

Research on the Relationship Between Patent Commonality and Firm Performance

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ABSTRACT: In the face of such a vast treasure house of patent information, many scholars have measured the characteristics of corporate patents from different angles, but these characteristics often focus on enterprises or individual technology systems, ignoring the industrial technology knowledge system as a whole, and ignoring the important dimension of "patent commonality". It can be said that improving the commonality of patented technological innovation and improving the quality of patented technology is a long-term driving force for economic development and social progress, and undertakes the historical mission of high-quality national development. Therefore, starting from the important dimension of patent commonality, this paper conducts an empirical analysis of the relationship between patent commonality and enterprise performance of 335 listed companies from 2009 to 2019, and examines the mechanism of differential influence of different patent characteristics on enterprise performance. The results of the study find that: (1) patent commonality is an inverted U-shaped relationship between firm performance; and (2) academic background plays a positive role in regulating patent commonality and firm performance.

Keywords: patent commonality, firm performance, academic background

1 INTRODUCTION

According to a report released by the World Knowledge Product Organization in 2019, the number of patents filed in China in 2018 reached 1.542 million, reaching half of the global total. In this huge number of patents, there is a large number of "patent bubbles", whether the quantitative growth can bring about a substantial improvement in the technological innovation ability of enterprises and the growth of economic benefits, has become a hot spot of attention of the government and academia, so the quality of patents has received more and more attention^[1]. China currently has a large number of patents, but in this huge number of patents, how many patents are made up, which has no effect on the concept of science and technology and the industry? We do not know that in order to accelerate the transformation and digitization process of China's technology industry^[2], maintaining the high quality of patents is the key to maintaining the core competitiveness of enterprises and even the country.

Patent commonality refers to a type of basic grasp technology that can be shared, shared and can be followed by differentiated application research and development in the industrial technology system, and such technology can enable enterprises to quickly obtain economic

benefits and form iterative and synergistic empowerment effects on industrial development^[3]. Therefore, in addition to the two perspectives of patent quantity and patent quality, which can evaluate the patent level of enterprises, this paper proposes a new research angle - patent commonality: borrowing from the common technology in industrial technology to evaluate the patent level of enterprises, and patent commonality is to evaluate patents from the perspective of commonality of industrial knowledge systems^[4]. At present, there are still deficiencies in the research on patent commonality and patent quality, and there is still a lack of research on the relationship between patent commonality and enterprise performance.

On the basis of the existing research, combined with the actual situation of listed enterprises in China, taking the patent information data as the breakthrough point, taking the common value and quality value of patents as the entry point, and considering the academic background of the management personnel of the enterprise and the multiple internal and external influences of the enterprise^[5], this paper selects the panel data of a total of 355 listed enterprises from 2009 to 2019 as a research sample, and deeply analyzes the relationship between the commonality of enterprise patents and the performance of enterprises. The academic background of senior executives is introduced as a moderating variable, with the aim of enriching empirical research on patent commonalities, and hoping to draw conclusions that can theoretically support enterprises to carry out patent research and invention activities or find ways to improve corporate performance from the perspective of corporate patents.

2 THEORETICAL BASIS AND RESEARCH ASSUMPTIONS

2.1 The impact of patent commonalities on firm performance

At present, there is no unified definition of patent commonality in the academia, mainly from the two aspects of the research and development of patent commonality or the scope of its technical impact^[6]. In 1990, the U.S. government defined patent commonality for the first time: general technology or process with a high degree of potential for diffusion to other industries is called patent commonality. In 1991, Tasseey divided the research and development of patent technology into different stages, the first stage of research is called is the study of patent commonality, reducing technical risks and improving technical benefits are the starting point of the research on patent commonality, in order to provide scientific and technological support^[7]. In addition to improving the technical capability of a single enterprise, patent commonality can also add up and improve the competitive advantage of the whole industry. Based on this, the definition of patent commonality is given, which is generally applicable to most fields, commonality and openness are the two manifestations of the importance of patent commonality^[8].

When the commonality of enterprise patents is at the middle and lower levels, the improvement of patent commonality can reduce the risk of patent technology application and market risk. Since patent commonality has incentive, correlation and demonstration effects and is shared and used in the same industry or even across industries, it plays an important role in reducing the risk of patented technology application and market risk, which is reflected in the improvement of enterprise performance.

First, the improvement of patent commonality can improve the industrial radiation driving ability of enterprises. Generic technology is a basic technology that can be used in the same industry or even across industries, when the enterprise develops a generic patent with a relatively high scientific and technological content, it has a strong radiation and driving ability^[9], which can make the enterprise become a small technology center of the industry, so as to have more resources and partners and make the research process of the enterprise more smooth, So as to reflect the improvement of firm performance.

