Article

The contribution of technology finance to the quality of economic growth-Empirical analysis based on spatial econometric model.

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Abstract: (1) Background: Most of the existing studies focus on the evaluation of technology finance; the relationship between technology finance and technology innovation. But there are few studies on the development of technology finance and the quality of economic development in our country; (2) Methods: Based on the panel data of 30 provinces in China, this paper constructs an index system to measure the development of technology finance through the improved entropy method, and tests the spatial correlation of the development of technology finance in China by Moran'I index. According to the test results, this paper constructs a spatial econometric model to empirically analyze the promoting effect of scientific, technological and financial development on high-quality economic development, and analyzes its promoting effect in different regions and different time periods; (3) Results: The results show that the quality of China's economic growth is spatially dependent, and the development of science, technology and finance can significantly promote the quality economic development in China. And the promotion coefficient of the central region is the largest, as well as the coefficient of the eastern region is the smallest. The promotion coefficient was small and not significant before 2015, and was significantly positive after 2015; (4) Conclusions: this paper puts forward the corresponding policy recommendations according to the research results.

Keywords: Technology finance; Quality of economic development; Spatial econometric model.

1. Introduction

General Secretary Xi Jinping pointed out in the report of the 19th CPC National Congress: "China's economy has changed from the stage of high-speed growth to the stage of high-quality development." In order to promote high-quality economic development, we must vigorously implement innovation-driven development and give full play to the supporting and leading role of scientific and technological innovation in the high-quality development. At present, science, technology and economy are being deeply integrated. Under the condition of innovation-driven, high-quality integration development is the new direction of China's current development. Currently, the major developed countries in the world have solid foundation research, continue to increase investment in scientific and technological innovation, develop new energy and other emerging industries, and seize the commanding heights of international economic technology. Scientific and technological innovation is becoming a new advantage for all countries to enhance their international competitiveness. In the complex environment such as the rapid development of knowledge economy and trade war, it is all the more necessary for our country to rely on innovation to drive development, and it is also an important embodiment of national comprehensive competitiveness and social productive forces. The world economic environment is changing rapidly, how to promote the development of technology finance and how to promote the quality of China's economic development through the development of technology finance is very important. Therefore, in-depth studying the impact of technology finance on the quality of real economic development undoubtedly has important theoretical value and practical significance.

3. Literature review and theoretical analysis

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

2.1. Literature review

The basic goal of technology finance is to promote technological innovation and ultimately promote the high-quality development of the economy. Many classical economic theories in history have discussed this problem, including Joseph Schumpeter's (2014) innovation theory, neoclassical economic growth theory, R&D endogenous economic growth theory,etc. It lays a theoretical foundation for the study of this paper.

Combing domestic and foreign literature, the research on technology finance is mainly divided into the following aspects:

Firstly, the research on the construction of technology financial system. Li Wensen et al. (2014) used the wide-caliber and multi-dimensional technology financial statistics system for the first time, which was tested by the parallel measure of total scale and structure information. Wang Jifa et al. (2015) constructed and judged the index system of orderly evaluation of technology financial system through weighted grey entropy algorithm. Xue Li and Ye Lingfei (2016) found that the role of government technology investment, bank loans, venture capital and capital market in scientific and technological innovation activities showed heterogeneous characteristics, thus constructed the "main bank" technology financial system. Li Ruijing et al. (2017) designed a multi-agent scientific and technological financial innovation service platform based on complex system theory ,in order to realize the deep integration of financial services and technological innovation. Kou Mingting et al. (2018) systematically reviewed the research framework of technology from the aspects of evaluation system, financial technology integration, etc., on this basis, Wu Yanyan (2019) carried on the construction and operation efficiency of technology financial system in four cities in central China.

Secondly, the research on the efficiency of technology finance. Based on the financial system architecture, scholars have found that financial institutions have policy guidance (Tadesse,2006), credit rationing (Herrera& Minetti,2007), financing threshold (Ughetto,2009), recapitalization (Anna Ilyina, 2012), bank self-development (Luigi, etc., 2008) has a positive effect on the innovation of enterprises. Cao Hao et al. (2011) through the cluster analysis of China's technology financial development index constructed by the method of inter-group connection, it is found that there is a structural contradiction between China's financial system and the financing needs of technology enterprises. In addition, scholars use DEA model to calculate the efficiency of technology financial integration. The empirical results show that the total output value of high-tech enterprises accounts for GDP, the number of venture capital enterprises, the amount of capital attracted (Zhang Sishi and Liyao Mine, 2017) and environmental factors (du Jinmin et al., 2016) are important factors affecting the efficiency of technology finance. The overall level of technology financial efficiency in China is low, and there are significant regional differences (Dai Zhimin et al., 2017). At the same time, Huang Ruifen and Qiu Mengyuan (2016) also draw the same conclusion through Malmquist index and SFA model. Xue Ye et al. (2017) used entropy method and Bayesian stochastic frontier model to find that the efficiency of technology and finance development in most areas is increasing, but there are great regional differences in the range of improvement.

