockchain, cloud computing, artificial intelligence and other emerging cutting-edge technologies [1]. Improve efficiency, enhance experience, expand scale and reduce operating costs. Financial innovation has blurred people's understanding of the risks of the real economy, and a series of problems caused by it all point to new risks. Regional financial risk is the extension of macro-financial risk research at the regional level. It generally refers to a certain economic region within the national scope (such as geographical or administrative divisions such as regions, provinces and counties). Some scholars believe that regional financial risks, as intermediate financial risks, are mainly formed by the regional diffusion of micro-financial risks, or the inter-regional correlation risk dissemination, and may also be the top-down infiltration of macro-financial risks. Regional financial risk is a comprehensive proposition involving "finance-enterprise-government-economy", and there is a mechanism of "generation-infection-reinfection", which leads to the self-replication and upgrading of regional financial risk in China [2].

Fintech innovation may have a negative systemic impact on the financial system. The impact would threaten the provision even the disruption of critical financial services, accelerate financial disintermediation, which could have serious potential negative effects on the real economy.

First, fintech itself contains the technical risk of data leakage and the risk of losing control of technology [3], which also increases the moral and ethical risk of fintech [4]. Due to its characteristics of openness, technology and connectivity, fintech makes the traditional financial risks of financial business departments more hidden and difficult to identify [5]. Among them, liquidity risk and credit risk are the most widely studied. In addition, fintech enterprises can use big data and other technical means to make price plans for consumers, easily realize price discrimination and obtain the consumer surplus of all consumers, namely "big data killing" [6].

Second, the application of fintech increases the interconnectedness of financial institutions and the complexity of the financial system, enhancing systemic financial risks. In addition to the traditional financial risks faced by the fintech sector itself, risks may also be amplified among fintech sectors through internal diffusion mechanisms and spill over to other financial sectors [7]. Assuming that AI is widely used in market-oriented financial institutions, financial institutions will inevitably have the homogeneity of algorithms and technologies as the technology matures. Such homogeneity continuously increases pro-cyclicality through feedback mechanism, thus continuously accumulating and amplifying endogenous risks in the system.

Finally, the development of fintech may make financial regulation much more difficult. Many fintech companies operate outside of regulation or are not subject to the same disclosure obligations as traditional financial institutions, and the algorithmically complex processes underpinning their operations are difficult to understand [8]. Li (2016) believes that the current separate supervision system is difficult to supervise new financial forms, and it may lead to instability in the financial sector as a whole when there is a gap in supervision [9]. In an era of frequent innovation, the rapid changes in the financial market make it more difficult for regulators to monitor and respond to risks, and there is an urgent need to obtain data and information related to major risks in fintech. Between innovation development and regulation, regulation is always lagging behind [10].

In addition to the above positive impacts, fintech innovation may have a positive impact on the financial system. The rapid development of modern science and technology in the financial field promotes the comprehensive data sources in financial activities and makes the information of both sides of the transaction more symmetrical. Under the FSB's fintech analysis framework, we can see that AI and machine learning can process information more effectively, such as credit decisions, financial markets, insurance contracts and customer interactions, which may contribute to a more efficient financial system. AI can assist institutions at all stages of the risk management process, including identifying exposures and assessing their impact [11]. It can also help select appropriate risk mitigation strategies and find tools that help transfer or trade risks. Exogenous risk of the financial system is measurable and quantifiable, and its results are subject to statistical distribution, which can be well controlled by regulators using artificial intelligence technology. Colladon and Remondi's study (2017) demonstrated the effectiveness of machine learning analysis systems in fraud detection using real data from 33,000 transactions from an Italian factoring firm [12]. Lee and Shin (2018) believe that blockchain technology is revolutionizing many traditional banking services with higher transaction security and faster currency exchange at a lower cost both domestically and globally [13]. Because competition for and retention of customers is fierce, customer management is critical. Robo-advisor aims to provide personalized 24/7 service to more low-cost people. Trade and investment strategy based on artificial intelligence and big data can redefine the price discovery mechanism of financial markets, increase speed and improve liquidity in financial markets, improve the

efficiency and stability of the financial markets, regulators can more effectively analysis, early warning and prevent systemic risk in financial markets.

