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R&D inputs, intellectual property protection and patents

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ABSTRACT

We conduct a empirical analysis of IPP'(IPP) moderating effect between R&D Inputs and performance based on the small-medium enterprises (SME) in Shenzhen Stock market, Results shows that IPP could raise the intensity of R&D Inputs for corporation, In addition, we find that Strong IPP play a positive role between R&D Inputs and patents, While We couldn't get that Weak IPP play a Negative role between R&D Inputs and patents.

KEYWORDS

R&D inputs; Intellectual property protection (Ipp); Patents; Stock market; SME.

INTRODUCTION

Arrow[1] thought that the results of R&D is knowledge, it has the attributes of public goods and the marginal cost of which is very low, It can't prevent other people from use the new knowledge or technology, even in the absence of authorized of the owner. The private profit of R&D will be lower than the full profit of R&D[2]. Thus, the IPP comes up. And as a kind of artificial barriers, it can keep the corporate maintain the technology monopoly status in a certain period of time, improve the performance of R&D Inputs and stimulate more and more R&D Inputs from the corporate. Base on the SME of Shenzhen stock market in china, we study the moderating effect of IPP between R&D Inputs and patents and whether IPP of china promotes the patents applied or not.

THEORY ANALYSISI AND HYPOTHESIS

IPP and R&D inputs

IPP

In prior study, the index of IPP was base on the national data, not base on the province-level (state-level) data, While the index of province-level (state-level) data is different from the one of national data, because the laws and regulations of IPP issued and the international conventions on IPP signed by Chinese government is applicable in all provinces of mainland. The difference of level in IPP among provinces mainly is reflected by the different level of these laws and regulations enforment. Many western scholars think that the condition of IPP in china is worse. In fact, after china entry into WTO, Great progress in legislation of china in IPP have taken place, but it is still weak in law enforcement of IPP due to people's awareness of IPP is still need time to culture and the intellectual property law enforcement team need time to develop. In this paper, level of IPP refers to the one of enforment.

IPP and R&D inputs

There is an interaction relationship between IPP and R&D Inputs. Prior research mainly focuses on the role of IPP affects R&D Inputs and ignores the role of R&D Inputs affects IPP. Firstly, IPP strives to resolve the problem of externalities, reduce the risk of intellectual property infringement and promote the benefit prospects of R&D Inputs, then encourage the corporate conduct more R&D Inputs[6]. Secondly, IPP reduces the difficulty of finance for the R&D project, when the government punishes the infringementors heavily. The corporate are more willing to disclose information about the R&D projects to fund–provider outside, thus reduce the problem of asymmetric information[7], so, the corporate in zones of strong IPP will input more resource to do R&D. Of course, we consider that the R&D Inputs would stimulate IPP. The reasons are follows, firstly, with the increase of R&D Inputs, in order to reduce the probability of knowledge spillover, the corporate will lobby the local government to punish the infringementor heavily to increase the private profits from R&D, secondly, in order to keep the leadship in particular technical areas, the corporate with huge R&D Inputs will take IPP as an impressive weapons to defeat the competitors. We can see a reality, after china entry into WTO, the western developed countries require china to establish the legislation of IPP and punish the infringmentors heavily. Besides, many multinational enterprises are willing to apply the patents in china and expand their intellectual property strategy.

IPP and patents

As we know, R&D Inputs is more risky. The success of R&D Inputs should go through many stages. First is the success of technology, the new products or process should meet the design requirements and become one kind of technology assets, whose main form is patents, The enhancement

of IPP will have a positive influence on the patents. We can see the corporate would be willing to apply the patents in the strong conditions of IPP, otherwise, if the local government couldn't deal with the infringmentor properly, the corporate couldn't get benefits from the patents, they doesn't apply patents, because, patents will disclose the information to the competitors.

