Spatial effects of financial scale and financial structure on technological innovation of enterprises

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Abstract: What is the spatial effect of the financial scale and the development of financial structure on the technological innovation of enterprises across the provinces? Spatial econometric model was used to analyze sectional data of 31 provincial administrative regions in mainland china. The results show that the technological innovation of enterprises in different provinces in China is not stochastic in space. The Moran s I scatter diagram shows that the innovation of enterprises in Jiangsu, Zhejiang and Shanghai shows obvious spatial agglomeration effect. Moreover, the development of financial scale plays a significant role in promoting the level of technological innovation of industrial enterprises. In addition, improving the financial structure, reducing the reliance on bank credit and upgrading the level of FDI technology spillover will effectively promote technological innovation.

1. Introduction

After nearly four decades of rapid growth, China's economy is facing a "new normal" in which its growth is shifting gears. National policy makers are paying more attention to improving the long-term internal driving force of economic growth and placing hopes on technological innovation of enterprises. However, the technological innovation of enterprises is inseparable from financial support.

Although there is a large number of literature examines the promoting effect of financial scale and financial structure on economic growth, such as Liu & Vaona from the view of easing the lack of innovation capital by financial activities examines the promotion effect of development of the financial system on technological innovation, but that doesn't mean the financial expansion will definitely promote technology innovation, realize the innovation of the social development. In order to effectively solve the endogenous problems of financial development, Levine & Loayza & Beck et al. (2000) studied the relationship between financial development and long-term economic growth by taking legal origin as the instrumental variable of financial development while there is still a lack of literature on the study of this topic by using spatial econometric analysis. At the same time, there is a significant gap in the level of economic and social development between different regions in China, which is manifested as the "club effect" in space, which requires us to further study from a spatial perspective.

In view of this, this paper establishes a spatial econometric model based on the existing research results, and takes the provincial data as samples to analyze the relationship between financial development and technological innovation of industrial enterprises in China, and to provide empirical evidence and countermeasures for promoting the technological innovation ability of industrial enterprises in China.

2. Empirical Analysis

2.1 Model setting and index selection

Griliches-Jaffe's knowledge production function has been confirmed by many empirical studies and is the main theoretical framework for analyzing knowledge production, technological innovation and its determinants. The empirical model established in this paper is based on the knowledge production function in the form of Cobb-Douglas production function, as shown below:

$$Q_i = AK_i^{\alpha} C_i^{\beta} \varepsilon_i \quad (1)$$

Where Q is the output of technological innovation; K is the R&D investment; C is a set of social variables, such as the degree of financial development, market demand, foreign direct investment technology spillover, etc; u is random error term; i represents the different observation units. In order to scientifically and comprehensively reveal the relationship between financial structure, financial scale and technological innovation of industrial enterprises, this paper, based on this function, establishes the following econometric model on the basis of existing research:

$$PAT_{it} = \alpha + \beta_1 RDE_{it-1} + \beta_2 FIN_{it} + \beta_3 STK_{it} + \beta_4 FIN - STR_{it} + \beta_5 GDP_{it} + \beta_6 FDI_{it} + \varepsilon_{it} \quad (2)$$

In equation（2），explained variable RDE_{it-1} refers to the R&D fund investment of enterprise innovation. As there will be lag between innovation input and output, this paper learns from the method of Peng Yuchao (2014), collecting the data from variables which used in the distributing lag model for the annual national mainland related data of 31 provincial level administrative region from "China statistical yearbook", "China financial yearbook",etc., and according to the need for the corresponding processing.

1、Patent (PAT).This paper measures the technological innovation ability of industrial enterprises in a region by the number of patents. This paper select the number of applications received of the three kinds of patent in regional industrial enterprises above designated size to measure industrial enterprise technology innovation level, the number used in this model is the ownership per 10,000 employees.

2、R&D Expense（*RDE*）.Investment and expenditure are often decisive factors influencing technological innovation. This paper uses the proportion of internal expenditure on R&D activities of industrial enterprises above designated size in the income of main business to measure the investment in technological innovation of industrial enterprises.

3、Financial Intermediary （*FIN*）.Gothic & Smith proposed the financial correlation rate as a measure index of the degree of financial development. The calculation method was the ratio of the total amount of social financial activity to the total amount of economic activity in a certain period.

4、Stock（*STK*）.This paper measures the development scale of regional stock market by the ratio of the total market value of regional stock market and the GDP of the region. Limited by the availability of data however, this paper selects the ratio of the total market value of stocks at the end of the year to the GDP of the region to measure the development scale of the stock market.