Thirdly, the research on the role of technology finance and technology innovation. Most foreign scholars believe that the capital market suppresses the development of scientific and technological innovation, but the tendency of financial policy can promote the development of innovation and economic growth (Lina Sonne,2012), and its venture capital has greatly promoted the growth of high-tech enterprises (Hyytinena& Toivanen,2005). Su Ying (2019) found that there is a dynamic cooperative evolution relationship between technological innovation and technological finance in China by using the degree of cooperation in time series coupling. Zhang Jiangpeng (2019) established the index system, using the synergy model to calculate ,the rusults show that the southeast cooperation is the best, the northeast and northwest are non-cooperative, and the development level is the lowest. Furthermore, the index system of influencing factors of coordination degree of composite system is established. By using the spatial econometric model, it is found that the support of scientific and technological innovation, the return of capital market, the intensity of financial expenditure on technology and the competitiveness of high-tech market have positive feedback effect on the degree of cooperation of regional compound system.

Above all, scholars have conducted theoretical and empirical studies on the relationship between financial development and the real economy, as well as the relationship between scientific and technological finance, technological innovation, technological investment and real economic growth. In recent years, more and more scholars have begun to explore the impact of the integration of financial development and scientific and technological innovation on the growth of the real economy. Duan Jie and Sun Mingxu (2017) introduced negative entropy flow to establish three inter-system coupling system models in closed and open system environments, respectively. Based on the dynamic adaptability of BP artificial neural network, this paper makes an empirical analysis on the dynamic influence factors of coupling system, and finds out the factors that have important influence on the coupling system of high-tech industry, traditional industry and regional economy. Based on the IS-LM model, He Hongqing (2018) concluded that there is a strong correlation between technology finance and high-quality economic development. Other scholars use grey relational analysis to construct the evaluation model of coupling coordination degree between technological innovation and high-quality economic development, and find that technological innovation plays a significant role in promoting green coordinated development (Ding Tao et al., 2018). On the whole, the provinces have initially achieved good and coordinated development, but there are regional differences, especially the increasing trend of differences between central and western provinces and cities (Huajian and Hu Jinxin, 2019). The correlation effect between banking-high-tech industry collaborative agglomeration and regional economic growth is obvious, the insurance industry is also strong, but the securities industry is not obvious (Lu Yajuan, Liu Hua, 2018). Liu Siming et al. (2019) compiled the innovation driving force index based on the data of 40 major countries from 2009 to 2016. The study found that both technological innovation index and institutional innovation index have a significant positive effect on total factor productivity.

Moreover, the innovation driving force index of developed countries is obviously high, and the construction of institutional innovation in China obviously lags behind the level of scientific and technological innovation.

In summary, the existing research provides a theoretical basis and train of thought for this topic. However, most of them ignore the impact of the integration of financial development and scientific and technological innovation on real economic growth, and do not bring them into the research framework of real economic growth at the same time. And most of the existing studies are measured by a single index system, but in fact, economic phenomena have spatial dependence, the above related studies have ignored the spatial characteristics of economic variables.

Therefore, this paper examines the spatial correlation between the development level of science, technology and finance and the quality of economic growth in various provinces and cities.

2.2 The effect of technology finance on the quality of economic growth

Economic development requires not only quantitative growth, but also qualitative improvement. By promoting scientific and technological innovation and transforming it into the driving force of economic development, technology finance ultimately optimizes the economic structure (Huajian et al., 2019). Based on the long tail theory and knowledge spillover theory, this paper expounds the internal mechanism and transmission mechanism of the integration of finance and technological innovation affecting economic quality from the intra-regional and interregional level.

2.2.1 The formation mechanism of long tail effect in the region

According to the long tail theory, the cumulative result of the tail market with small demand at both ends of the normal curve and large differentiation is greater than that at the head of the normal curve. The innovation of financial technology within the region can promote the high-quality development of the economy by promoting the growth of the tail market. Traditional financial service models often devote limited resources and energy to a small number of high-end customers, so they ignore the value of the long tail market. However, with the emergence of technology finance, it has solved the previous service difficulties and relied on the underlying technological innovations such as big data, cloud computing and block chain to provide tool channels for inclusive financial services.

The integration of technology and finance has given birth to new financial business models such as insurance technology, equity crowdfunding, and mobile payment, resulting in new business models, technology applications, and product innovation, promoting the formation of financial new business type at the level of financial service supply. Complete the transformation from offline to online, and provide rich financial services for long-tail demand groups. Therefore, technology finance deeply excavates the financial function based on technological innovation, which not only subverts the restrictions of traditional financial institutions, but also gives birth to a long-tail market dominated by enterprise demand groups. Specifically, the integration of technology and finance analyzes big data of financial institutions and enterprises through intelligent sharing decisions to ensure information security, reduce risks, reduce the cost of asymmetric information in the long tail market, and expand the scope of financial services. It expands the service means of financial institutions, promotes the diversified development of financial resources, optimizes the market system, realizes the optimal allocation, and improves the efficiency of scientific and technological innovation.

In addition, in the integration with financial development, scientific and technological innovation can effectively promote the innovation of financial products, financial services, and tools, so as to better serve scientific and technological enterprises, broaden financing channels, and reduce financing costs. Effectively squeeze out the profit space, so as to optimize and upgrade the capacity structure, and create a new growth point for the real economy.

