An Empirical Analysis on Inner Impact Factors of Independent Innovation of Innovative Pilot Enterprises in Fujian Province of China

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Abstract: In this paper, we take the first batch of innovative pilot enterprises in Fujian province as the research object, authorized patent quantity is chosen as output index, and R&D input intensity, R&D personnel proportion in employed person, staff educational expenditure proportion in main business income, the construction condition of R&D institution, the construction condition of intellectual property management system and the construction condition of Innovation development strategy are chosen as impact factors, regression model is used to estimate their influence on authorized patent quantity. Results showed that R&D input intensity; the construction condition of R&D institution, the construction condition of intellectual property management system and the construction condition of Innovation development strategy are the main impact factors of authorized patent quantity.
Keywords: Innovative pilot enterprise; Independent innovation capability; Inner impact factor; Fujian province

1 Introduction

Fierce international competition and the reality of China's economic development that make our government recognize that enhancing China's economic competitiveness greatly depends on our ability to create a group of innovation-oriented enterprises with independent intellectual property rights, independent brands and sustained innovation capability. Due to the independent innovation achievements of innovative pilot enterprise mainly come from internal factors, some external factors can play a role through the internal factors. At present, there are many research literatures at home and abroad, but they are mainly based on the comprehensive evaluation of innovation inputs and outputs. Foreign economic circles often use R & D investment and patent activity index as an approximation when they measure innovation inputs and outputs. To innovation inputs, most part of scholars inspect only from the perspective of R & D costs, but using R & D costs and R & D personnel (usually the quantity of scientists and engineers engaged in research) two indicators is still occupying the mainstream. Innovation output quantitative index have a development process, due to the close relationship with innovation, data accessible, and slowly, the patent standard is objective, slowly changeable, since 1970s patent as a measure of innovation output level index has been widely applied. In recent years, along with people' further understanding of innovation process, relevant research has gradually involved in the education and training of enterprise R & D personnel, innovation strategy, R & D institution and intellectual property rights management, etc. But the discussion of impact factors of independent innovation ability of Innovative pilot enterprise is still relatively lacking, the research that combining with the enterprise regional characteristics is also rare. So, it provides a good study space for this paper.

Usually, the independent innovation capability of enterprise mainly studies whether enterprise achieves a breakthrough in core technology and obtains independent intellectual property rights. Because patents are the most important and intuitive intellectual property products, they are often used to measure innovation capacity. Therefore, this paper emphasized on discussing the significant impact factors of independent innovation output (especially patent).

2 The Inner Impact Factors' Selection and Data Source of Enterprises Independent Innovation

2.1 The inner impact factors' selection

Based on the related research achievements at home and abroad, according to the overall requirements of innovative enterprise, and enterprise development in Fujian province, we absorb two indexes commonly used in traditional research of R&D costs and R&D personnel. Secondly, due to the innovation practice proves that enterprise innovation output not only depends on whether the enterprise R&D personnel, but also depends on the enterprise later input for education and training [1]-[3], because

only the human capital increase to a higher level of innovation can produce positive effects [4]. At present, the elasticity of scientific research personnel input to innovation output is 1.201[5]. Therefore, we incorporated the worker education, training, learning expenditure indexes into the evaluation system. After that, the development of enterprise independent innovation needs a complete innovation system's support, so enterprise technology R&D institution construction index is indispensable. In addition, the patent output and its growth rate of modern enterprise depend on its innovative management level, especially the feasible intellectual property management system and innovation strategy are the most important [4]. Therefore, this article mainly chose six internal factors for research; there are enterprise R&D input intensity, R&D personnel proportion in enterprise employees, education, training and learning expenses proportion in main business gross income, the construction condition of enterprise technology R&D institution, intellectual property management system, and innovation development strategy.

