ISSN:2790-1661 DOI: 10.56028/aemr.3.1.150

Intellectual Property Rights Protection, Science and Technology Intensity and Enterprise Innovation Investment

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Abstract. Using the data sets of Chinese A-share listed companies from 2013 to 2017, we investigate the relationship between intellectual property rights (IPR) protection and innovation investment. The results show that IPR protection has positive effect on innovation investment and this positive relation is less announced among the firms with strong science and technology intensity. This research enriches the existing papers with the innovation effect of IPR protection, enlightens institutional reform in the field of intellectual property rights, and stimulates the innovation vitality of enterprises.

Keywords: intellectual property rights protection, innovation investment, science and technology intensity

1. Introduction

With the development and maturity of big data and other emerging technologies, the application of digital economy is becoming more and more extensive. With the rise of digital economy and the acceleration of economic globalization, the importance of intellectual property rights in international competition cannot be neglected. IPR protection has been extended from original pure legal category to national development strategies. As the strategic resources of national development and the core of international competitiveness, IPR protection plays an important role in stimulating innovation vitality and improving economic quality. Strengthening the protection of intellectual property rights is important to improve the property right protection system, and is significant to improve the economic competitiveness.

Intellectual property system is a basic system to protect scientific and technological innovation, which plays an irreplaceable role in advancing scientific and technological progress, protecting innovation achievements, promoting the application of scientific and technological achievements. Past studies have carried out extensive and in-depth research on the relationship between intellectual property rights and enterprise innovation, which imply that there is a close relationship between intellectual property rights and enterprise innovation activities [1-6]. Based on this, further studies find that IPR plays a key role in encouraging innovation, promoting technological progress and stimulating economic growth [7-15]. For example, Leger [16] found that IPRs have a positive and significant impact on innovation. Schneider [17] found that the impact of

intellectual property rights on innovation is more significant in developed countries.

However, there are still some deficiencies in the prior researches. First, most of the previous studies measure the level of IPR protection from the national and industrial levels. Few studies is based on the enterprise level and considers the differences of enterprises. Second, because of the differences in research methods and samples among papers, the conclusion is not comparable. Based on the data sets of Chinese A-share listed firms from 2013 to 2017, this paper first investigates the positive effect of IPR protection on innovation investment, and further explores the

ISSN:2790-1661 DOI: 10.56028/aemr.3.1.150
moderating role of science and technology intensity. The result of this paper enriches the stream of IPR protection and enlightens the adjustment of future intellectual property policy.

2. Hypotheses Development

IPR protection is a vital part of market policy, which affects the nature and speed of innovation activities in countries [4]. Empirical researches show that IPRs have a positive and significant effect on overall innovation [16-19]. And the research of Eriksson et al. [20] shows that employee mobility is an important mechanism of enterprise innovation activities. In innovative enterprises, the higher the turnover rate of R&D personnel, the higher the possibility of innovation, but the lower the intensity of innovation activities and innovation performance.

According to the provincial data on IPR protection attached to the report of Chinese State Intellectual Property Office (CSIPO), regional IPR protection has a incentive effect on innovation investment to an extent. Differences in the data sets, such as country-level, industry-level or enterprise-level data, can lead to differences in the assessment of the impact of IPR on innovation. The innovation activities of high-tech enterprises are the quite active but the consciousness of patent protection in domestic high-tech enterprises are feeble. These factors may cause the incentive effect asserts differently in enterprises which show heterogeneity in science and technology intensity.

Although researches have discussed the innovation effect of IPR protection, most of them are transnational and cross- industry research at the macro level. The research that investigates the impact of IPR protection on the innovation of different enterprises is very scarce. Therefore, this paper

attempts to explore whether IPR protection has an effect on innovation investment and whether the science and technology intensity has a moderating role on the relationship between them.

This paper puts forward the following research hypotheses: H1: There is a positive correlation between the intensity of

IPR protection and innovation investment of enterprises.

H2: The higher the intensity of science and technology, the weaker the incentive effect of IPR protection on innovation investment.

Table 1 Description of Variables

Type	Variables	Symbol	Description
Dependent variable	Innovation investment	R&D	R&D intensity is the ratio of R&D spending to revenue
Independent variable	IPR protection	IPR	Intellectual property rights Protection Index
Moderator variable	Science and technology intensity	H_Te	If enterprise is a high- tech enterprise, the value is 1, otherwise the value is 0.
Control variables	Firm size	LnAssets	The natural log of total assets at year end
	Intangible assets ratio	Int	Ratio of net intangible assets to total assets
	Asset- liability ratio	Lev	Ratio of total liabilities to total assets
	Rate of return on total assets	ROA	Ratio of net profit to average balance of total assets
	Firm age	LnAge	The natural log of business age plus 1
	Year	Year	Dummy variable
	Industry	Industry	Dummy variable

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3. Research Design

3.1 Sample Selection and Data Sources

The initial sample of this paper is the data sets of Chinese A- share listed companies from 2013 to 2017, and are screened according to the following principles: 1) excluding ST and *ST companies; 2) excluding financial companies according to the CSRC version 2012 industry classification; 3) putting forward companies with serious lack of financial data; 4) Winsorize processing of all data at 1% and 99% and 7,535 firm-year observations are obtained. The data of IPR protection index in this paper include the scores of IPR protection index from 31 provinces in China (provinces, autonomous regions, municipalities directly under the Central Government). After the cross-matching of enterprise code, province and year, the enterprise sample data of 31 provincial administrative areas are obtained. Enterprise-level data are from the CSMAR database; IPR protection data are collected from the State intellectual property Office of China.