2.2.2 Transmission mechanism of interregional spatial knowledge spillover effect

Knowledge spillover theory refers to the unconscious process of knowledge exchange and dissemination between geographical locations, that is, spatial knowledge spillover. Among regions, there are two main ways for the integration of finance and scientific and technological innovation to promote high-quality economic development under the effect of spatial knowledge spillover:

The first is the network effect: the integration of finance and scientific and technological innovation can accelerate the spatial spillover of knowledge and enhance the economic growth point of the region. Technology finance spread and applied in the Internet with the help of network technology analysis tools such as big data, artificial intelligence and block chain technology. This innovative behavior has the characteristics of technical knowledge, and the Internet has significant network effects. Break the regional restriction of knowledge transmission and accelerate the dissemination of knowledge in regional space. Secondly, by learning from each other and imitating advanced technical knowledge, neighboring regions can not only improve technological progress and efficiency, but also control the financial risks that may arise in R & D technology.

The second is the effect of personnel mobility: the integration of finance and scientific and technological innovation can accelerate the mobility of talents between regions, and accelerate the absorption and dissemination of knowledge through the rational allocation of personnel and technology. Broaden the spatial spillover space of invisible knowledge so as to enhance the economic growth point of the region. Since it is difficult to identify, code and record invisible knowledge by information technology, the dissemination of invisible knowledge is mainly applied to the field of science, technology and finance through direct communication between people. The flow of innovative talents between regions can accelerate the spillover of spatial knowledge, produce the effect of personnel flow, and have a positive impact on enterprise innovation. Therefore, the transfer of tacit knowledge between different regions and between enterprise groups can broaden the spatial spillover of tacit knowledge, and different regions can play an imitation effect in the process of absorbing knowledge and promote their own technological innovation and progress. So as to further promote economic growth.

Based on the IS-LM model, the macro effect analysis of technology finance promoting economic growth can be seen in figure 1 below.As financial institutions increase their investment in financing for technology enterprises, the innovation achievements and benefits of enterprises continue to increase, and then the scale continues to expand, and the IS curve moves to the right from IS1 to IS2,. Therefore, the intersection of IS curve and LM curve has changed from E1 to E2. As a result, interest rates rose from i1 to i2, resulting in an increase in the cost of scientific and technological innovation. In this case, enterprises seek new financing models, promote continuous innovation in the financial

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market, and financial institutions innovate financial products and financial instruments to provide financing for enterprises. With the increase in the supply of scientific and technological financial products and tools, the LM curve is flat, moving from LM1 to the intersection of LM2,IS and LM curve from E2 to E3, thus the interest rate drops from i2 to i3, and the cost of scientific and technological innovation decreases. Therefore, to stimulate scientific and technological innovation in the market continues to increase, the final national income from Y1 to Y2, to achieve economic growth.

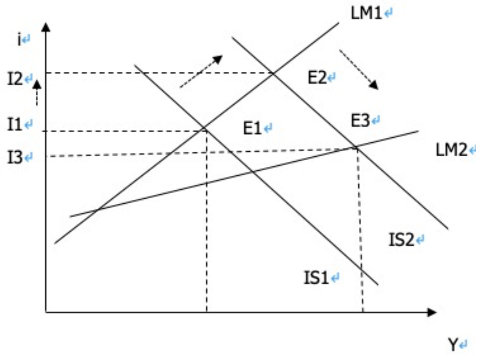

Figure 1. curve of economic growth promoted by technology financial innovation

However, from the perspective of risk supervision, driven by interests, the rapid development of financial technology and constantly updated financial products have an impact on the existing regulatory framework and the financial sector, and high-risk financial instruments are easy to regulate arbitrage. Induce systemic financial risks, technology finance has a reverse inhibitory effect on the quality of economic growth. Under the promotion of macro policy, there is a speculative phenomenon that some enterprises carry out informal financing by exaggerating scale effect, which eventually leads enterprises to fall into the debt repayment dilemma of " robbing Peter to pay Paul ", and the capital chain is broken. The formation of non-performing assets of financial institutions.

In addition, the asymmetry of information makes it difficult for financial institutions to grasp the core production information and market dynamics of enterprises, and is unable to accurately and timely evaluate the quality of assets, profitability and technological competitiveness of enterprises. Therefore, it is wrong to allocate financial resources to enterprises with backward technology and poor market prospects, so as to increase the potential risk of technology loans. In this case, the output benefit of the investors gradually decreases, resulting in the shrinkage of scientific and technological innovation, and with the increase of the risk of investment and financing of technology finance, so it directly leads to a large number of funds to withdraw from the field of scientific and technological innovation, which directly affects the quality of economic growth. At the same time, regulatory technology (Reg Tech) is also corresponding birth, to make up for the lack of traditional financial regulatory coverage and other problems, as a whole, the current financial technology innovation to promote total factor productivity is far greater than its inhibitory effect.

From above, technology finance are closely related to the quality of economic growth.In order to promote the high-quality development of the economy, it is necessary to speed up the integration of technology finance, improve the efficiency of financial support for the development of technology and the transformation of achievements, and promote the development of high-tech industries in order to make the economy move towards a higher level of quality.