As a financial innovation driven by technology, fintech has been developing rapidly with its technology and cost advantage. But the fact that its development foundation is weak, and traditional financial industry form a larger impact, also caused the domestic and foreign academic discussion about security problems of fintech, which has much related work and different conclusions. Some scholars believe that fintech has positive externalities and its innovation capability provides an opportunity for the development of traditional financial industry. More scholars believe that the rapid development of fintech has a strong impact on financial and economic security. However, there are literatures on the influence of fintech on regional financial risks, which mostly stay at the theoretical level, but rarely involve the empirical analysis of that. Therefore, this paper will use available data to analyze the impact of fintech on regional financial risk and its spatial spillover effect, in order to put forward constructive suggestions for the development of China's fintech and regional financial risk prevention.

3. THE INFLUENCE MECHANISM OF FINTECH ON REGIONAL FINANCIAL RISK

3.1. THE IMPACT OF FINTECH ON FINANCIAL RISK IN A SINGLE REGION

Fintech itself is the financial innovation that influences the traditional financial industry through technological innovation. Technology itself is both the driving force of fintech development and the risk point of fintech. Fintech itself contains the technical risk of data leakage and the risk of technological loss of control. The application of fintech increases the relevance of financial institutions and the complexity of the financial system, and strengthens the systemic financial risk.

However, the rapid development of modern science and technology in the financial field can promote the comprehensive source of data in financial activities and make the information of both sides of the transaction more symmetrical. Under the condition of decentralization, block chain technology forms a distributed data structure, which makes the information sharing of identity information, transaction process and settlement transaction on the bookkeeping system, and greatly expands the formality and application scope of financial information. In terms of identifying fraudulent transactions, based on blockchain technology, financial trading platforms can prevent runaway and fraud to a large extent. Trading based on artificial intelligence and big data is conducive to the construction of financial market robustness, improve the efficiency of price discovery in financial market, and promote the liquidity of financial market [14]. Based on big data and scientific decision-making methods, regulators can analyze and warn the systemic risks of financial transactions and prevent the occurrence of "black swans" and "gray rhinos" [15].

Hypothesis 1: The development of fintech will restrain regional financial risks.

3.2. SPATIAL SPILLOVER EFFECTS OF FINTECH ON REGIONAL FINANCIAL RISKS

Spillover effect refers to the transactional process of changing, causing and expanding in economic and financial aspects or as a whole when the financial crisis hit. Spillover effect can be divided into trade spillover effect and financial spillover effect.

With the constant improvement of socialist market economy construction in China and opening to the outside world step acceleration, the relationship between regional economy and financial sectors become increasingly close, which in helps to give play to the role of finance and economic support and also increases the chances of the regional financial risk spillover and propagation speed. At the same time, as a product of the development of fintech, Internet finance, a rapidly developing new financial model, has gradually linked the national financial industry into a whole, which not only improves the vitality of the financial industry, but also further increases the possibility of spillover of regional financial risks to other regions. Among them, reputational contagion is a potential concern of fintech, especially in activities that directly interact with households and businesses. For example, a significant unexpected loss on a single fintech lending platform could be interpreted as a potential loss for the entire industry. Increased exposure and online risk can increase the risk of infection.

From a systemically important perspective, highly connected entities are most likely to emerge in the future in the form of market infrastructure in the context of fintech. For example, distributed account technology has a wide range of potential applications, digital currencies and wallets themselves could replace traditional bank payment systems, and aggregation platforms could become the default way to access banks and apply for new bank accounts and loans. Other oligopolies or monopolies may also emerge, for example in the collection and use of customer information, which is essential for the provision of financial services. And entities deemed systemically important may unethically magnify risk. For example, they may be more inclined to take excessive risk if the downside is limited by implicit guarantees of public support. Predatory service pricing also stifles competition and reduces the likelihood that other service providers will step in when systemically important entities get into trouble.

