Research on the Impact of FDI on China's Regional Innovation Capacity--Based on the Perspective of Intellectual Property Protection

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Abstract. Intellectual property rights have a very important role in China's independent innovation and technology spillover of foreign direct investment, in order to better clarify the role of FDI on China's regional innovation capacity, this paper considers the effect of the element of intellectual property rights protection as a way to enrich the theoretical system in the field related to FDI and innovation. Using the panel data of prefecture-level cities in China from 2012 to 2019 as a sample, we empirically analyze the impact of FDI on China's regional innovation capacity. The regression results find that FDI has a significant promotion effect on China's regional innovation capacity. In addition, through empirical analysis, this paper concludes that intellectual property protection plays a key role in positive regulation in this process. The innovation of this paper is that the degree of intellectual property protection is included in the research system to investigate the moderating effect of intellectual property protection, which extends and analyzes the mechanism of intellectual property protection in the process of innovation, and enriches the literature research in this field.

Keywords: Foreign Direct Investment, Regional Innovation Capability, Intellectual Property Protection

1 INTRODUCTION

Intellectual property protection is a rigid demand for innovation and development, especially under China's “innovation-driven” strategy, focusing on intellectual property protection is of great significance[1]. In this paper, I will combine IPR protection, FDI and regional innovation development capacity to investigate whether the innovation effectiveness of China's FDI is constrained by the level of IPR protection and what is the level of IPR protection in China?What level range of intellectual property protection is appropriate in this country?The study of these issues is of great significance to the improvement of China's technological innovation capacity and the sustained growth of its economy[2].

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2 STUDY DESIGN

2.1 Modeling

$$INNOV_{it}=\alpha_0+\beta_1 FDI_{it}+\beta_2 Controls_{it}+\gamma_i+\delta_t+\varepsilon_{it} \quad (1)$$

$$INNOV_{it}=\alpha_0+\beta_1 FDI_{it}+\beta_2 IPP_{it}+\beta_3 IPP_{it}*FDI_{it}+\beta_2 Controls_{it}+\gamma_i+\delta_t+\varepsilon_{it} \quad (2)$$

Model (1) is an empirical model to test the impact of foreign direct investment on regional innovation capacity, where $INNOV_{it}$is the explanatory variable of this paper, the innovation level of city i in year t, which is measured in this paper using the number of patents granted in each city,$FDI_{it}$is the core explanatory variable of this paper, foreign direct investment, which is represented by the ratio of the amount of actual foreign investment utilized by city i to the GDP in year t, $\alpha_0$is a constant term, and $Controls_{it}$ is the set of control variables. γ_i represents city fixed effects,$\delta_t$represents time fixed effects, and$\varepsilon_{it}$is a random perturbation term.Model (2) is a model to test the moderating effect of IPR protection, where$IPP_{it}$is the level of IPR protection in province i in year t, and $IPP_{it}*FDI_{it}$is the interaction term between FDI and the level of IPR protection[3].

2.2 Variable Selection and Data Description

The variables and settings involved in the main selected model of this paper are as shown in Table1.

1. The explanatory variable in this paper is regional innovation level. This paper draws on the measurement method of Jin Qiaohua (2017), and selects the number of patents authorized by each of our prefecture-level city units in 2012-2019 to measure the innovation capacity of a region[4].

2. The explanatory variable of this paper is foreign direct investment. This paper draws on the measurement method of Ning Jingbo et al (2022)[5].

3. Moderating Variables.The moderating variable in this paper is the degree of intellectual property protection. This paper draws on the method of measuring IPR in Dang, Wenjuan and Luo, Qingfeng (2021), where the intensity of IPR protection is represented by the product of the intensity of IPR legislation and the intensity of IPR enforcement. The legislative intensity is the ratio of the number of patents granted in each region to the number of patents granted nationwide.The legislative intensity is the ratio of the number of patents granted in each region to the number of patents granted nationwide, and the enforcement intensity is the ratio of the number of patent disputes settled in each region to the number of patent disputes filed in each region[6].

The indicators in this paper[7]are shown in the Table1:

Table 1. Main variables

variable type	The name of the variable	variable meanings	Definition
the explanatory variables	INNOV	Regional innovation capacity	Logarithm of the number of patents granted
explanatory variables	FDI	FDI level	FDI/GDP (%)
moderating variable	IPP	Level of IPR	Legislative Intensity* Enforcement Intensity
control variables	PGDP	Level of regional economic development	Logarithm of GDP per capital
	IND2	Level of industrial development	Value added of secondary industry/GDP (%)
	URBAN	Level of urbanization	Share of urban population in total population (%)
	OPEN	Dependence on foreign trade	Total import and export trade/GDP (%)
	EDU	Education development level	Education expenditure/total fiscal expenditure (%)
	TECH	Level of science and technology	Expenditure on science and technology/total fiscal expenditure (%)

The extreme values of the data may bias the results in the regression process, in order to avoid this situation, all the continuous data variables used in this paper, are used to remove the extreme values by shrinking the tail processing. The descriptive statistics table in Table 2 shows the results after the tailing at 1% as well as 99%. In addition,most of the control variables in this paper are in the state of significant difference.