3. Models and variables

3.1 Model setting and Test

3.1.1 Spatial autocorrelation test

The spatial correlation test can be used to study the spatial distribution of a space unit and its surrounding units. The most widely used method is the Moran's I index, which is calculated as shown in Equation 1.

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(Y_i - \overline{Y})(Y_j - \overline{Y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \qquad (1)$$

$S^2 = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \overline{Y})^2$, $\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$ 。 Y_i represents the observed value of the region i 。 The value range of I is $-1 \le I \le 1$ 。 The Moran index of the level of technology finance and total factor productivity of 30 provinces in China from 2011 to 2017 was calculated by Geoda software. The results are shown in Table 1.

Table 1. Moran index of TFP and Technology finance development

	TFP		Technology finance	
Year	Moran's I	P	Moran's I	P
2011	0.4250	0.003	0.1994	0.040
2012	0.4183	0.001	0.2315	0.024
2013	0.4112	0.003	0.2441	0.018
2014	0.4091	0.001	0.2500	0.011
2015	0.4055	0.001	0.2527	0.013
2016	0.4243	0.002	0.2528	0.024
2017	0.4454	0.001	0.2512	0.015

From the results in Table 1, it can be seen that the Moran index of total factor productivity is positive and passed the 5% significance level test, which indicates that the total factor productivity of 30 provinces in China has a significant positive correlation in spatial distribution. . The Moran index for the development of technology finance is positive and has passed the 5% significance level test, which indicates that the development of technology finance in 30 provinces in China has a significant positive correlation in spatial distribution, and the Moran index of technology finance development has gradually increased from 2011 to 2017. This shows that with the continuous deepening of market economic system reform, the barriers in various regions of China are constantly being eliminated, and economic exchanges and links are increasingly close. As a result, the spillover of the space of technology finance is in a state of continuous strengthening. Therefore, it is more appropriate to use the spatial measurement model to study the relationship between the development level of China's technology finance and total factor production than the traditional measurement method.

3.1.2 Models

Firstly, in order to investigate the impact of technology finance on the quality of economic growth, this paper builds a panel data model without spatial effects based on panel data of 30 provinces and cities in China from 2011 to 2017.

$$\ln TFP_{it} = \alpha + \beta \times Keji_{it} + \sum \gamma_{it} \times x_{it} + \mu_{it} \qquad (2)$$

Among them, i indicates the region, t indicates time, $Keji_{it}$ indicates the technology financial development index of each region, X_{it} is the control variable, μ_{it} is the residual.

In order to comprehensively examine the impact of China's provincial technology finance development on total factor productivity, according to different ways of spatial correlation of observations, it can be divided into spatial lag model (SAR), spatial error model (SEM) and spatial dubin model (SDM).Since it is impossible to determine in advance which model can fit more effectively, it is usually necessary to pass the Lagrangian factor (LM) test, the test results are shown in Table 2.

Table 2. The results of LM test

LM test	Samples	T	P
LM test no spatial lag	210	75.7383	0.000
robust LM test no spatial lag	210	112.7037	0.000
LM test no spatial error	210	0.8087	0.368
robust LM test no spatial error	210	37.7741	0.000

From the results in Table 2, LM-error is not significant at the 5% significance level, and the spatial lag model should be used. Therefore, the construction model of this paper is shown in Equation 3.

$$\ln TFP_{it} = \alpha + \rho \times W \times \ln TFP_{it} + \beta \times KJ_{it} + \sum \gamma_j \times x_{it} + \varepsilon_{it} \quad (3)$$

In Equation 3, i represents a different province, t represents a different year, $\ln TFP$ is the logarithmization of total factor productivity, ρ is a spatial regression coefficient, x_{ijt} is a control variable, ε_{it} is a random error term vector, W is the space Weight moment of $n \times n$.

At present, the most commonly used spatial weights are leading distance matrix, geographical distance matrix and economic distance matrix. Because regional production activities are affected by some non-geographic factors, it is not comprehensive to consider only the spatial weight matrix of geographical location. Therefore, this paper constructs an economic distance spatial weight matrix from an economic perspective. It refers to the difference in the ability of the region to develop due to the differences in the regional economic base. The economic base distance weight matrix can be expressed as:

$$W_{ij} = W_d diag(\frac{\bar{Y}_1}{\bar{\bar{Y}}}, \frac{\bar{Y}_2}{\bar{\bar{Y}}} \cdots \frac{\bar{Y}_n}{\bar{\bar{Y}}}) \quad (4)$$

Among them, W_d is the geographical weight matrix. $\bar{Y}_i$ is the per capita GDP. $\bar{Y}$ is the total per capita GDP. In this paper, first calculates the economic distance from 2011 to 2017， after weighting the average, than standardize it, set the results to the economic weight distance.