Base on above analysis, we come up with the following hypothesis:

Hypothesis1: strong IPP will have a positive moderating effect between R&D Inputs and Technology Performance of R&D Inputs;

Hypothesis2 weak IPP will have a negative moderating effect between R&D Inputs and Technology Performance of R&D Inputs;

DESIN

Data and method

We choose the SME in Shenzhen stock market as the samples, and research period is 2006-2011, Reasons are followed: Firstly, the SME in Shenzhen stock market has a smaller size, focus on one industry and has a dominated products, So R&D Inputs has its importance apparently for these companies. Secondly, at present, The Exchange Commission of Shenzhen stock market requires that the listed SME companies of Shenzhen stock market should disclose their innovation acvities, and we can get the data easily. Finally, we get 1706 panel dates, from 200-2011, they are 234,257,278,284,301,352.

Besides, in this paper, we need data about province, for instance, Number of intellectual property Proxy Companies, population of the province, Transfer Scale of technology market of the province and GDP of the province, we acquire the data from Chinese national Ministry of science and technology and the National Bureau of Statistics website. We got 32 provinces' data except Macao, Hongkong and Taiwan.

Definition of variables

Dependent variable: Patents

Due to most of corporate in the sample belong to manufacture and computer service industry, we take patents the dependent variables.

Independent variable: R&D inputs

Generally speaking, R&D Inputs include stuff inputs and Capital inputs. So, there are two measurement indexes about the R&D Inputs. One focus on the technology stuff that corporate owned, another focus on the capital investment, considering the size of the corporate, We come up with the relative index, here, we take the intensity of R&D Inputs to measure the R&D Inputs embraced R&D Stuff input intensity and R&D capital input intensity.

Moderatoring variable: IPP

We use two indexes to describe the level of IPP. The first index of IPP (IPP1) is the density of intellectual property Proxy Companies. Generally speaking, the increase of the density of intellectual property proxy companies reflects that local governments enhance the strength of IPP. Increasement of the density of intellectual property proxy companies shows the upsurge of demand of the companies in IPP. We can see when the company gets an infringement of intellectual property and then they ask for help from intellectual property Proxy Companies. For instance, patents application, Survey evidence of infringement and Ask the government to investigate and punish the infringementor. If the government couldn't give a heavy or a proper punishment to infringementor of intellectual property, the demand of ask for intellectual property protection from the government will be decline, so does the number of intellectual property Proxy Companies. As Langouw and Lemer (1997) say, the cost the companies

would pay for legal protection depend on the benefit they would get from it. If the companies couldn't get the proper protection of intellectual property, they will bear the infringement. Therefore, the density of intellectual property Proxy Companies in proviences depends on the enforcement of IPP from the government.

The second index of IPP (IPP2) is the scale in technology transfer market of provinces, which is divided the amount of technology market turnover by GDP for a province. The amount of technology market turnover mainly refers to the use fees and transfer fees of the patents, trademarks and other intellectual property rights.

Controlled variable

The first controlled variable is firm size. As we know, the bigger company has many resources to do R&D activities than the smaller one, which would affect the relationship between R&D Inputs and R&D performance.

The second controlled variable is industry. The outputs of patent depends on the industry that company belong to largely. It originates from the speciality of assets and the extent of benefits from the R&D. we can say, different industry has different level of spillovers, so the corporate has the different level of benefit from R&D. Base on the classification of industry in Shenzhen stock market, we introduce 8 industries.

The third controlled variable is competitive intensity, which would be calculated by the average gross margin rate of dominated products in an industry, generally speaking, higher gross margin rate means lower competitive intensity,

Model

Base on the mean of IPP, we classify the samples into sub-samples: the corporate in zone of strong IPP and the ones in zone of weak IPP. Then we analyze the sub-samples individually.

Because the number of patents is discrete variable, generally speaking, we deal with the discrete variable by possion regression. But Assumed mean and variance are the same in the possion distribution, if the vaiance exceeds the mean, over-dispersion will exists, in prior study, many scholars use negative binomial regression model to overcome the over-dispersion and variable missing[8], So we use Negative binomial regression to deal with the patents.

