The Impact of FDI on Technological Innovation

Empirical Analysis Based on Panel Data of 31 Provinces in China from 2010 to 2019

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Abstract. In the context of globalization, China is one of the countries that attracts the most foreign investment. Based on the panel data of 31 domestic provinces in China from 2010 to 2019, this paper uses a random fixed-effects model to analyze the impact of FDI on the country's innovation capacity and proves the following conclusion: Firstly, foreign investment has a positive effect on the country's overall technological innovation. Secondly, the level of education and human capital also has important impact on the technological innovation capability of the host country and the host country's resource endowment will affect its digestion and absorption of technology, which in turn affects the transformation of its innovations. Thirdly, the current level of foreign investment in the country as a whole varies greatly and some regions have not received sufficient foreign investment, which in turn expands the gap between provinces in economic development.

Keywords: FDI · Technological innovation · Empirical analysis

1 Introduction

China has emphasized the importance of the open economy and put forward innovation-driven development strategy. Since 1993, China has been one of the countries that attracts the most foreign investment for 11 years. The foreign direct investment (FDI) in capital, technology and management skills is considered to be directly important source of capital input and indirect knowledge spillovers [1]. Innovation is the important dynamic force of economic growth [7]. FDI can enhance the innovative ability of the host country to promote economic growth. And does FDI really have a positive impact on China's own innovation capabilities while bringing advanced technology? Under the background of globalization, the research on FDI whether there is a positive effect on China's innovation ability undoubtedly has important practical significance. Therefore, this paper is based on 31 provinces in 2010–2017 panel data to empirical analysis and discusses the influence of FDI on China's technology innovation.

2 Manuscript Preparation

Since the 20th century, especially after the end of World War II, the rapid development of international trade and international investment has become the mainstream of international industrial division of labor and economic development. As a result, many scholars

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have conducted a lot of research on the impact of FDI on host countries but have not yet reached a unified conclusion.

Judging from the relevant domestic research conclusions, most studies believe that FDI technology spillover is conducive to promoting the economic and technological development of the host country. Non-state-owned components have positive internal effects on improving the technical level of industrial enterprises in China and the shares of various non-state-owned components in various industries have positive external effects on the technical efficiency of individual enterprises [10]. In the process of FDI spillover in Guangdong Province, the demonstration-imitation effect and the linkage effect are significant and form a certain aggregation effect [4]. However, foreign capital has a significant positive spillover effect on the number of patent applications in China. On the other hand, this spillover effect is mainly reflected in some small innovation projects and the spillover effect of foreign capital is more obvious in the eastern region. The economic development level of the central and western regions of China still fail to cross the development threshold that prompts significant positive spillover effects of foreign investment [3]. Within the industry, the spillover effect of foreign-funded enterprises is not obvious. The industry has produced significant technology spillovers to domestic enterprises through the effect of personnel training or the flow of personnel [6]. According to the panel data of large and medium cities and national high-tech zones, through empirical research, it is found that foreign direct investment (FDI) significantly promotes the development of high-tech zones and has obvious spillover effects on high-tech zones. The greater the intensity of foreign investment, the better the spillover effect on high-tech zones.

However, a small number of scholars believe that FDI has negative effects on the economy and technology of the host country. FDI technology spillover effect mainly occurs in the eastern region, and is not obvious or even negative in the central and western regions [5]. FDI has no positive technology spillover for Sichuan's economic development effect and cannot effectively promote economic development [8]. Ningbo FDI has had negative technology spillover effects on the local economy [2].

3 The Research Process

3.1 The Research Methods

After acting BP test and hausman test, this research selects the random effects model:

$$patent_{it} = \beta_1 FDI_{it} + \beta_2 school_{it} + \beta_3 people_{it} + u_i + e_{it}$$

In the above model, the patent is the explained variable, indicating the level of technological innovation. The FDI is an explanatory variable, indicating the level of foreign investment. The school and people are control variables, representing the level of education and human capital. The i means different provinces (31 provinces). The t represents different years (2010–2019). The u_i is the intercept term for individual heterogeneity. The e_{it} is the time-varying random disturbance term.

3.2 The Index Selection

3.2.1 Model Variable Settings

Based on the panel data of 31 provinces in China, this paper analyzes the spillover effect of FDI on technological innovation by constructing a random effect model. Relevant variables in the model structure is as follows.

(1) Explained variable (patent)

To measure the level of technological innovation in the research, scholars mostly use indicators such as the number of patent authorizations, the number of patent applications, and the sales of new products. Here, this paper chooses the amount of patent grants as the explained variable on the following reasons: Firstly, the national intellectual property protection system has been established and gradually improved in my country. Secondly, patent application is the main means to protect the research and development achievements of scientific researchers. At the same time, the number of patent authorizations can also well reflect the actual transformation of innovation achievements. Among the existing data, the data on the number of patent grants are relatively easy to obtain.

(2) Core explanatory variables (FDI)

Considering the availability of data, this paper selects total foreign investment as the core explanatory variable to measure the level of foreign investment.

(3) Control variables

The main bodies of innovation activities are scientific research institutes, enterprises, etc. The host country's introduction, digestion, absorption and re-innovation of foreign technologies are closely related to local resource endowments. Human capital is one of the decisive factors for whether the host country can absorb foreign technology, and it is the basis for the competition and demonstration-imitation effect [9]. Therefore, this paper uses the average number of students in colleges and universities per 100,000 population (unit: person) to measure the level of education, and the number of professional and technical personnel (unit: person) in public economic (state-owned) enterprises and institutions to measure the level of human capital and uses them as a control variables.