3.2 Variables

3.2.1 Explanatory variables

More scholars choose total factor productivity to measure the quality of economic growth (Mei L. & Chen Z.2016.Liu Siming et al.2019), empirical evidence also demonstrates that total factor productivity is a key determinant of high-quality economic development. This article also refers to the above scholars, using the total factor productivity of each region to measure the quality of regional economic development. Among the methods for measuring total factor productivity, Solow's residual method is one of the most used methods. This paper also uses this method to measure the total factor productivity of each region in 2011-2017. Among them, the output and capital stock are adjusted to the actual value based on the year 2000. Under the assumption that the scale returns are constant, the Cobb-Douglas production function is used to measure, and the model is expressed as:

$$Y_{it} = A_{it} K_{it}^{a} L_{it}^{1-a} \quad (0 < a < 1) \tag{5}$$

In Equation 5, Y represents the total output, K represents the capital stock, L represents labor input, A represents total factor productivity, α is capital output elasticity, i is the region, and t is time. The total factor productivity of each province in different periods is expressed as:

$$A_{it} = Y_{it} / K_{it}^{a} L_{it}^{1-a} \tag{6}$$

This paper uses regional real GDP to measure regional output. The GDP index is flattened by nominal GDP, which is converted into real GDP value expressed by the constant price of the base year. Labor input is expressed by the number of employees in all provinces. The capital stock is estimated by the internationally accepted perpetual inventory method. This paper refers to the calculation results of Zhang Jun (2004), and sets the base period to 2000. The same method is used to estimate the data after 2000. The specific formula is:

$$K_{it} = K_{it-1}\left(1 - s\right) + I_{it} \tag{7}$$

Among them, K_{it} is the capital stock of the t-year in i province, I_{it} is the investment in the t-year of i province. s is the economic depreciation rate. The main indicators are calculated as follows: Most of the existing studies use total capital formation or total fixed capital formation to represent the current year's investment. The "fixed capital formation total" published in the statistical yearbook can be regarded as an investment indicator without deduction of depreciation. Therefore, the investment indicator used in the current year is the total amount of fixed capital formation and is considered to be a reasonable indicator for measuring the investment I in the current year. In the calculation of this indicator, it is necessary to use the fixed asset investment price index published in the China Statistical Yearbook to reduce the investment for each year and convert it into the actual value expressed in the constant price of the base year 2000. Economic depreciation rate s is referred to the calculation results of Zhang Jun et al. (2004), with a value of 9.6%. The value of capital output elasticity α is basically 0.3~0.5. This paper mainly refers to the study of Liu Siming et al. (2019) to take α as 0.4.

3.2.3 Explained variable

This article uses 30 inter-provincial data from China as samples (excluding Hong Kong, Macau, Taiwan, and Tibet). Refer to the index system of Cao Yu et al. (2011) and Xu Yulian et al. (2017), from the four aspects of technology financial resources, technology financial investment, technology financial output and technology financial marketization, we build a scientific and technology financial index to measure the development of regional technology finance in China. Among them technology financial resources are divided into two parts,the number of people and the number of R&D institutions. The investment in technology finance is divided into R&D investment and financial loan investment, which are measured by R&D investment intensity and technology financial loans respectively. The output of technology finance is divided into paper output and patent output, which are measured by the number of scientific papers and patent grants respectively. The marketization of technology finance is divided into three parts: technology market, new product income and high-tech industry. They are measured by the turnover of technology market, the income of new products in the proportion of main business income and the export volume of high-tech industries. Because the technical market turnover is inconsistent before and after 2011, the sample interval of this paper is set to 2011-2017. The data comes from China Statistical Yearbook and China Technology Statistical Yearbook.

The methods for determining weights include subjective weighting evaluation method and objective weighting evaluation method. The subjective empowerment method lacks the objectivity of judgment and relies on subjective judgment, therefore, this paper uses the entropy method in the objective weighting method. In order to compare the results between different years, we draw on Yang Li and Sun Zhixuan (2015) method, using the improved entropy method, adding time variables to make the analysis results more rational. The specific method is as follows.

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(1) Data standardization

$$x_{ijk}{}' = \frac{x_{\max} - x_{ijk}}{x_{\max} - x_{\min}}$$

(2) Determine the weight of the indicator

$$y_{ijk} = x_{ijk}^{'} / \sum_{k}\sum_{j} x_{ijk}^{'}$$

(3) Calculate the entropy value of the indicator i:

$$e_i = -\ln(kj)\sum_{k}\sum_{j} y_{jk}\ln(y_{ijk})$$

(4) Information utility value for the indicator i

$$g_i = 1 - e_i$$

(5) Weight of the indicator i

$$\omega_i = g_i / \sum_{i} g_i$$

Among them, i represents the indicator, j is the province, and k represents the year. This paper calculates the status of technology financial development in each region according to the weight of each indicator. The specific index selection and weight setting are shown in Table 3.

Table 3. The specific index selection and weight setting

Primary indicator	Secondary indicators	Weight of indicator
Technology financial resources	R&D full staff	0.1145
	Number of R&D institutions	0.1219
Technology finance investment	R&D input intensity	0.1171
	Technology loan of financial institution	0.112
Technology finance output	Scientific paper output	0.1079
	Number of patent licenses	0.1096
Technology financial marketization	Technical market turnover	0.1011
	New product revenue as a percentage of main business income	0.1226
	High-tech industry exports	0.093

Multiply the weights of the indicators calculated in Table 3 by the values of the standardized obtain the sum of the technology financial indexes of each province. According to the division of China, 30 provinces are divided into the eastern, central and western regions. Figure 2 shows the average scores of China's regional technology financial index from 2011 to 2017. As can be seen, the development of technology finance in China has been on the rise from 2011 to 2014, showing a downward trend from 2014 to 2016. The development of technology finance in the eastern part of China is the best, far beyond the national average. The central region is second, with a certain gap with the national average, but the gap is gradually decreasing over time. In the end, the development level of the western region is far from the average level of China. From 2011 to 2017, the level of technology finance is with little change, and only shows a downward trend between 2014 and 2016. Generally speaking, the development of technology finance in China's region presents a certain spatial distribution. And each region showed a little downward trend from 2014 to 2016.