Table 2. Descriptive Statistics for Key Variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Regional Innovation Ability	2230	8.025	1.731	3.296	12.03
Foreign Direct Investment	2230	1.64	1.161	0.006	7.206
Regional Economic Development Level	2230	10.751	0.586	9.446	12.466
Industrial Development Level	2230	46.094	10.232	19.4	70.8
Urbanization Level	2230	31.462	19.265	2.268	88.799
Degree of Dependence on Foreign Trade	2230	19.763	29.867	0.17	169.87
Education Development Level	2230	17.829	3.818	9.419	27.236
Science and Technology Level	2230	1.674	1.557	0.14	8.447

Note: ***, ** and * respectively represent significant at 1%, 5% and 10% levels;

3 EMPIRICAL RESULTS AND ANALYSIS

3.1 Benchmark Regressions

First, the core explanatory variable FDI is included in the model for regression analysis. The regression results are shown in the first column of the Table3, indicating that FDI has a positive impact on regional innovation capability, and this impact is significant. The coefficient obtained from the regression is 0.088, which is significant at the 1% level. Subsequently, all control variables are added one by one into the regression, with results that FDI has a positive effect on promoting regional innovation capability. Expanding the scale of foreign investment can significantly advance the region's technological research and development level and output. FDI can effectively enhance regional innovation capability, which also demonstrates that the country's investment promotion policies have achieved good results. By attracting substantial capital and learning advanced technologies, FDI has become one of the important means of promoting regional innovation capability[8].

Table 3. Baseline regression results.

Variables	(1) INNOV	(2) INNOV	(3) INNOV	(4) INNOV	(5) INNOV	(6) INNOV	(7) INNOV
Fdi	0.088***	0.075***	0.076***	0.076***	0.072***	0.075***	0.069***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Pgdp		0.391***	0.318***	0.300***	0.330***	0.313***	0.271**
		(0.096)	(0.104)	(0.104)	(0.105)	(0.105)	(0.106)
ind2			0.008*	0.009*	0.011**	0.011**	0.011**
			(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Urban				0.011**	0.009*	0.009*	0.010**
				(0.005)	(0.005)	(0.005)	(0.005)
Open					0.007**	0.007**	0.009***
					(0.003)	(0.003)	(0.003)
Edu						0.017*	0.017*
						(0.009)	(0.009)
Tech							0.071***
							(0.025)
_cons	7.373***	3.282***	3.617***	3.438***	2.937***	2.708***	2.993***
	(0.053)	(1.003)	(1.019)	(1.021)	(1.040)	(1.046)	(1.049)
City / Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2230	2230	2230	2230	2230	2230	2230
r2	0.225	0.232	0.233	0.235	0.237	0.239	0.242

Note: ***, ** and * respectively represent significant at 1%, 5% and 10% levels;

3.2 Test of the Moderating Effect and Endogeneity

In reality, the relationship between FDI and innovation capacity is a dynamic process, which is related to current influences and at the same time influenced by past factors, with obvious path-dependence effects. After considering this dynamic change, it is necessary to incorporate the lagged terms of the explanatory variables in the model.

However, once this operation is carried out, the lagged terms of the explanatory variables become explanatory variables, bringing more serious endogeneity problems, and at the same time failing to satisfy the assumption that the explanatory variables are uncorrelated with the disturbance terms, at which point the estimation results will be the same as in the case of the forced adoption of a fixed- or random-effects model.