Second, the improvement of patent commonality can send investment signals to the capital market. Patent research and development as a very important intellectual property rights, is one of the factors that investors pay more attention to when investing, the improvement of corporate patent commonality, can send a positive investment signal to the capital market, so that the company's stock price rises and obtains more external investment, the cost of using the company's funds is lower, which is reflected in the improvement of corporate performance^[10].

The above two points have a more significant impact on the commonality of patents when they are at the middle and lower levels, and the commonality of patents has a positive impact on the performance of enterprises, but with the increase of patent commonality, the positive impact on enterprise performance is getting weaker and weaker, the marginal benefits are decreasing, and when the commonality of patents reaches a certain value, the impact value on enterprise performance is the largest.

Firstly, When the commonality of enterprise patents is at the middle and upper levels, when the commonality of patents continues to increase, the research and development costs of enterprises will increase. Because the enterprise is a rational enterprise, the pursuit of profit maximization^[11], only when the research and development cost is less than the benefit, the enterprise will carry out research activities, when the patent commonality continues to increase, the company's technology has been ahead of the industry average, at this stage, the enterprise in order to develop new technologies need to pay more financial, human, material resources, will lead to R & D costs greater than the target patent to obtain the benefits, in such a case, the performance of the enterprise will be reduced.

Secondly, When the commonality of patents continues to increase, the R&D risks of enterprises will be more. Patent R&D and technological innovation due to the long R&D cycle and high failure rate, so in the continued research and development of patent commonality, it will face greater technical application risks and market risks^[12]. Once the R&D fails or the technology is not suitable for the existing market, it will cause a lot of research costs and efforts to be wasted, resulting in a decline in the performance of the enterprise.

Therefore, in the process of patent commonality continuing to increase, it will have a negative impact on the performance of enterprises in the opposite direction, and the performance of enterprises will be reduced. Based on the above, this article proposes the following assumptions:

Hypothesis 1: Patent commonality and firm performance have an inverted U-shaped relationship.

2.2 The moderating role of academic background

The academic background of senior executives in this paper refers to the academic experience of senior executives who have taught in colleges and universities, engaged in research in associations and scientific research institutions. The nature of their work has been related to scientific research.

First, the higher the academic background of executives, the higher the innovation ability of the company. Academic background executives contribute to corporate innovation, and academic background executives will make the company have higher risk tolerance and lower management shortsightedness, which can promote corporate innovation^[13]. Moreover, studies have shown that people who have experienced academic training will form an academic thinking. When making decisions, they will think and analyze independently according to their own experience and ability^[14]. Therefore, executives with academic background will provide a different academic problem-solving direction from non-academic executives. Proposing different solutions to reduce the technical and market risks of patents can help enterprises improve the impact of patent commonality and firm performance.

On the other hand, the higher the academic background of the executive, the higher the economic and technical effect of the company. The academic experience of executives can not only improve their knowledge reserves and capabilities, but also give them a certain amount of social resources^[15], have more channels, and information that others cannot access, these social resources can make them reduce transaction costs in business activities and decision-making, thereby improving the economic and technological effects of enterprises and improving the marketing of common technologies for enterprise performance. Therefore, the academic background of executives is an important way for patent commonality to affect corporate performance. Based on the above, this article proposes the following assumptions:

Hypothesis 2: An executive's academic background plays a positive role in regulating patent commonality and firm performance.

3 METHOD

3.1 Data collection

The financial data for this article is from the CSMAR database, which provides patent data for all sample companies. In the end, 335 companies with complete patent and financial data were collated for a total of 10 years from 2009 to 2019. A total of 14 variables in 335 samples form non-equilibrium panel data.

3.2 Variable definition and measurement

3.2.1 Explanatory variable: Business performance (Tobin Q)

This paper is interpreted as a variable for enterprise performance, because Tobin Q is the relative ratio of the market value of the enterprise to the replacement cost, representing the market's expectation of the long-term change trend of enterprise performance, so this study uses the Tobin Q value to represent the performance of the enterprise.

3.2.2 Explanatory variables: Patent Commonality (Tg)

This paper uses patent data from the Derwent database to measure patent commonality, and with respect to the method of measuring patent commonality, we use Ardito's formula for calculating the Herfindahl index^[16], which measures the diversity of technical fields of those specialties that cite a focal patent. The principle behind this index is that the higher the diversity of the technical fields in which the patent is granted, the higher the technical versatility of the target profession, and conversely^[17], if the citation patent focuses on a few technical fields, the target patent has a lower technical versatility.

$$Tg = \frac{F_p}{F_p - 1} \left[1 - \sum \left(\frac{F_{ip}}{F_p} \right)^2 \right] \quad (1)$$

In formula (1), F_p is the number of all forward citations of the target patent, and F_{ip} is the number of times the target patent has been cited in the United States three-digit patent classification number (large class) i . The Herfindahl index of an enterprise in that year can be aggregated from the Herfindahl index of these specific patents in that year.