Hypothesis 2: The impact of fintech on regional financial risks has spatial spillover effects.

4. METHODOLOGY

4.1. VARIABLE SELECTION AND DATA SOURCES

Main explanatory variable. Referring to the practice of Song et al. (2021) [16], this paper uses the number of fintech companies to reflect the real development of regional fintech. Firstly, keywords such as "fintech", "cloud computing", "big data", "blockchain", "artificial intelligence" and "Internet of Things" were searched on the website of "Tianyanzha" to obtain the industrial and commercial registration information of all relevant companies, and the samples of companies with less than one year of operation or abnormal operating conditions (such as suspension, dissolution, revocation, etc.) were removed. The annual number of fintech companies in each province is counted to measure the regional fintech development level (FTD). The higher the value is, the higher the development level of fintech is.

Explained variable. The measurement of regional financial risk refers to the method of Shen et al. (2019) [2], and selects 11 indicators from the financial, enterprise, government and macroeconomic environment to construct regional financial risk pressure index (FIR). Specific indicators are selected as shown in Table 1. After interpolating and completing a small amount of data, panel data of 30 provinces from 2010 to 2018 were finally collected. All data come from EPS database and official website of National Bureau of Statistics. First, the data are converted into positive risk indicators. After the dimensionality of the data is normalized, the entropy method is used to determine the weight of each indicator. After determining the weight, using the formula $Z_{it} = \sum \rho_j \times X_{j\,(it)}$ to sum the index data, the annual financial risk index of each region can be obtained.

Table 1. Basic Indicators and Meanings of Regional Financial Risk Index

	Index	Calculation method	Index properties
Financial sector	Non-performing loan ratio	Non-performing loans/total loans	Positive
	Credit inflation rate	Loan growth /GDP growth	Positive
	Loan-to-deposit ratio	Total loans/total deposits	Moderate
	Insurance penetration	Premium income /GDP	Negative
	Market value of stocks	Total market value of stocks /GDP	Positive
Corporate sector	Asset-liability ratio	Total liabilities/total assets	Moderate
	The amount of enterprise loss	Loss of loss-making enterprises /GDP	Positive
Government	Fiscal gap	(Fiscal expenditure - Fiscal revenue) /GDP	Positive
Macroeconomic environment	Investment	Investment in fixed assets /GDP	Negative
	The amount of foreign trade	Amount of exports /GDP	Negative
	CPI	Measure inflation	Moderate

Control variables. Urbanization rate (URB) is measured by the proportion of urban population in the total population. Urbanization construction accelerates, and the higher the urbanization rate, the higher the government debt is likely to be. Different financial structure (CON) has different effects on regional systemic financial risk, financial assets department structure restricts the systemic financial risk of different financing ways, embodied in direct financing and indirect financing, its efficiency is also has difference, so the distribution of assets structure has important influence to the regional systemic financial risk. The financial structure is divided into sector structure and financing structure, and market value/total loans of listed companies are selected as financing structure variables. The operation of the real economy (REAL), the physical and fundamental impact of the real economy on the financial market, determines that it becomes one of the main factors of regional and systemic financial risks. The losses of industrial enterprises/total profits of industrial enterprises are selected as the variables of the real economy. Government power (GOV) is used to measure the degree of local government intervention in the regional economy by comparing the total annual fiscal expenditure of the government with the regional GDP. When local government intervenes moderately in regional economy, financial risk can be effectively controlled. The percentage of added value of tertiary industry in regional GDP is used to represent the industrial structure (INS). With the upgrading of industrial structure, financial risks gradually decline. Internet penetration rate (NET), compiled according to statistical reports on Internet Development in China over the years. The development of the Internet not only contributes to the economic support of the financial industry, but also increases the possibility and speed of regional financial risk spillover.