5、Financial-Structure variables（*FIN-STR*）.According to Beck 's research, financial structure index can be measured by the ratio of total stock market trading volume to private sector loan amount, this paper uses the year-end bank loan balance and the total stock market value of the region to measure, with referring to existing studies.

6、Per capita GDP（*GDP*）.According to Keynesian theory, demand determines supply, so the market demand for technological innovation will become an important factor affecting the output of technological innovation.

7、 Foreign direct investment（*FDI*）.The spillover effect of FDI can improve the technical level of local enterprises, which has been theoretically agreed. This paper uses the ratio of regional FDI

to GDP to measure the scale of FDI, in order to test the impact of FDI on regional technological innovation.

2.2 Model parameter estimation

Firstly, the proportion of R&D investment in China's industrial enterprises above designated size in total R&D investment is calculated.

Stata13.0 was used to test the spatial correlation of the number of patent applications per 10,000 employees of industrial enterprises above designated size in various regions of China, and the results were shown in table 1.

Table1 The **Moran's I** result of applying patents

Index	enterprises above the designated size
Moran'I	0.139
(P)	（0.002）

As can be seen from table 1, the number of patent applications of industrial enterprises above designated size in various regions of China and the value of the ownership per 10,000 employees have passed the test of significance level, indicating that the technological innovation ability of industrial enterprises in various regions of China has obvious spatial correlation in spatial distribution, rather than independent random distribution. Moran's scatter diagram can more intuitively show the relationship between the technological innovation level of industrial enterprises in various regions and their neighboring regions.

The first quadrant in figure 1 shows that provinces with high technology innovation are surrounded by other regions with high technology innovation(High-High). The second quadrant indicates that provinces with low technological innovation are surrounded by other regions with high technological innovation(Low-High). The third quadrant indicates that regions with low technological innovation are surrounded by other regions with low technological innovation(Low-Low). The fourth quadrant indicates that areas of high technology innovation are surrounded by other areas of low technology innovation(High-Low), including Guangdong. Fujian is located in the first and second quadrants at the same time. The first and third quadrants are positive spatial autocorrelation, and the second and fourth quadrants are negative spatial autocorrelation. In figure 2, enterprise innovation in Jiangsu, Zhejiang and Shanghai shows obvious spatial agglomeration effect, and Bohai rim region with Beijing as the core is gradually forming.

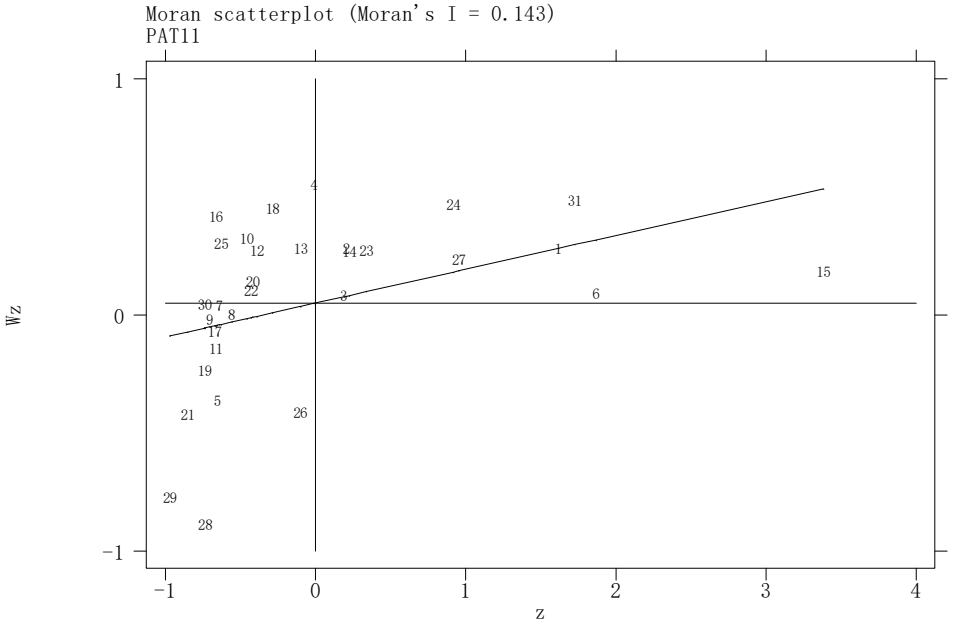

Diagram1 Moran's I Schematic plot for PAT of enterprises above the designated size in provinces of China