3.2.3 Moderating Variable: Executive Academic Background (Ab)

This variable is downloaded from the Number of executives with academic background field in the Cathay Pacific database, and those with the following experience are called people with academic background 1, university teaching 2, scientific research institutions 3, associations engaged in research, and then the number of executives with academic backgrounds is calculated.

3.2.4 Control variables

Based on the existing research, in order to reduce the influence of other variables on the research model in this paper, the following variables are controlled in this paper. (1) Cumulative digitization (Di). (2) Breadth of cooperation (Bc). (3) Z index (Z). (4) Current ratio (Cr). (5) Earnings per share (Eps)^[18]. (6) Capital intensity (Ci)^[19](Chang & Sun, 2009). (7) Financial leverage (Fl)^[20](Chatterjee & Wernerfelt, 1991). (8) Equity concentration (Oc). (9) Return on equity (Rona). (10) Number of employees (Noe).

4 RESULTS AND ANALYSIS

4.1 Descriptive statistical analysis

The results of the descriptive statistics are shown in the following table 1. The average value of the patent commonality of enterprises is only 0.5203, indicating that the patent commonality of most enterprises is not high, and the standard deviation is small, indicating that the patent commonality between enterprises is not ideal, so that the development of patent commonality is slow. It shows that the current situation of enterprise research technology is the lack of patent commonality.

4.2 Correlation testing

See the correlation test results in the table 1. Patent commonalities are negatively correlated with firm performance, significantly correlated at the 1% level. Academic background and firm performance are positively correlated, significantly correlated at the 1% level, with a correlation coefficient of 0.042. However, after the control variables are added, further regression analysis is needed to verify whether these assumptions hold.

4.3 Regression analysis results

The way this paper deals with the performance of the dependent variable is to take a lag of one period^[21], that is, one year. At the same time, the interaction terms are decentralized to prevent multicollinearity problems between variables. The regression analysis results are shown in the following table 2. Each model passed the significance test.

In the following table 2, Model 1 is the relationship between control variables and enterprise performance, and Model 2 adds two terms of patent commonality. From the data, we can see that the correlation between the two items of patent commonality and enterprise performance is negative, and it is significantly correlated at the level of 0.05, and the one-time item of patent commonality is related to enterprise performance. The correlation is positive and significantly correlated at the level of 0.05, indicating that there is an inverted U-shaped relationship between the two, and with the increase of patent commonality, the performance of enterprises shows a parabolic change. First rise to the maximum value and then decline, that is, when the commonality of patents changes to a certain value, the performance of the enterprise will reach the highest. So, suppose 1 is supported.

Table 1: Descriptive statistical results

	mean	stand ard deviat ion	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Tobinq	2.323 023	1.615 816	1												
2. Tg	.5203 684	.3123 075	- 0.121 ***	1											
3. Ab	4.249 335	2.776 32	0.042 ***	0.033 *	1										
4. Di	133.8 295	232.9 337	- 0.019 0	0.057 ***	0.010 0	1									
5. Bc	1.556 879	3.798 087	- 0.086 ***	0.110 ***	0.100 ***	0.041 **	1								
6. Z	8.598 177	15.95 074	- 0.032 **	0.069 ***	- 0.012 0	- 0.068 ***	0.122 ***	1							
7. Eps	.3824 792	.5595 53	0.072 ***	- 0.030 *	0.084 ***	- 0.048 ***	0.091 ***	- 0.005 00	1						
8. C	2.310 926	2.067 091	- 0.062 ***	0	- 0.036 **	- 0.037 **	- 0.056 ***	- 0.080 ***	- 0.187 ***	1					
9. FI	1.440 405	2.131 087	- 0.088 ***	0.041 **	0.010 0	- 0.039 **	0.004 00	0.019 0	- 0.141 ***	0.059 ***	1				
10. Oc	31.74 672	13.85 74	- 0.063 ***	0.063 ***	0.033 **	- 0.183 ***	0.093 ***	0.431 ***	0.190 ***	0.089 ***	0.045 ***	1			
11. Rona	.0633 6	.2524 515	0.088 ***	- 0.014 0	0.025 *	- 0.013 0	0.035 **	- 0.007 00	0.399 ***	- 0.105 ***	- 0.086 ***	0.041 ***	1		

12.	5294.	12244	-	0.119	0.056	0.023	0.269	0.093	0.178	-	0.104	0.046	0.162	0.02	1
Noe	198	.95	0.131 ***	***	***	0	***	***	***	0.104 ***	***	***	***	5*	
13.	3.017	4.930	0.059	-	0.011	-	-	-	0.095	0.139	-	-	0.02	-	1
Cr	085	478	***	0.148 ***	0	0.069 ***	0.054 ***	0.074 ***	***	***	0.095 ***	0.007 00	6*	0.10 7***	