ANLYSIS

Statistical description

Descriptive statistics of IPP index

From the TABLE 1, the mean of density of intellectual property Proxy Companies is 0.009, which doesn't vary in time. In 2006, its value is 0.0071, in 2011; its value is 0.0074, but the density of intellectual property Proxy Companies has great differences in different provinces. The max is 0.092, the min is 0.002, it is just like the calculation results of Wu Chaopeng[6], the density of intellectual property Proxy Companies among different provinces has difference significantly, coastal area is the best, second is the northeast of china, the worst is the southwest area and central china.

TABLE 1 : Descriptive statistics of IPP index

IPP	Mean	SD	Min	Max	N
IPP1	0.009	3.89	0.002	0.092	224
IPP2	0.005	3.08	0.001	0.080	224

In order to explain the moderating effect of different level of IPP more accurately, we do a sort about the 32 provinces of china mainland. The method is: base on the computation of IPP index IPP1 and IPP2 in TABLE 2, First, calculate the average, then, the above average number are classified as zone of strong IPP, others are classified as zone of weak IPP.

Finally, we got the 12 strong IPP province, they are Guangdong, Beijing, Shanghai, Zhejiang, Jiangsu, Tianjin, Fujian, Hunan, Shanxi, Heilongjiang, Jilin, Liaoning, Other ones belong to the weak IPP provinces. From the results of classification, the strong IPP province mostly located in the coastal developed area, of course, northeast three provinces also pay attention to the IPP due to the base of heavy industry.

Base on the computation, the samples is divided into two parts, the ones in zone of strong IPP and the ones in zone of weak IPP. The number of samples in zone of strong IPP is 1172. And the number of samples in zone of weak IPP is 534.

Statistical description of R&D intensify in different level of IPP

Base on the computation of IPP index and classification of the zone of strong IPP and the zone of weak one. We made statistics on R&D Inputs intensity of corporate in two different categories of IPP zone. The results are as shown in TABLE 2.

TABLE 2 : The zone of samples and its R&D intensity

Zone	N	R&D intensity			
		Mean	Min	Max	SD
strong IPP	1172	4.94%	0.34%	22.85%	2.05
weak IPP	534	4.11%	0.27%	18.23%	1.84
Total	1706				

From TABLE 2, the Min, Max and Mean of R&D intensity for corporate in zone of strong IPP is greater than that one for corporate in zone of weak IPP. The max R&D intensity of corporate in zone of strong IPP is 22.85%, which shows that strong IPP could stimulate the R&D Inputs of corporate.

Results

TABLE 3 show that the relationship between the R&D Inputs and patents in strong IPP situation and the weak one.

Moderating effect of strong IPP

From TABLE 3, model1 and model2 shows that the R&D Inputs have a positive relationship with patents in strong IPP ($B=0.862$, $P<0.01$; $B=0.106$, $P<0.05$), which support hypotheses 1. It demonstrate that the corporate would have a strong will to apply the patents and get better technology performance if the local government take heavy punishment on the infringement of intellectual property rights.

Besides, From TABLE 3, model1 and model2 shows that size of corporate has a positive relationship with the patents, which demonstrate the big corporate have much more efficiency than the small one, at present in china. While the size of corporate has a weak positive relationship with the financial performance and the size of corporate has a negative relationship with the value performance. It means the bigger company has shortcomings in late commercial development of new products and patents. Also, the capital market would undervalue the bigger company.

Moderating effect of weak IPP

From TABLE 4, model1 and model2 shows that the R&D Inputs have a positive relationship with technology performance of R&D Inputs in weak IPP (B=0.016, P<0.05; B=0.028, P<0.05), which doesn't support hypotheses 4 and it demonstrates that the corporate have a strong will to apply patents in weak IPP, maybe which lead by the "innovation project" hosted by local governments, at present, local government in china take the numbers of patents application as a indicator to assess the corporate. And theses administrative acts promote the increase of patents application for these corporate.