3.2 Variable Definitions

3.2.1 Dependent variable

Innovation investment. according to the existing papers, innovation ability is mainly measured by innovation input and innovation output. Innovation input includes R&D intensity, number of technical personnel, total cost of R&D input, etc. Innovation output includes patent application volume, patent ownership, proportion of new product sales income, etc. The relevant data of patent application or research and development in China are not complete, the number of patents is mainly used to measure the technological innovation ability of enterprises, and the innovation of high-tech enterprises is mainly related to R&D intensity. Therefore, this paper measures the innovation investment of enterprises through R&D intensity (R&D input / operating income) to reflect that the innovation investment of high-tech enterprises is different.

3.2.2 Independent variable

Although several IPR indices have been established, the most common used is the Ginarte-Park Index (GPI) which was first proposed by Ginarte and Park [21]. However, according to the actual situation and the availability of index data, this paper measures the IPR protection of enterprises through the IPR protection index in the evaluation report on intellectual property development of China issued by the intellectual property Bureau over the years. The report constructs the evaluation index system of intellectual property development in China, sets up the first- level indicators of intellectual property creation, application, protection and environment, and evaluates the comprehensive development of intellectual property rights in China.

3.2.3 Moderator variables

Science and technology intensity. The variable is represented by the H_Te dummy variable. If an enterprise is a high-tech enterprise, the H_Te value is 1; otherwise, 0.

3.2.4 Control variables

According to previous studies, we add control variables to the multiple regression model that may affect the level of enterprise innovation, including enterprise size, measured by the logarithm of total assets at the end of the year, intangible assets ratio, measured by the ratio of net intangible assets to total assets, and asset-liability ratio, measured by the ratio of total liabilities to total assets. Rate of return on total assets is measured by the net profit divided by the average balance of total assets, and the age of the enterprise is measured by the natural logarithm after the establishment of the enterprise. In addition, it also includes year fixed effect and industry fixed effect. All variables are defined in Table I.

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3.3 Model Design

To test the proposed hypothesis, we constructed a fixed effect model as the regression model for our empirical research, and put the interaction term between IPR protection and virtual variables of science and technology intensity into the model in order to test whether science and technology intensity has a moderating effect. The specific forms of regression model are as follows:

Innovationi,t= 0+ 1IPRi,j,t+ 2H_Tei,t+ 3IPRi,j,t*HTi,t+ 4Control si,t+ i,t (1)

Among them, i and t represent the firm and year, respectively, and j represents the province. Innovation investment of i enterprises in t year is measured by the R&D intensity of t year. IPRi,j,t represents the level of IPR protection in the province j where the first sample enterprise is located in t year. If strengthening the protection of intellectual property rights can

stimulate the innovation level of enterprises, then the expectation 1 should be significantly positive. H_Tei,t is a dummy variable, which measures whether the enterprise is a high-tech enterprise in t year, if enterprise i is a high-tech enterprise in the t year, then the value is 1, otherwise, 0. IPRi,j,t*HTi,t is the cross-interaction term of IPR protection intensity and whether or not high-tech enterprises, aiming to explore the impact of IPR protection on the innovation investment of heterogeneous enterprises. This paper concerns the interaction coefficient 3, if it is significantly negative, it shows that the protection of intellectual property rights is less conducive to the innovation incentive of high-tech enterprises. Controlsi,t is the control variable at the enterprise level at the end of t year, including enterprise size, intangible asset rate, asset- liability ratio, total net asset profit rate, enterprise age, and includes both year and industry fixed effect.

4. Empirical Results and Analysis

4.1 Descriptive Statistics

The results of descriptive statistics (see Table II) show that the innovation investment of high-tech enterprises is significantly higher than that of high-tech enterprises at the significant level of 1%. Moreover, the R&D intensity of China high-tech enterprises is significantly higher than that of non- high-tech enterprises. In addition, the correlation test results among key variables (see TABLE III) show that there is a significant positive correlation between IPR protection intensity and R&D intensity at a significant level of 1%.

4.2 Regression Analysis

Columns (1) and (2) in Table IV examines the impact of IPR protection on the innovation investment of enterprises. Where column (1) only controls time and industry fixed effects, column (2) adds all control variables. The estimated values of IPR protection coefficient are significantly positive at the significant level of 1%, which indicates that IPR protection is positively correlated with the innovation investment of enterprises. The higher the intensity of IPR protection, the more can encourage enterprises to innovate and improve the innovation investment of enterprises.