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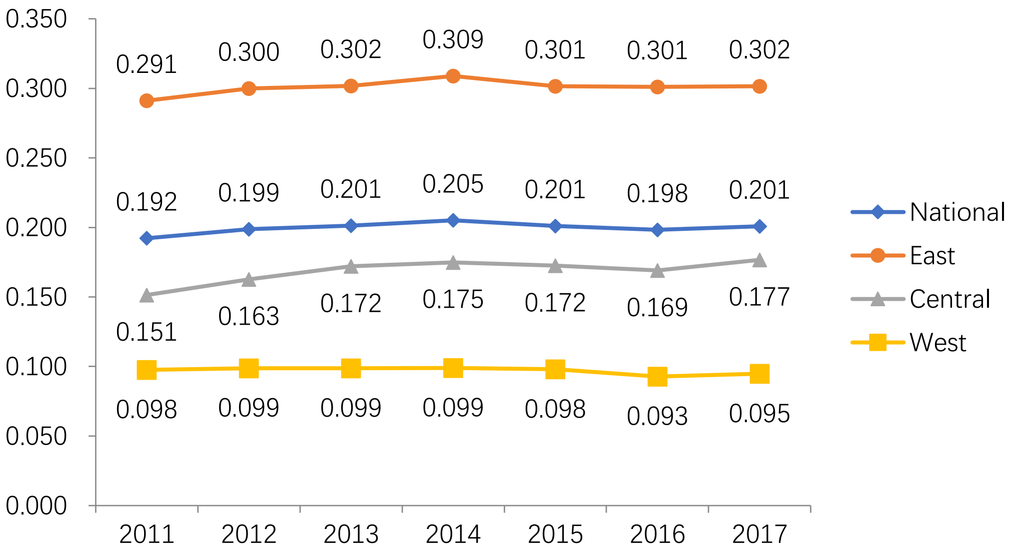

Figure 2. 2011-2017 China's regional technology finance scores

3.2.3 Control variable

In order to avoid deviations in the estimation results due to the absence of other variables, this paper adds other control variables that affect total factor productivity in the model. Referring to the results of previous scholars' research, this paper introduces foreign trade dependence (Open), which is calculated by multiplying the annual import and export of each region by the average exchange rate of the year and dividing by the GDP of each region. Communication facility (Com), which is measured by the ratio of mobile phones to the total population. Industrial structure (Indu), considering that the tertiary industry is the main source of economic growth, this paper uses the added value of the tertiary industry to account for the proportion of the total output value to reflect the industrial structure. Human capital (HC), technological reform and innovation require human capital to achieve, and the professional skills, experience and knowledge quality of human capital have a significant role in promoting economic growth. his paper uses the average number of college students per 100,000 population and logarithmize it to measure human capital.

4. Empirical research

4.1 The results of full sample regression

In the processing of traditional cross-section data and panel data models, it is assumed that there are spatial homogeneity and spatial independence of sample observations between different regions, often ignore the differences between interactions and spatial structures between different regions. But for the spatial panel data model, after determining the spatial dependence, it is necessary to judge its reasonable spatial econometric model. In the selection of the spatial measurement model of the panel data, it is necessary to determine whether it is a fixed effect or a random effect. In this paper, under the condition of neglecting space factors, the Hausman test value is 12.2658, and the P value is 0.0313, which passes the test at the 5% significance level, the assumption that individual effects are independent of explanatory variables is rejected and a fixed effect model should be used. And only when the random sampling of a large number of individuals is large, the sample can be regarded as a judgment of the overall relationship, and the random effect model can be selected. However, this paper analyzes 30 regions in China, with fewer individuals, so it is more appropriate to consider individual effects as fixed effects.

First, OLS estimation is performed on the original sample without considering spatial factors. The estimated results are shown in Table 4. It was found that technology finance can significantly promote the growth of total factor productivity with a coefficient of 0.2838. Secondly, under the condition of considering spatial factors, the spatial measurement model can be divided into two kinds of non-observation effects of space effect and time effect according to fixed effects, and its effects are divided into spatial fixed effect (sF) ,time fixed effect (tF), and space time double fixed effect (stF). This paper constructs a spatial lag model for the three types of effects, and the regression results of the model are shown in Table 4. The results show that the LogL value of the regression of the spatial effect is larger than that of the ordinary OLS regression, that is, the regression result considering the spatial factor is more significant than the ordinary regression. This shows that for China as a whole, the impact of technology finance on TFP has a spatial effect, and the general regression results cannot accurately show this relationship. Then compare the different fixed effects, comprehensive consideration the value of $AdjR^2$ and LogL. Although the LogL of the regression result under the time fixed effect is not the largest, the $AdjR^2$ value is much larger than other models, so this paper selects this fixed model for analysis. Finally, analysis the results under the time fixed effect, the spatial coefficient is found to be significantly positive, indicating that the provincial economic development quality level has significant spatial dependence,that is to say, the level of economic development quality of neighboring provinces is relatively high, so the quality level of economic development of the province will be higher. On the contrary, the economic quality of neighboring provinces is relatively low, and the province's economic quality is also low. The coefficient of development of technology finance is 0.2783, which is significantly positive. It shows that under the whole sample, China's technology finance has a significant promoting effect on the high-quality development of the economy.