Diagram2 Moran scatter plot of local spatial autocorrelation coefficient for PAT of enterprises above the designated size in provinces of China

3. Regression results of spatial measurement

Due to the strong correlation between financial intermediary variables, market rate of change and stock market variables, in order to avoid the occurrence of multicollinearity in the model and the interference of the estimation results, the influences of three variables, namely, the scale of financial intermediary, market capitalization rate and financial structure, were estimated respectively. In the research process, the sample data of industrial enterprises above designated size in 2012 were estimated.

3.1 Robustness test of the model

The OLS test values in table 2 and table 3: the p-values of Lagrange multiplier and Robust LM as well as the Likelihood ratio of SEM all passed the 5% significance test, and the model was robust and desirable. At the same time, the results of the table show that the estimation results of the spatial error model considering the spatial effect are given in the table.

Table2 OLS analysis results of financial intermediaries, stock market and financial structure on technological innovation of enterprises

Explained variable：Patent（*PAT*）				
	（1）	（2）	（3）	（4）
RDE	17.0210**	19.7425**	21.0224**	15.0200**
	（2.474）	（2.339）	（2.473）	（2.045)
GDP	8.2450*	9.5121*	12.9918**	12.094
	（1.637）	（2.339）	（2.442）	（2.400）
FDI	2.4519**	2.5417**	2.0335*	2.006

	（2.007）	（1.880）	（1.494）	（1.424）
FIN	4.9637***			5.0300*
	(2.601)			（1.693）
STK		1.7080*		2.8023*
		(1.472)		（1.805）
STRU			-0.0896	0.0026
			（-0.068）	（0.006）
cons	-90.0340*	-92.6710*	-126.058**	-120.011**
	（-1.919）	（-1.719）	（-2.204）	（-2.199）
R^2adjust	0.6958	0.6462	0.6168	0.6020
AIC	236.847	244.017	239.327	264.386
SC	239.335	244.017	246.469	271.170
Lagrange multiplier	0.2218	0.4656	0.6561	0.6842
Robust LM	0.4712	0.5749	0.6530	0.7051

Table 3 estimation results of spatial error model (SEM) considering spatial effect

Explained variable：Patent（*PAT*）			
	（1）	（2）	（3）
RDE	14.3400**	15.9274**	19.7802***
	（6.512）	（7.163）	（7.643）
GDP	10.7602**	11.0965**	15.5416**
	（4.736）	（5.328）	（5.019）
FDI	1.8381**	2.1873*	1.6924
	（1.002）	（1.153）	（1.494）
FIN	5.1712***		
	(1.691)		
STK		2.0162**	
		(0.972)	
STRU			-0.2267
			（-1.028）
cons	-110.0340*	-92.6710*	-149.758**
	（-43. 193）	（-50. 175）	（-49.204）
LAMBDA	0.3556*	0.3509*	0.2621
	(0.201)	(0.202)	(0.212)
R^2adjust	0.7306	0.6851	0.6738
AIC	229.328	234.217	238.193
SC	236.557	241.414	245.163
Likelihood ratio	7.942**	7.510*	7.277*

3.2 The Economic Significance of Model Estimation Results

The coefficient of R&D investment is significantly positive, indicating that the R&D investment of industrial enterprises in China has a higher efficiency, and the capital investment does have a significant role in improving the technological innovation level of enterprises. The coefficient of GDP is also significantly positive, indicating that market demand does have a significant role in promoting technological innovation.

The increase of financial intermediary scale and the increase of capitalization rate are both positively correlated with the technological innovation level of industrial enterprises, indicating that

financial deepening can significantly promote the technological innovation of industrial enterprises in China. The coefficient of financial structure variable is negative, indicating that the development of stock market can better promote the improvement of technological innovation level of industrial enterprises than the growth of bank credit. However, the estimated result is not significant, which may reflect some deep-seated problems in China's capital market. At present, there are still a large number of state-owned shares and legal person shares in the equity structure of listed companies in China that cannot be circulated. Under this situation, the stock market cannot effectively supervise listed companies, so that the function of the stock market cannot be fully exerted. In addition, some listed companies are lack in behaving standard and true in information disclosure, which makes investors lose confidence in long-term investment and weakens the capital allocation function of the stock market to some extent.

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