TABLE 3 : Regression analysis for strong IPP samples

Variables	Patents	
Controlled variables:	**Model1**	**Model2**
SIZE	0.012** (0.128)	0.029** (0.189)
IDUSTY-1	-0.231 (0.400)	-0.236 (0.130)
IDUSTY-2	-0.521 (0.186)	-0.239 (0.186)
IDUSTY-3	0.232 (0.341)	-0.411 (0.236)
IDUSTY-4	-0.230 (0.221)	-0.0732 (0.135)
IDUSTY-5	-0.662 (0.511)	-0.636 (0.834)
IDUSTY-6	-0.621 (0.433)	-0.401 (0.233)
IDUSTY-7	-0.311 (0.212)	-0.301 (0.124)
IDUSTY-8	0.145 (0.521)	0.712 (0.414)
CI	0.023 (0.018)	0.012(0.012)
Dependent Variables		
R&D-M	0.862***(0.028)	
R&D-H		0.106** (0.087)
Wald chi-square	398.231	378.432
Log likelihood	-723.234	-717.831

N=1172, *, **, * significant at 99%, 95%, 10% level**

Discussion and analysis

IPP and R&D inputs

The above statistics and the empirical results show that enterprises are more willing to increase R&D Inputs in the strong IPP situation, the reasons are followed:

Firstly, the strong IPP provinces, which have the leading positions in economic development, could provide an important material foundation for the implementation of intellectual property strategy, Local governments can use the advantage of rich resources to maintain the innovation market order, on the hand, intensify efforts to crack down on IPR infringement and encourage enterprises to innovate, on the other hand, increase public subsidies of R&D Inputs for enterprise, make up knowledge spillovers of R&D activities and stimulate enterprises to increase investment in R&D.

Secondly, it is an important ways to maintain the advantage technology and market of enterprises through strengthen the protection of intellectual property for the developed provinces, because these enterprises in developed provinces are in a leading position in innovation, in order to keep the advantage, these enterprises will invest more R&D resources in strong IPP situation.

Moderating effect of IPP

The empirical results show that strong IPP promotes patents applied and play a positive moderating role between R&D Inputs and patents; weak IPP play a positive moderating role between R&D Inputs and patents, the meanings shows two aspects: one hand, it demonstrates strong IPP could provide enterprises a better outside conditions for their innovation, stimulate the innovation and raised the financial performance of innovation, the reason is obvious in strong IPP situation, the enterprise could get much more financial supports from the outside easily, includes External debt financing, the informal financial institutions and external equity financing and they would be willing to invest much resources in R&D activities to produce much more patents and new products. On the other hand, it shows that local government plays a determinative role in IPP. Even in the weak IPP situation, the local government and enterprises would do some apparent innovation activities and get some achievements in patents under the pressure of achievements in one's official career, while these results of innovation would be low quality and these enterprises couldn't get much benefit. So we think, the government should take more market methods in the process of design a future IPP system.

TABLE 4 : Regression analysis for weak IPP samples

Variables	Patents	
Controlled variables:	**Model1**	**Model2**
SIZE	0.0232 (0.142)	0.526 (0.318)
IDUSTY-1	-0.621 (0.501)	-0.025 (0.013)
IDUSTY-2	-0.421 (0.211)	-0.503 (0.010)
IDUSTY-3	0.293 (0.277)	0.198 (0.034)
IDUSTY-4	-0.139 (0.153)	-0.059 (0.053)
IDUSTY-5	-0.654 (0.424)	-0.154 (0.204)
IDUSTY-6	-0.012 (0.033)	-0.231 (0.034)
IDUSTY-7	-0.162 (0.158)	-0.124 (0.135)
IDUSTY-8	0.109 (0.112)	0.009 (0.002)
CI	0.012 (0.015)	0.023 (0.010)
Dependent Variables		
R&D-M	0.016**(0.052)	
R&D-H		0.028**(0.084)
Wald chi-square	512.122	521.829
Log likelihood	-812.411	-826.124

N=534, *, **, *significant at 99%, 95%, 10% level**

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