4.2. SPATIAL AUTOCORRELATION ANALYSIS

Moran I index is generally used to test the existence of spatial autocorrelation. When the index is greater than 0, it means that the index has a positive spatial correlation among regions; when the index is less than 0, it means that the index has a negative spatial correlation among regions; when the index is equal to 0, it means that the index is randomly distributed among regions without any spatial correlation. In this paper, Moran I index is calculated by using the geographical adjacency weight matrix W.

Table 2. Global Moran I Values of Regional Financial Risks under the Two Weight Matrices

Year	Geographical adjacency weight matrix	Geographical distance weight matrix
2011	0.125*	0.019*
2012	0.116*	-0.012
2013	0.292***	0.067***
2014	0.1*	0.02**
2015	0.221***	0.058***
2016	0.205**	0.019*
2017	0.293***	0.116***
2018	0.256***	0.149***

*Note: ***, ** and * are significant at 1%, 5% and 10% levels respectively.*

4.3. MODEL SETTING

The calculation result that the average height of Moran's I index is significantly positive shows that there is a high positive correlation between provincial financial risks, and it is necessary to establish a spatial econometric model for demonstration. The spatial Dubin model can reflect the spatial spillover effect of independent variables as well as the spatial correlation of dependent variables, which is consistent with the theory that financial technology innovation leads to the spatial spillover of financial risks. Therefore, this paper chooses to establish the spatial Dubin model for empirical research. The spatial Dubin model set is:

$$\text{FIR}_{it} = \alpha_0 + \gamma W \times \text{FIR}_{it} + \alpha_1 \text{FTD}_{it} + \alpha_2 \text{LnGDP}_{it} + \alpha_3 \text{URB}_{it} + \alpha_4 \text{UEM}_{it} + \alpha_5 \text{NET}_{it}$$
$$+ \alpha_6 W \times \text{FTD}_{it} + \alpha_7 W \times \text{FDV}_{it} + \alpha_8 W \times \text{LnGDP}_{it} + \alpha_9 W \times \text{URB}_{it}$$
$$+ \alpha_{10} W \times \text{UEM}_{it} + \alpha_{11} W \times \text{NET}_{it} + \varepsilon_{it}$$

Where i represents the sample province, t represents the period, W represents the adjacent space matrix, and ε_{it} is the random disturbance term. FIR_{it} represents the level of regional financial risk, and $W \times \text{FIR}_{it}$ is used to investigate the spatial correlation of financial risk. FTD_{it} represents the development level of fintech; $\text{URB}_{it}, \text{CON}_{it}, \text{REAL}_{it}, \text{GOV}_{it}, \text{INS}_{it}$ and NET_{it} are control variables, representing urbanization rate, financing structure, real economy, government power, industrial structure and Internet penetration rate respectively.

$W \times \text{FTD}_{it}, W \times \text{URB}_{it}, W \times \text{CON}_{it}, W \times \text{REAL}_{it}, W \times \text{GOV}_{it}, W \times \text{INS}_{it}$ and $W \times \text{NET}_{it}$ represent the spatial spillover effects of corresponding independent variables respectively.

5. RESULTS

Based on the spatial Dubin model, this paper empirically analyzed the impact of Internet financial innovation on regional financial risks and their spatial spillover effects, and the results are shown in Table 3. It can be seen from the estimated test statistics that the goodness of fit is 0.441 and the absolute value of Loglikelihood is 313.16, indicating that the model is set reasonably and reflects the influence of various factors on regional financial risks.

Table 3. Regression Results of Regional Financial Risks

Variables	Estimated value	Z statistic
FTD	-0.019***	-2.96
URB	0.036	-0.39
CON	0.114***	5.48
REAL	-0.011	0.95
GOV	0.146*	1.75
INS	-0.063	-0.55
NET	0.001*	1.89
$W \times FTD_{it}$	0.027***	2.58
$W \times URB_{it}$	0.432	1.44
$W \times CON_{it}$	-0.112***	-3.45
$W \times REAL_{it}$	-0.011	0.95
$W \times GOV_{it}$	0.146*	1.75
$W \times INS_{it}$	-0.063	-0.55
$W \times NET_{it}$	-0.001*	-1.89
ρ	0.934***	55.23
R^2	0.441	
Log likelihood	313.16	

Note: ***, ** and * are significant at 1%, 5% and 10% levels respectively.