Table 4. Regression Results of Endogeneity Test and the Moderating Effect

Variables	(1) INNOV	(2) INNOV	(3)
L. Apply			0.615***
			(0.134)
Fdi	0.069***	0.073***	0.037**
	(0.019)	(0.019)	(0.134)
Ipp		0.725**	
		(0.355)	
ipp_fdi		(0.114)	
Pgdp	0.271**	0.287***	0.395*
	(0.106)	(0.106)	(0.207)
ind2	0.011**	0.012**	-0.012
	(0.005)	(0.005)	(0.011)
Urban	0.010**	0.010**	-0.007*
	(0.005)	(0.005)	(0.004)
Open	0.009***	0.006**	0.008
	(0.003)	(0.003)	(0.006)
Edu	0.017*	0.014	0.049**
	(0.009)	(0.009)	(0.020)
Tech	0.071***	0.072***	0.109
	(0.025)	(0.025)	(0.069)
_cons	2.993***	2.396**	-1.395
	(1.049)	(1.089)	(1.521)
City / Year	Yes	Yes	Yes
N	2230	2230	1941
r2	0.242	0.247	
AR(1)			0.234
AR(2)			0.234
Hansen			0.445

Note: ***, ** and * respectively represent significant at 1%, 5% and 10% levels;

In this case, if a fixed or random effect model is forced, the estimation results will be biased and non-consistent. Therefore, in order to increase the reliability of the conclusions in this paper, a two-step GMM model is used for test estimation. In this method, the condition of moment constraints is added, so further autocorrelation and instrumental variable validity tests are required[9]. Next the autocorrelation test is carried out using the AR test, the original hypothesis of this test is that there is no autocorrelation, the first order autocorrelation can relax the requirements but the second order autocorrelation can not exist. Test of instrumental variables validity method Hansen test, the original hypothesis that the instrumental variables are

considered valid variables.As shown in the table above, the original hypothesis could not be rejected in AR (1) of the system GMM model at 1% level, which means that the model does not have first-order autocorrelation, while the original hypothesis was passed in both AR (2), which means that there is no second-order autocorrelation.The Hansen's test indicates that the original hypothesis could not be rejected, which means that the use of the two-stage system GMM estimation is appropriate. The coefficient of its outward direct investment FDI is 0.037, which is significant at the 5% level, indicating that FDI still significantly improves regional innovation capacity[10].

As can be seen from the model, the estimated coefficient of the core explanatory variable FDI is significantly positive, indicating that the regional innovation effect of FDI in China is significant, which is consistent with the test results above. The estimated coefficients of IPP*FDI are significantly positive at the 5% level of significance in the third column of the total sample estimation in Table 4,, intellectual property protection plays a positive moderating role in the regional innovation-driven process of FDI.

3.3 Robustness Tests

In response to the above conclusions of this paper, it can be seen that the findings of this paper are consistent with most scholars that foreign direct investment can play an obvious role in promoting regional innovation, but in order to make the empirical results more reliable, this part will be used in the following three ways: replacing the explanatory variables, adding lagged terms, and replacing the modeling method to conduct a robustness test.

The regression results are shown in Table 5: the coefficients and significance of the core explanatory variable FDI as well as the rest of the control variables do not change significantly, which shows that the reliability of the previous regression results is high and the estimation results are robust.

Table 5. Robustness test regression results

Variables	(1) INNOV	(2) INNOV	(3) INNOV	(4) INNOV	(5) INNOV	(6) INNOV
Fdi	0.072***	0.050***	0.051***	0.040**	0.100***	0.089***
	(0.017)	(0.017)	(0.019)	(0.019)	(0.009)	(0.009)
Pgdp		0.539***		0.166		0.494***
		(0.094)		(0.104)		(0.044)
ind2		0.011***		0.008*		0.004**
		(0.004)		(0.005)		(0.002)
Urban		-0.009**		0.011**		-0.001
		(0.004)		(0.005)		(0.001)
Open		0.004*		0.006*		0.016***
		(0.002)		(0.003)		(0.001)
Edu		0.012		0.022**		0.021***
		(0.008)		(0.009)		(0.004)
Tech		0.025		0.063**		0.170***
		(0.022)		(0.025)		(0.013)
_cons	5.798***	-0.528	7.619***	4.470***	7.275***	0.953**

		(0.047)	(0.928)	(0.050)	(1.046)	(0.032)	(0.431)
City / Year		Yes	Yes	Yes	Yes	Yes	Yes
N		2230	2230	1941	1941	2225	2225
r2		0.616	0.629	0.203	0.216		

Note: ***, ** and * respectively represent significant at 1%, 5% and 10% levels;

4 CONCLUSIONS OF THE STUDY

Using the panel data of prefecture-level cities in all provinces of China in 2012-2019, we empirically examined the moderating effect of intellectual property protection in the process of driving FDI on China's regional innovation capacity by constructing a fixed-effects regression model and a moderating-effects model, and adding the interaction term in layer-by-layer regression.

We empirically test the moderating effect of intellectual property protection in the process of FDI driving China's regional innovation capacity. The results of this paper show that:First, as a whole, FDI has played a very significant role in promoting China's regional innovation capacity. Second, by improving the protection of intellectual property rights, FDI can effectively promote the enhancement of the innovation capacity of China's regions.

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