Table 4. Spatial lag model regression results

	OLS	Spatial lag model			
		nonF	sF	tF	stF
C	-1.7785*** (-5.9595)	-0.5596*** （-3.1024）	-	-	-
Keji	0.2838** （2.5967）	0.2856*** （4.6894）	0.8186*** （3.3733）	0.2783*** （4.5066）	0.6836*** （2.8608）
Chukou	0.1856*** （3.2877）	0.0455 （1.3644）	-0.2225*** （-4.8025）	0.0917** （2.3163）	-0.0755 （-1.4102）
Com	0.4815*** （7.1753）	0.1906*** （4.8943）	0.1871*** （3.2752）	0.1796*** （4.2254）	0.1169* （1.7587）
Indu	-0.3934** （-2.3704）	-0.3615*** （-3.8825）	-0.4989*** （-4.9395）	-0.4834*** （-4.4552）	-1.1945*** （-6.4875）
Lnr	0.3077*** （7.6412）	0.0965*** （3.8315）	0.4209*** （6.1242）	0.1026*** （4.0159）	0.2024** （2.4747）
ρ	-	0.7250*** （25.1661）	0.4340*** （8.0403）	0.7060*** （23.2476）	0.2756*** （3.9514）
R2	0.7584	0.9234	0.9766	0.9242	0.9792
$AdjR^2$	0.7525	0.8712	0.6183	0.8859	0.3464
LogL	126.2455	221.2338	362.1733	223.7556	380.4645

4.2 Subsample regression

On the basis of the whole sample, this paper divides 30 provinces into the eastern, central and western regions, and examines the impact of technology finance on total factor productivity in different regions, and staged regression to examine the impact differences at different time periods. The regression results are shown in Table 6. The time-fixed effect was selected in both the eastern and western regions，in the central region, both the double fixed effect and the LogL were larger than those under the time fixed effect. Therefore, the central region selected the results of the double fixed effect for analysis. Time-fixed effects were used in time-separated regression, and the regression results are shown in Table 5.

Table 5 . Subsampled space lag model regression results

Variables	East	Central	West	2011-2014	2015-2017
Keji	0.4089*** (6.8811)	2.1893*** (3.4080)	1.1665*** (3.6502)	0.0365 (0.5276)	0.4964*** (4.8879)
Chukou	0.2200*** (5.3827)	-0.6206 (-1.0936)	0.4350 (2.5063)	0.1173*** (2.7514)	0.1597** (2.0878)
Com	-0.0847*** (0.1227)	-0.8373*** (-3.9030)	1.1340*** (7.6890)	0.1950*** (4.4802)	0.0206 (0.2701)
Indu	-0.4535*** (-3.7360)	-1.5062*** (-4.7300)	-0.4238 (-1.4703)	-0.4927*** (-4.1863)	-0.3282* (-1.8216)
LnR	0.1553** (3.7360)	0.3948*** (2.5974)	-0.0562*** (-0.8368)	0.0918*** (3.7047)	0.1084** (2.2782)
ρ	0.5280*** (11.8927)	-0.2313 (-1.6049)	0.4090 (4.5233)	0.7930*** (25.2719)	0.6310*** (12.2375)
R2	0.9475	0.9737	0.8298	0.9512	0.9128
AdjR2	0.9360	0.7991	0.8253	0.9114	0.8771
LogL	124.239	99.512	78.900	150.685	92.1705

According to the estimation results in Table 5, it is found that the regression coefficients of technology finance in the eastern, central and western regions are all positive, indicating that they all have a significant effect on total factor productivity. Among them, the central region has the largest coefficient and the eastern region has the smallest. The reason is that the average level of economic development in the eastern region is relatively high, and the level of development of technology finance is much higher than the national average. Compared with the central region and the western region, its resource allocation is perfect and in a relatively saturated state. Therefore, the promotion of technology finance to its economic development quality is not as obvious as that in the central region and the western region. However, compared with other indicators of export, communication, industrial structure and human capital, the coefficient value of technology finance is only lower than the industrial structure, and it can still greatly promote the quality of economic development in the eastern region. The central region's technology financial coefficient has the largest value of 2.1893. At present, the resources and markets for the development of technology finance in the central region are relatively complete, there is a certain technology financial base, and the mechanisms for the transformation of technology financial achievements and marketization are relatively mature. Therefore, it is currently possible for the central region to improve its technological development level to promote its economic development quality. Compared with other variables, the development of technology finance is also the biggest factor to promote its economic development. In the western region, due to the low level of development of technology finance, the resources and equipment for the development of technology finance are insufficient, the mechanism for the transformation of technology financial achievements and marketization is relatively weak, and it is still in the stage of technological development and market construction, so its promotion effect on the economy is not as good as that in the central region. However, compared with other factors, the largest coefficient is technology finance and it is the biggest factor in promoting the development of the western region. In addition, unlike the eastern and central regions, for the western region, communication can also greatly promote the quality of its economic development. This also shows that the current development of the western region is relatively backward and still in the stage of infrastructure construction. There is need for government support, and the completion of its infrastructure will enable further development.