2.2 Data source

Table 1 Regional Data of Innovative Pilot Enterprises in Fujian Province

Region	Enterprise quantity	R&D input intensity	R&D personnel proportion in employed person	Staff educational expenditure proportion in main business income	Technology R&D institution	Intellectual property management system	Innovation development strategy	Authorized patent quantity of One thousand researchers
Fuzhou	21	9.09	28.79	0.61	98.30	5.95	6.90	271.76
Putian	3	4.07	21.33	0.97	104.53	5.67	7.00	99.47
Quanzhou	8	4.48	11.19	0.76	104.08	6.13	6.50	409.76
Sanming	10	4.65	19.32	2.05	122.76	5.30	7.00	191.67
Nanping	6	4.84	16.33	0.14	52.52	5.67	7.50	149.42
Longyan	3	4.00	20.10	0.10	70.93	6.00	7.33	156.17
Zhangzhou	4	4.44	14.23	0.22	103.38	7.25	7.75	677.93
Ningde	4	4.85	13.31	0.45	121.15	7.75	6.75	461.75
Xiamen	2	3.13	12.25	0.10	72.20	7.00	7.00	118.75

This paper takes the first pilot enterprise in Fujian province as research samples, including Fuzhou (21), Putian (3), Quanzhou (8), Sanming (10), Nanping (4), Longyan (3), Zhangzhou (4), Ningde (4), and Xiamen (2). The sample data mainly comes from the first batch of 61 innovative pilot enterprises' "innovative enterprise self-evaluation report" that jointly collected by the federation of Fujian Provincial Science and Technology Department, Economic and Trade Commission, the SASAC, trade unions (not including the commentary on the state-level innovation-oriented enterprises, and those have been included or recommended by the national pilot innovative enterprise). Since this paper mainly verified the independent innovation situation of these companies after two years' pilot period, therefore this paper also uses the annual examination data for research (i.e. the 2008). (Table 1).

3 Model Establishments

3.1 The establishment of preliminary multiple linear regression model

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu$$

Y: the authorized patent quantity of one thousand researchers
X1: R&D input intensity (%)
X2: R&D personnel proportion in employed person (%)
X3: Staff educational expenditure proportion in main business income (%)
X4: the construction condition of enterprise technology R&D institution (qualitative index)
X5: the construction condition of intellectual property management system (qualitative index)
X6: the construction condition of innovation development strategy (qualitative index)

3.2 Parameter estimation (Table 2)

Table 2 Preliminary OLS Estimation

Source	SS	df	MS	Number of obs =	9
				F(6, 2) =	14.50
Model	300135.799	6	50022.6331	Prob > F =	0.0659
Residual	6900.23137	2	3450.11569	R-squared =	0.9775
				Adj R-squared =	0.9101
Total	307036.03	8	38379.5038	Root MSE =	58.738

y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
x1	83.55132	20.94913	3.99	0.057	-6.58552	173.6882
x2	-36.34711	7.509381	-4.84	0.040	-68.65737	-4.036846
x3	-329.7366	111.6521	-2.95	0.098	-810.1369	150.6636
x4	11.9605	2.627263	4.55	0.045	.656295	23.2647
x5	-143.2189	71.98822	-1.99	0.185	-452.9592	166.5214
x6	304.63	65.57469	4.65	0.043	22.48489	586.7751
_cons	-1675.53	563.6638	-2.97	0.097	-4100.779	749.7202

Using OLS estimation, the model is:

$$\hat{Y} = -1675.53 + 83.55X_1 - 36.35X_2 - 329.74X_3 + 11.96X_4 - 143.22X_5 + 304.63X_6$$

3.3 Model test

3.3.1 Economic sense test

Preliminary estimation result shows that R&D input intensity (X1), the construction condition of enterprise technology R&D institution(X4) and the construction condition of innovation development strategy (X6) have positive influence on the authorized patent quantity of One thousand researchers (Y), and the effect is significant, the results accord with economic sense. But the parameters of R&D personnel proportion in employed person (X2), staff educational expenditure proportion in main business income (X3) and the construction condition of intellectual property management system (X5) are negative, they don't accord with economic sense. May be caused by the multi-co linearity, thus we should carry on further analysis and test.

3.3.2 Statistical test

From the results, it can be seen that the R-squared is 0.9775, means the whole model fits very well. In a given level of α=0.05, the value of t-statistic of explanatory variables X1, X4 and X6 are respectively higher than its critical value, means that their influence on dependent variable is significant. But the other variables are not passed t-test, analyzed it may be due to the multi-co linearity between variables; we should carry on further analysis and test.

3.4 Model Updating

Through the calculation, we can see that the mean variance inflation factor is higher than 1. Means there are existing multi-co linearity between explanatory variables. We used OLS method carry on simple linear regression for Y to X1, X2, X3, X4, X5 and X6 respectively. The regression results are in Table.3. Combining economic significance and the statistical test, we got the linear regression equation with the best fitting effect.