It can be seen from Table 3 that the impact of financial technology (FTD) on regional financial risks is negative, and passing the significance test of 1%, it can be proved that hypothesis 1 is true, that is, fintech slows the accumulation of regional financial risks. This is because the development of fintech has optimized the process of financial services, improved the efficiency of financial services, and reduced the risk of financial services. Big data, blockchain, artificial intelligence and other technologies are conducive to improving the coverage of financial risk management, improving the pertinence of financial risk management and improving the accuracy of financial risk management. Modern financial technology is more accurate and scientific than traditional means to screen risks. The construction of fintech infrastructure system and the improvement of financial supervision will help prevent systemic financial risks.

It can be seen from the regression results that the ρ height of the coefficient representing the spatial correlation of regional financial risks is significantly positive, indicating that regional financial risks have a high positive correlation, that is, regional financial risks have a strong spatial spillover effect, and the outbreak of local financial risks will quickly spread to the surrounding areas. Hypothesis 2 is valid. On the one hand, the financial industry has the characteristics of strong integrity and is sensitive to fluctuations in the economic and social environment. On the other hand, with the rapid development of fintech, the financial industry of the whole society is connected by the Internet, which may also be the reason for the obvious spillover effect of financial risks. This further shows that it is of great theoretical and practical significance to explore the impact of fintech on financial risk.

6. CONCLUSIONS AND IMPLICATIONS

This paper uses data from 30 provinces in China from 2011 to 2018 as samples to analyze the impact of fintech on regional financial risks and their spatial spillover effects using spatial Dubin model. Through the analysis, the following conclusions are drawn: fintech can restrain the accumulation of regional financial risks, but it will aggravate the spillover of financial risks to neighboring regions.

Based on the above conclusions, the following suggestions are put forward:

Building an infrastructure system for fintech can help prevent systemic financial risks. Fintech is the application of modern technology in the financial industry, helping to improve efficiency, enhance experience, expand scale and reduce operating costs. Due to the financial science and technology has two sides, the development of the technology is beneficial to prevent financial risks, technology itself and could increase the risk of financial risk, therefore in the process of financial development of science and technology, the government should pay attention to the standardization of its development, while benefit from the massive construction of financial technology, control its hidden uncertainty. From the macro level by the central government for financial policies and regulations and regulatory means, in the field of science and technology in the protection of financial innovation and development of science and technology at the same time, avoid the unreasonable development may be a direct impact on the financial sector, local government should use its intervention in the economy ability, from the micro level to strengthen the online supervision of financial enterprises of science and

technology, According to the development status of the local economy and financial market, the regional fintech development plan should be reasonably formulated to reduce the regional financial risks that may be brought by the excessive development of fintech.

Improve the construction of the financial system and optimize the financial environment. It is necessary to build regional financial centers in cities with good economic and financial foundations. While improving financial efficiency and strengthening industry regulation, the risk spillover inhibition effect of financial centers should be effectively utilized to weaken the financial risk dissemination caused by fintech innovation.

While developing fintech, attach importance to the supervision of fintech. Many fintech companies are outside the supervision, or are not subject to the same disclosure obligations as traditional financial institutions. The current separate supervision system is difficult to supervise the new financial forms, and the gap in supervision may lead to the instability of the financial sector as a whole. In an era of frequent innovation, the rapid changes in the financial market make it more difficult for regulators to monitor and respond to risks, and there is an urgent need to obtain data and information related to the major risks of fintech. Therefore, in order to more effectively prevent and control regional financial risks, the central government and local governments should attach importance to the supervision of fintech, which on the one hand can promote the steady development of regional fintech, on the other hand is conducive to the stable and healthy development of regional financial industry.

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