3.2.2 The Data Source

In order to ensure the objectivity and authenticity of the research, after fully considering the consistency and availability of data statistics, this paper selects the panel data of 31 provinces in China from 2010 to 2017. The variable data are all from the EPS platform "China Regional Economic Database".

4 The Empirical Analysis

4.1 Descriptive Statistics

This paper uses Stata to perform descriptive statistics on variables with a sample size of 248 and obtains the mean, median, maximum and minimum values of each variable, as shown in Table 1. It can be seen that the level of foreign investment in various provinces varies greatly and the foreign investment that can be obtained in some provinces is only a small part. As a result, there is a large gap in the number of patent authorized in various provinces and the ability of innovation is poor.

4.2 Correlation Analysis

The correlation analysis of the variables are shown in Table 2.

4.3 Regression Results Analysis

This paper uses the panel data of 31 provinces in China from 2010 to 2019, establishes a random effect model, and explores the impact of FDI on my country's technological innovation. The regression results are shown in Table 3. According to the results, the following conclusions are obtained.

Table 1. Descriptive statistics

VARIABLES	N	mean	sd	min	max
year	248	2,014	2.296	2,010	2,017
FDI	248	1,306	2,083	5	17,622
school	248	2,482	844.9	1,082	6,196
patent	248	40,419	59,595	121	332,652
people	248	653,610	354,350	50,124	1.598e+06

Table 2. Correlation analysis

	year	FDI	school	patent	people
year	1				
FDI	0.194	1			
school	0.113	0.310	1		
patent	0.176	0.834	0.202	1	
people	0.0393	0.350	−0.0761	0.514	1

Table 3. The regression results of the impact of FDI on technological innovation

VARIABLES	ln(patent)
ln(FDI)	0.657***
	(13.26)
ln(school)	1.307***
	(6.20)
ln(people)	0.805***
	(6.04)
Constant	−15.246***
	(−6.53)
Observations	248
Number of code	31
F test	0
r2_a	.
F	.

z-statistics in parentheses
***p < 0.01, **p < 0.05, *p < 0.1

(1) The regression results show that at the 1% level of significance, the core explanatory variable FDI coefficient is significantly positive, indicating that foreign direct investment has a significant positive effect on technological innovation. As a developing country that attracts most foreign investment, the overall technological innovation capability of China can be improved by utilizing foreign capital. After obtaining foreign investment, China can promote the spillover of knowledge through the introduction and absorption of technology, imitation effect, and demonstration effect, and then realize the improvement of technological innovation capability.
(2) From the perspective of control variables, education level and human capital level have the same strong correlation with technological innovation ability. At the 1% significance level, the coefficients of the two control variables are significantly positive, indicating that the education level and human capital level as the resource endowment of the host country have great impact on its technological innovation ability. Technological innovation depends not only on foreign investment, but also the host country should have matching resource endowments to complete the leap from learning and imitation to independent innovation.

4.4 Robustness Testing

In order to ensure the reliability of the regression results, this paper uses the panel data of 31 provinces in China from 2004 to 2010 to perform the same regression. The regression results are shown in Table 4. In the regression results using the panel data from 2004

Table 4. Robustness testing

VARIABLES	ln(patent)
ln(FDI)	0.390***
	(5.60)
ln(school)	1.573***
	(9.51)
ln(people)	0.899***
	(6.28)
Constant	−17.546***
	(−7.83)
Observations	217
Number of code	31
F test	0
r2_a	.
F	.

z-statistics in parentheses
***p < 0.01, **p < 0.05, *p < 0.1

to 2010, at the 1% significance level, the coefficient of the core explanatory variable is still significantly positive and the coefficients of the two control variables are also significantly positive, which shows that the above regression results robustness.

5 Conclusion and Shortage

Based on the panel data of 31 provinces in my country from 2010 to 2019, this paper uses a random effect model to test the impact of FDI on technological innovation in China and proves the following conclusion: Firstly, foreign investment has a positive effect on the country's overall technological innovation. Secondly, the level of education and human capital also has important impact on the technological innovation capability of the host country and the host country's resource endowment will affect its digestion and absorption of technology, which in turn affects the transformation of its innovations. Thirdly, the current level of foreign investment in the country as a whole varies greatly and some regions have not received sufficient foreign investment, which in turn expands the gap between provinces in economic development.

Based on the empirical results, this paper puts forward the following suggestions: At first, the country should continue to pay attention to the introduction of foreign investment and the economic development model with a high level of openness can support the innovation-driven development strategy. Then, the level of education and human capital are very important. The country should pay attention to the enhancement of the overall quality of the youth, improve the quality of education and strategically

mine human capital so that it can empower the nation's overall technological innovation capability. At last, pay attention to the introduction of foreign capital to some provinces and establish relevant support policies to improve their regional innovation capabilities to remove the imbalance of development.

This paper only takes 31 provinces in China as a whole for empirical analysis, which also has some shortcomings. For example, this paper can learn from descriptive statistics that the development of various provinces and regions is unbalanced. However, it does not demonstrate the differences between the eastern, central and western regions and analyze underlying reasons for their innovation capabilities. The comparison between the group and the ordinary area still needs to be further deepened and improved.

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