An Empirical Study on the Impact of Patent Policy on Enterprise Technological Innovation

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Abstract—The funding and protection of patents in the national patent policy is a major incentive for enterprises to carry out technological innovation. Based on the data of the National Bureau of statistics from 2001 to 2020, this paper makes an empirical analysis on the impact of patent funding and protection policies on enterprise technological innovation. In this paper, the time series data are used to pass the unit root test and cointegration test, and the regression results and conclusions are obtained by using the error correction model. Government funding has an obvious positive correlation effect on the generation of patents, and it has an incentive effect on improving the innovation performance of enterprises; while the government protection policy has strengthened the investigation and handling of patent infringement cases, and the practice of increasing patent protection is affected by internal factors and the complexity of the patent market. The impact of this policy did not produce a good policy effect.

Keywords—patent funding, patent protection, technological innovation, error correction model

1 INTRODUCTION

In the area of knowledge economy, intellectual property, as a strategic resource for an enterprise or even a country to improve its core competitiveness, has played an unprecedentedly important position. [1] As the core part of intellectual property rights, patent rights are widely valued due to their exclusiveness and exclusivity. Since my country put forward the innovation-driven strategy, it has triggered an upsurge of "innovation and entrepreneurship", and many enterprises have used the number of patents as a quantitative indicator to measure the level of enterprise innovation. China's related patent policies and systems have gradually improved and developed, and to a certain extent have played a role in encouraging innovation and stimulating economic development.

In the study of patent protection policies, early scholars believed that intellectual property protection policies had an incentive effect on technological innovation [2], and Wu Xinwang (2006) showed that the enthusiasm of enterprise innovation was weakened by the enhancement of patent protection [3]. In the research on patent funding and creation policies, Yao Weimin (2021) believe that the government funding policy has a positive effect on scientific and technological R&D investment as a whole, but has no direct impact on the

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output of innovative R&D. [4] Lin Zhouyu (2015) pointed out that government subsidies have a U-shaped relationship with the output of corporate patents, that is, government subsidies that exceed a certain value will have a restraining effect. [5] In addition, Gu Xiaoyan (2021) believe that strengthening intellectual property protection has a more high-quality technological innovation development bias. Under the protection of the patent system and patent standards, compared with the social optimum, companies will be in the consideration of maximizing their own profits and choose low-risk innovative research, leading to the reuse of social resources. [6]

It can be seen that the existing research does not have a unified conclusion on the relationship between patent policy and technological innovation, and different patent policies have different effects on the technological innovation of enterprises. The effect of patent policy remains to be tested, and it has also triggered thinking about the rationality of government patent subsidy protection and policies.

2 THEORETICAL ANALYSIS

According to the capabilities of patent policies, China's current patent policies can be roughly divided into four types: creation, application, protection and management. Among them, the application and management policies can be further refined into patent quality, service, conversion, funding, etc. This article mainly starts from the patent funding policy and patent protection policy.

Patent funding mainly includes subsidies for maintenance costs and patent applications; competitive advantages and patent rewards resulting from qualification assessment; tax incentives and tax refunds based on patent ownership. [7], while patent protection focuses on handling patent infringement disputes and investigating counterfeit patent behaviors. [8] The government's patent funding to enterprises can be measured by government R&D investment funding, but whether the technological level of the enterprise can be improved depends on the size of its incentive effect and whether the enterprise can properly and rationally use R&D funding. [9] The domestic patent protection implements a "dual-track system", using judicial and administrative means to jointly develop patent protection. [10]

In 2000, the state revised the Patent Law for the second time. In 2008, my country implemented an intellectual property strategy. In 2020, my country revised the Patent Law for the fourth time to further strengthen patent funding and protection. In the past two decades, the number of patent applications and patent grants in my country has increased sharply. This article selects data on patent grants and government R&D investment funds from the National Bureau of Statistics from 2001 to 2020, and uses data from Peking University’s magic weapon patent ownership infringement disputes to compare patent policies. Do an empirical analysis of the effect of corporate technological innovation.

3 EMPIRICAL ANALYSIS

3.1 Research methods

3.1.1 Literature review method

Through consulting and searching papers, books and news related to patent policy and technological innovation, and analyzing and discussing them, we absorb the essence of previous research results and improve their shortcomings, forming the thinking method of this article.

3.1.2 Empirical Research Method

Empirically analyze the impact of different patent policies on innovation based on hypothetical models, draw corresponding conclusions and design optimized paths.

3.2 Index evaluation system

For the study of patent policy, the number of annual research and experimental development personnel is selected, and the government fund expenditures for research and experimental development, and patent ownership infringement disputes are used as indicators to measure the intensity of patent funding, creation, and protection policies. Use the number of patent applications granted to measure enterprise technological innovation.

Table1 Index Evaluation System

First-level index	Secondary indicators	unit
Patent policy	Full-time equivalent of research and experimental development personnel (x1)	10-thousand
	Research and experimental development government funding expenditure (x2)	100 million
	Patent right infringement disputes (x3)	Pieces
Technological-innovation	Number of patent applications granted (y)	item

3.3 Descriptive Statistics

Statistical analysis of the relevant data from 2001 to 2020, due to the different indicator units of the variables, the logarithm of the time series is used to reduce the scale of the variables to alleviate the impact of heteroscedasticity, obtain statistical description results, and eliminate outliers.