The estimated results in columns (3) and (4) in Table IV show that the coefficient of interaction term IPRi,j,t*HTi,t is significantly negative at the significant level of 1%, which indicates that science and technology intensity can weaken the incentive effect of IPR protection on innovation investment. The results were consistent with Eriksson et al. [20]. Considering that this paper uses R&D intensity to measure the innovation investment of enterprises, we speculate that there are three reasons. First, due to the deepening of marketization and the acceleration of economic structure change, the active labor market, the loss of knowledge workers in high-tech enterprises, and the flow of personnel in the process of personnel movement, current employment situation of high-tech enterprises has become the most important factor, which leads to the loss of IPRs and affects the innovation investment of enterprises. Second, because the awareness of IPR protection of high-tech enterprises is not strong, high-tech enterprises pay more attention to the aspect of scientific research, but ignore the aspect of intellectual property. Enterprise researchers pay more

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Table 2 Decriptive statistics

Variables	H_Te=0		H_Te=1		t-test for difference in means
	Mean	Std. Dev.	Mean	Std. Dev.	
R&D	4.219	4.145	5.298	4.213	-1.079***
IPR	75.16	12.930	78.64	12.01	-3.475***
lnAssets	22.26	1.238	21.98	1.062	0.278***
Int	0.048	0.042	0.0454	0.0376	0.003**
Lev	0.417	0.199	0.374	0.189	0.043***
ROA	0.041	0.0532	0.0446	0.0499	-0.004**
lnAge	7.601	0.00248	7.601	0.00234	-0.000***

*** p<0.01, ** p<0.05, *p<0.1

Table 3 Correlation coefficient matrix

	R&D	IPR	lnAssets	Int	Lev	ROA	lnAge
R&D	1						
IPR	0.097***	1					
lnAssets	-0.285***	-0.168***	1				
Int	-0.028**	-0.071***	0.018	1			
Lev	-0.324***	-0.122***	0.557***	0.012	1		
ROA	0.027**	0.123***	-0.002	-0.074***	-0.362***	1	
lnAge	0.166***	0.080***	-0.115***	0.022*	-0.157***	0.027**	1

*** p<0.01, ** p<0.05, *p<0.1

attention to academic research, resulting in the loss of the novelty of new technology. Third, due to the gradual expansion of the influence of high-tech enterprises, the competition gets fiercer in the industry.

5. Conclusion

The empirical results show that the intensity of IPR protection can significantly improve the innovation investment of enterprises, and is less announced in firms with high science and technology intensity. That is, compared with non-high-tech enterprises, high-tech enterprises will weaken the positive incentive effect of IPR protection on enterprises innovation investment. The study enriches the related research on IPR protection and enterprise innovation investment and provides a theoretical basis for the government to formulate differentiated IPR protection policies to a certain extent.

There are still some shortcomings in the result of this paper. First, this paper uses R&D intensity to measure the innovation investment of enterprises, which is relatively single and cannot fully reflect the enterprises innovation investment. Second, there are no uniform indicators for the measurement of IPR protection. IPR protection is related to the modernization of the national governance system and governance ability, and to the development of high quality. More detailed researches on IPR protection and enterprise innovation still need to be carried on.

In the future, relative bureau need to closely combine the infrastructure construction of IPR protection and major

scientific and technological requirements for career development. And they should vigorously strengthen the interdisciplinary and the convergence of the new technology and actively promote

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the usage of artificial intelligence, big data in the application of intellectual property protection. They also should provide more technical support and better technology services for the intellectual property information protection.

Table 4 Correlation coefficient matrix

Variables	(1)	(2)	(3)	(4)
IPR	0.026*** (6.92)	0.015*** (4.03)	0.014*** (3.72)	0.018*** (4.42)
H_Te			0.521*** (4.65)	2.206*** (3.28)
IPR*HT				-0.022** (-2.54)
lnAssets		-0.272*** (-5.99)	-0.263*** (-5.77)	-0.266*** (-5.84)
Int		2.237** (2.11)	2.339** (2.21)	2.358** (2.23)
Lev		-4.812*** (-16.59)	-4.790*** (-16.54)	-4.774*** (-16.48)
ROA		-6.772*** (-7.58)	-6.865*** (-7.69)	-6.827*** (-7.65)
lnAge		169.246*** (9.76)	164.210*** (9.46)	164.452*** (9.48)
Constant	1.118** (2.25)	-1276.479*** (-9.68)	-1238.388*** (-9.39)	-1240.452*** (-9.40)
Industry fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	7535	7535	7535	7535
Adj R- squared	0.177	0.258	0.260	0.261
F value	82.16	105.73	102.78	99.28

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

6. Acknowledgment

We are grateful for the support of National Natural Science Foundation of China (71902128), the Innovation spark project of Sichuan University (2018hhf-49), the Graduate Education Innovation and Reform Project of Sichuan University (GSJCPY2021014), the Social Science Research Fund in Sichuan Province (SC20C013), the Fundamental Research Funds for the Central Universities (2020-BS-C03).

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