Note: ***, **, and * indicate that the double-tailed t-test values are statistically significant at the 1%, 5%, and 10% levels, respectively

As shown in the table 2, Model 3 is a regression model that incorporates the academic background of the regulatory variables and the interaction terms of the academic background and the independent variables. It can be found that the correlation coefficient between the interaction term of the academic background and the performance of the enterprise is negative, and it has passed the 5% significance level test. The correlation coefficient between the square interaction term and the performance of the enterprise in the academic background is positive, and it has passed the 10% significance level test. It shows that the academic background has a tuning effect, and the regulatory role of the academic background is that the inverted U-shaped relationship between patent commonality and enterprise performance will be enhanced. That is, the smaller the academic background, the less the impact of patent commonalities on the performance of the enterprise. So, hypothesis 2 is supported.

Table 2: The overall regression results

		(1)	(2)	(3)
VARIABLES		F1_Tobinq	F1_Tobinq	F1_Tobinq
Explanatory variables	Tg		0.914**	0.746*
	Tg ²		-0.932**	-0.981**
	Tq			
Adjust variables	Off			0.029
Adjust variable interaction items	i			
	I			-0.098*
	I ²			0.031**
Control variables	Of	-0.001***	-0.001***	-0.001***
	Bc	-0.019*	-0.019*	-0.019*
	Oc	0.000	0.000	-0.001
	With	0.001	0.001	0.002
	Eps	-0.375**	-0.355**	-0.374***
	C	-0.039	-0.039	-0.040
	Fl	0.004	0.004	0.004
	Rona	4.548***	3.948***	4.018***
	Something	0.000	0.000	0.000
	Cr	-0.041***	-0.041***	-0.042***
constant	Constant	2.565***	2.526***	2.538***
	Observations	1,937	1,937	1,937
	R-squared	0.056	0.054	0.059
	N	335	335	335
	r ² _a	0.0457	0.0479	0.0518
	F	4.975	4.855	4.491

Note: *. significantly correlated at the 0.1 level (bilateral); **. significantly correlated at the 0.05 level (bilateral); ***. significantly correlated at the 0.01 level (bilateral).

4.4 Robustness testing

In order to avoid the possibility of chance in the empirical study, and to ensure that the conclusions of the study are valid and reliable, the robustness test of the main model and the regulatory effect is carried out. In this paper, three robustness test methods are selected: increment and decrease control variables, different measurement methods of the same variable, and tailing processing. The results show that the significance level and correlation coefficient of the main effect and the regulatory effect have not changed substantially, which proves that the conclusions of this paper have good robustness.

5 CONCLUSIONS

5.1 Main conclusions

Through the study of the impact of patent commonality, patent quality and enterprise performance of listed enterprises, this paper draws the following conclusions:

First, there is a significant inverted U-shaped relationship between patent commonality and corporate performance. In the early stage of research and development, when the patent commonality of enterprises slowly increases, because the patent commonality has incentive, correlation and demonstration effects to achieve the same industry and even cross-industry use, and has the effect of reducing technical risks and market risks, has better market response, and transmits investment information to the capital market, increases stock prices and increases external investment, reduces financial costs, and thus helps enterprises improve performance [22]. However, in the middle and late stage of research and development, when the patent commonality is ahead of the industry average, the enterprise needs more costs to continue technology research and development, and the research and development partners will be reduced, and the benefits brought by research and development will be less than the research and development costs, resulting in the performance of the enterprise will decline in the process of rising patent commonality.

Second, the academic background has a regulatory effect on patent commonality, patent quality and enterprise performance. Academic background positively regulates the relationship between patent commonality and firm performance. This is because executives with academic backgrounds not only have more excellent personal characteristics, can ensure the efficiency and results of technological innovation in research and development activities, but also because they have more social resources, can reduce the cost of all aspects of the enterprise in the process of technology research and development, because executives with academic backgrounds can provide an academic solution to the problem, in the technology research and development decision-making, will be considered more comprehensively, so that enterprises can create more excellent performance. As a result, the academic background makes the commonality of patents more significant in the positive role of enterprise performance.

5.2 Management implications

The following aspects are the main management implications of this article. First, when conducting patent research and development, enterprises can start from the perspective of patent commonality, study patent common technologies, build a platform for enterprise technology

exchanges, and create an innovative atmosphere of patent commonality. Enterprises should improve the overall strategic layout of patents and seek layout in terms of patent commonality, so that enterprises can have the core competitiveness of patent innovation and achieve healthy growth of enterprises.

Second, enterprises can introduce executives with academic backgrounds to reduce the risk of decision-making and operation of enterprises, and executives with academic backgrounds can effectively improve the performance of enterprises brought about by patent commonality.

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