Table2 Descriptive Statistics

	LNY	LNX1	LNX2	LNX3
Mean	13.43972	5.479807	7.300103	7.85128
Median	13.69298	5.603416	7.488405	7.663813
Maximum	15.10722	6.232821	8.473701	9.855295

Minimum	11.64615	4.560696	5.733665	5.049856
Observations	20	20	20	20

3.4 Correlation analysis

Correlation analysis of the variables, it can be observed that the correlation coefficients of LNY and LNX1, LNX2, and LNX3 are all above 0.9, and there is a significant correlation.

Table3 Correlation coefficient matrix

	LNY	LNX1	LNX2	LNX3
LNY	1			
LNX1	0.995563575	1		
LNX2	0.996371364	0.997685168	1	
LNX3	0.935348346	0.93653471	0.951059475	1

3.5 Unit root test

This paper selects the time series. In order to avoid the pseudo-regression phenomenon in the regression equation, the unit root test is performed before the analysis to select stable variables for regression.[11] Here, the ADF test method is selected, based on the AIC value, SC value, HQ The minimum value criterion is used to judge.

Table 4 Unit root test

variable	(C, T, K)	ADF value	T value	P value	result
LNY	(C,T,4)	-3.3623	-3.7332	0.0921	smooth***
LNX1	(C,T,4)	-1.900038	-3.710482	0.6106	unstable
LNX2	(C,T,4)	-3.562697	-3.02997	0.0174	smooth**
LNX3	(C,T,4)	-3.704102	-3.759743	0.0548	smooth***
DLNY	(C,T,4)	-4.536152	-3.040391	0.0025	smooth**
DLNX1	(C,T,4)	-3.400999	-3.7332	0.0865	smooth***
DLNX2	(C,T,4)	-4.297889	-3.690814	0.0166	smooth**
DLNX3	(C,T,4)	-3.21813	-3.040391	0.0356	smooth**

(Note: D represents the first difference of the variable, ** represents the rejection of the null hypothesis at the 5% significance level. *** indicates that the null hypothesis is rejected at the significance level of 10%)

The original sequence LNX1 is not stationary, and both LNY and LNX3 are stable at the 10% significance level. Therefore, the first-order difference sequence is performed to obtain the first-order difference sequence of LNY, LNX2, and LNX3 that is stable at the 5% significance level. LNX1 The first-order difference sequence of is stable at the 10% significance level. In order to analyze the co-integration relationship of the same-order difference sequence, the co-integration test is performed below.

3.6 Cointegration test

Table 5 Cointegration test

variable	ADF value	T value	P value	result
ecm	-4.365414	-1.960171	0.0002	pass through

Since the VAR model is not selected in this article, the E-G two-step method is used to test the residual sequence. The ad oint probability 0.0002 is obtained, and it is considered that the residual sequence does not contain unit roots. A stable residual sequence means that there is a co-integration relationship between LNY and LNX, that is, a long-term stable equilibrium relationship between variables, so the error correction model regression analysis is performed.

3.7 Error correction model

Table 6 Error correction model test regression results

Variable	Coefficient	Std. Error	t-Statistic	prob.*
ECM (-1)	-1.148921	0.270856	-4.241817	.0007
C	0.070352	0.05088	1.38269	.187
DINX2	0.880347	0.304984	2.886537	.0113
DINX3	-0.112593	0.060696	-1.855023	.0834

R-squared	0.669886	Mean dependent var	0.182161
Adjusted R-squared	0.603863	S.D.dependent var	0.122943
S.E.of regression	0.07738	Akaike info criterion	-2.095519
Sum squared resid	0.089814	Schwarz criterion	-1.89669
Log likelihood	23.90743	Hannan-Quinn criter.	-2.06187
Prob(F-statistic)	0.00067		

In order to eliminate multicollinearity, stepwise regression analysis was performed on the model at the 10% significance level. The DINX1 P value was greater than 0.1, so DINX1 was eliminated, and the linear regression equation was obtained:

$$\Delta lny_t=0.070352+0.880347\Delta lnx_2-0.112593\Delta lnx_3-1.148921e_t-1$$

$$t = \quad (2.886537) \quad (-1.855023) \quad (-4.241817)$$

3.8 Model checking

Table 7 Test of heteroscedasticity and serial correlation

Heteroskedasticity Test: White			
F-statistic	2.133551	Prob. F(9,9)	0.1372
Obs*R-squared	12.93659	Prob. Chi-Square(9)	0.1655
Scaled explained SS	8.116665	Prob. Chi-Square(9)	0.5224
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.195265	Prob. F(2,13)	0.8250
Obs*R-squared	0.554127	Prob. Chi-Square(2)	0.7580

The model P value is 0.0067, which is less than 0.05. The model test result is significant, and there is no heteroscedasticity and autocorrelation. The model can better explain the relationship between the increase in the amount of patent grants, government funding expenditures for research and experimental development, and patent ownership infringement disputes.

4 CONCLUSION

Through the empirical analysis of the error correction model, the following research conclusions are drawn:

Government R&D investment as a quantitative indicator of government patent funding policy has a significant positive correlation with the growth of patent grants. Companies with government subsidies and funding are more likely to carry out research and innovation activities, and to improve and innovate products and technologies through R&D investment.

This article uses patent ownership infringement disputes to quantify government patent protection policies, and there is no obvious positive correlation between patent protection policies and patent grants. In the process of continuous improvement of the country's rule of law and continuous strengthening of the protection of intellectual property rights, patent infringement cases have been increasing year by year. On the one hand, it shows the strengthening of national patent protection, and on the other hand, it has become one of the main crises in the development of enterprises in the era of knowledge economy in my country. Investigating the reason, this article believes that government policies are affected by internal factors of enterprises and the complexity of the patent market. The country still needs to implement more specific, detailed and practical policies to protect patent rights and maintain the order of the patent market.

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