In the time-phase regression, the technology economy at this stage in 2011-2014 can promote the quality of economic development, but its promotion effect is not significant, and the corresponding coefficient is relatively small. However, after 2015, technology finance has been able to significantly promote the quality of economic development at the 1% level, and the coefficient is higher at 0.4964. I think it is because China proposed the "Made in China 2025" plan in 2015, and plans to comprehensively improve the quality of China's manufacturing industry, and strive to be the first in advanced manufacturing areas such as high-tech equipment. After that, China has continuously paid attention to the adjustment of industrial structure and the cultivation of human capital. The development of technology financial resources has been rapid, and the market system has gradually improved， its own development has also played a strong role in promoting the improvement of the quality of economic development.

5. Conclusion and suggestion

This paper constructs the technological financial evaluation index system and uses the modified entropy weight method to measure the development of technology finance in 30 inter-provincial regions of China. Through the use of spatial econometric regression model to study the impact of the development of technology finance on the quality of China's economic development, finally, subsample regression is performed by sample and time segments. The study found that: First, the degree of development of technology finance in different regions of China is different. The eastern technology finance has the highest degree of development, followed by the central region and the lowest in the west. The polarization between the eastern region and the central and western regions is severe and the imbalance is relatively large. Second, the development of technology finance can significantly promote the quality of China's economic development, and the quality level of economic development in China's provinces has significant spatial dependence. The quality of economic development in neighboring provinces can have a positive impact on the province. Third, the sub-regional regression found that technology finance can significantly promote the quality of economic growth in all three regions. Among them, the central region has the largest promotion effect, followed by the western region and the eastern region is the smallest. Time-lapse regression found that before 2015, the promotion coefficient of technology finance to economic development quality was small and insignificant, and in 2015, it could significantly promote the quality of economic growth, and the coefficient was larger. Based on the above conclusions, this paper proposes the following policy recommendations.

First, we must continue to steadily improve the development level of China's technology finance. To achieve high-quality economic development is inseparable from innovation-driven, and technology finance, as a deep integration of technological innovation and finance, can promote R&D and innovation, improve economic efficiency, and promote the quality of China's economic development. Therefore, it is necessary to improve the market transformation system of technology finance, improve the market transformation mechanism, promote the innovation of financial products and financial services such as intellectual property pledge loans, investment and loan linkages, and promote financial institutions to develop new products to better serve the development of technology finance.

Second, strengthen economic exchanges between regions at different levels of development. High-quality economic development is not a special case, but a global and overall development. Therefore, it is necessary to strengthen economic exchanges between regions at different levels of development, give full play to the radiation effects of the region, integrate resources across different development regions, and construct an innovation community. Let some regions with better technological development drive other cities through space spillover effects, sharing excellent financial products and financial services, and reasonably improve the degree of exchange and sharing of production technology and knowledge between regions, and promote the efficient flow of innovative talents.

Third, increase support for underdeveloped regions.Since the development foundation of technology finance has the characteristics of spatial spillover, the government should fully consider the spatial connection and interaction of the development of technology finance between cities when formulating policies, ensuring equalization of basic economic development conditions, focusing on the rational distribution of technology financial allocation among regions, focusing on supporting the pace of construction of technology industries in the central and western regions of China, promote the improvement of infrastructure and human capital in the central and western regions, and improve the basic conditions for the development of the central and western regions, so as to promote the rapid development of technology and finance in the central and western regions.

Fourth, establish an intermediary platform for technological financial services. The establishment of intermediary platform plays an important role in solving the financing problems of enterprises, promoting the marketization of technological achievements, cultivating and developing strategic new industries. Driven by this platform, it can accelerate the breaking down of regional barriers, promote the spillover effect of technology financial development, and give full play to the promoting effect of its development on the quality of economic growth. At the same time, the technology financial service platform can also supervise the implementation of regional technology financial policies, so that technology finance can better serve the economic growth of our country.

Author Contributions: The authors contributed equally to this work. conceptualization, Yuming Xu And Xu Zhou; methodology, Yuming Xu And Xu Zhou; software, Yuming Xu And Xu Zhou; validation, Xu Zhou.; formal analysis, Yuming Xu And Xu Zhou.; investigation, Yuming Xu.; resources, Yuming Xu And Xu Zhou.; data curation, Yuming Xu And Xu Zhou; writing—original draft preparation, Yuming Xu And Xu Zhou; writing—review and editing, Zhiqiang Li; visualization, X.X.; project administration, Zhiqiang Li;

Funding: "This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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 doi:10.20944/preprints201908.0281.v1

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