Table 3 The Result of Simple Linear Regression

variable	X1	X2	X3	X4	X5	X6
Parameter Estimation	13.08	-12.64	-47.04	3.75	150.10	68.35
t-statistic	0.30	-1.02	-0.40	1.37	2.19	0.36
R-squared	0.0126	0.1296	0.0226	0.2109	0.4064	0.0180

R-squared from high to low is X5, X4, X2, X3, X6, X1. We took $\hat{Y} = -663.95 + 150.10X_5$ as preliminary model, based on X5, and used stepwise regression, sequential adding other variables to regress. Finally, we got the updated model: $\hat{Y} = -2457.63 + 22.57X_1 + 4.11X_4 + 136.17X_5 + 195.45X_6$

3.5 Results

From the multiple regression model, we found that keeping other factors unchanged, the elastic of authorized patent of one thousand researchers of innovative enterprises in Fujian province of R&D input intensity, the construction condition of enterprise technology R&D institution, intellectual property management system, and innovation development strategy are 22.57,4.11,136.17 and 195.45, it means these four factors have significant influence on enterprise independent innovation, and the most significant impact factor is the construction condition of innovation development strategy. The influence of R&D personnel proportion in employed person (X2) and Staff educational expenditure proportion in

main business income (X3) is not significant. Maybe is because we take authorized patent of one thousand researchers as output index, this index involved R&D personnel of enterprise.

4 The Comparative Analysis of Regional Innovative Pilot Enterprise

We classify the innovative pilot enterprises by different region, use the same method, analysis the differences of enterprise independent innovation inner impact factors in different areas. Some areas research samples are too little, can't do separate analysis, so we classify them into one kind. To save space, this paper omitting the calculation process, only provides the results for analysis. (Table 4).

The results revealed the most significant factor of innovative pilot enterprise in Quanzhou and Sanming, the most significant factor is R&D input intensity. In Nanping the factor is the construction condition of innovation development strategy. As in Fuzhou and the rest areas, the factor is the construction condition of intellectual property management system. Although these factors are different, the main impact factors have no big difference. This matches the analysis results of overall enterprises.

Table 4 The Comparative Analysis Results of Regional Innovative Pilot Enterprise

region \ Impact factor		X_1	X_2	X_3	X_4	X_5	X_6	Statistic test
Fuzhou	Beta	5.606	-8.320	44.360	1.437	154.047	-39.977	F=1.76 R^2=0.430
	t	0.37	-0.91	0.38	0.80	2.98	-0.31	
	P>|t|	0.718	0.377	0.711	0.439	0.010	0.763	
Quanzhou	Beta	439.823	-63.296	-250.098	2.075	343.200	391.486	F=81.42 R^2=0.998
	t	5.35	-6.91	-12.54	5.46	12.59	6.77	
	P>|t|	0.118	0.092	0.051	0.115	0.050	0.093	
Sanming	Beta	156.408	-14.187	-22.885	-0.883	138.099	85.653	F=5.41 R^2=0.9153
	t	0.78	-1.40	-1.12	-0.38	3.53	0.21	
	P>|t|	0.490	0.255	0.345	0.728	0.039	0.844	
Nanping	Beta	-8.300	-0.177	-0.04	3.537	59.884	112.550	F=52.42 R^2=0.995
	t	-1.23	-2.00	-0.31	12.55	4.48	3.05	
	P>|t|	0.435	0.047	0.757	0.051	0.140	0.202	
Other regions	Beta	34.448	-1.584	-93.878	-0.943	190.470	37.905	F=1.46 R^2=0.494
	t	0.28	-0.11	-0.41	-0.54	2.36	0.29	
	P>|t|	0.782	0.912	0.693	0.600	0.043	0.782	

5 Conclusions

Based on the subject of the first batch of innovative pilot enterprise evaluation data in Fujian province, this paper focused on the empirical analysis of the main inner impact factors of enterprise independent innovation, and we has explored and analyzed the differences of inner impact factors in different areas. But the sample size of the first batch of enterprises is not big enough, especially, in some areas, there are only two or three enterprises, maybe it will have some influence on the results of quantitative research results. Through our research, we figured out the main inner impact factors of innovative pilot enterprises independent innovation in Fujian province. This will helpful to promote the enterprise to establish and perfect the internal mechanism for independent innovation. It also can provide important reference for government to guide and control enterprise technology innovation activities, and further development of innovative pilot enterprise work.

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