An empirical study on the impact of intellectual property rights on the management performance of companies: focusing on patent rights

Changyong Yang[1], Jung-Wan Hong[2*], Yen-Yoo You[2]
[1]Ph.D. Candidate, Dept. Of Knowledge Service & Consulting, Hansung University
[2]Professor, Dept. Of Knowledge Service & Consulting, Hansung University

지식재산권이 기업의 경영성과에 미치는 영향에 대한 실증연구: 특허권을 중심으로

양창용[1], 홍정완[2*], 유연우[2]
[1]한성대학교 지식&컨설팅학과 박사과정, [2]한성대학교 지식&컨설팅학과 교수

Abstract In previous research, large companies were analyzed to focus on their past management performance and patent rights, but in this study we looked at the variability in future sales of small and medium-sized enterprises with patents through empirical analysis. We looked at how the quantitative and qualitative value of patent rights affect management performance of company. We used 'the number of patents' as the quantitative value of patents, 'the average score of patents' as the qualitative value of patents, and the average sales growth rate as the management performance of company. Through a discriminant analysis using the statistical program SPSS, both independent variables used in this study were significant for distinguishing between companies with an average growth in sales more than twice that of general small and medium-sized enterprises and those with less than twice the average sales growth rate. Therefore it is meaningful to provide stakeholders with an analysis framework on how sales will change in the future using the results of this study during guarantee or loan screening for small and medium-sized enterprises with patent rights.

Key Words : Classification function, Discriminant analysis, Hit ratio, Patent, Sales growth rate, Small and medium-sized enterprise

요 약 그동안은 규모가 큰 기업 위주의 분석과 과거 경영실적과 특허권의 관계위주의 분석을 했으나, 본 연구에서는 실증분석을 통해 중소기업을 대상으로 특허를 보유한 기업의 미래 매출액 변동성에 대해 살펴보았다. 본 연구에서는 지식재산권인 특허권의 양적가치와 질적가치가 기업경영성과에 미치는 영향을 분석하였다. 특허의 양적가치로는 특허의 수를, 질적가치는 특허평균점수를 기업경영성과로는 평균매출액증가율을 사용하였다. SPSS를 이용한 판별분석을 통해 2가지 독립변수 모두 평균매출액 증가율이 2배 이상인 기업과 2배 미만인 기업을 구분하는데 유의적인 변수임을 확인하였다. 따라서 특허권 보유 중소기업에 대해 보증심사나 여신심사시 본 연구결과를 이용하여 향후 매출액이 어떻게 변경될지에 대한 분석의 틀을 이해관계자에게 제공한다는데 의의가 있다.

주제어 : 분류함수, 판별분석, 적중률, 특허권, 매출성장률, 중소기업

1. Introduction

Today, our society is changing faster than ever before. In the past, the industrial revolution has greatly improved the productivity of the physical labor force, but now it is an era when creating, accumulating and utilizing knowledge to differentiate between product development, production, service and distribution depends on competitiveness. Since the 1990s, countries around the world have made knowledge-based economies the most important topic of the 21st century and have been actively studying them. As the implementation of this knowledge-based economy accelerates, the role of intellectual property as a key component in the survival and competitiveness of companies and the importance of the activities of intellectual property are emphasized[1-3]. Entering the so-called Fourth Industrial Revolution, the importance of securing and protecting intellectual property rights is further emphasized. The trade war between the U.S. and China also has its essence in protecting intellectual property rights[4,5].

Patents are a system that gives exclusive rights to inventors who create new industrial intellectual property for a certain period of time. The first purpose of the patent system is to encourage invention by protecting the rights and interests of inventors. The second purpose is to contribute to the development of technologies in related fields by disclosing information. In particular, the role of patent rights in small and medium-sized enterprises is greater than that of large corporations. Small and medium-sized enterprises make up 99% of all enterprises, and 83% of all workers work for small and medium-sized enterprises, so the status of small and medium-sized enterprises is large enough to be large in the national economy[6]. However, competition with large companies has limitations in many aspects such as capital and business networks of small and medium-sized enterprises.

But for patents that are intellectual property, innovation and ideas are more important than the size of capital or the size of companies. Therefore, small and medium-sized enterprises can compete with large companies in this field. For this reason, it is believed that the activities to secure intellectual property are meaningful for small and medium-sized enterprises.

As the importance is highlighted, intellectual property rights in Korea are increasing quantitatively, but in terms of their usability, they are showing a trend that is declining. Therefore, we would like to examine the impact of patents, which are representative intellectual property rights, on the performance of companies. This study differs from the previous studies as follows. In particular, we will conduct an empirical study the impact of the quantitative and qualitative aspects of patent rights on management performance on small and medium-sized enterprises that did not have much research due to lack of data. We want to look at whether the growth rate of sales in the management performance of small and medium enterprises after securing patent rights is different from that of general small and medium-sized enterprises. Due to the lack of manpower, the activities to secure intellectual property rights in small and medium-sized enterprises hinder normal business activities, resulting in reduced sales growth or remaining at the current level for many companies. In the screening of company's loans, external growth, such as company sales, is particularly significant, but in this regard, small and medium-sized companies engaged in patent-related activities, are at a disadvantage. Therefore, we would like to analyze empirically how the increase in sales of small and medium-sized enterprises that have secured patent rights is distinguished from other companies in general, instead of focusing on analysis of the management performance of companies and relationship in the past. Financial

institutions usually focus on future sales when reviewing loans to small and medium-sized enterprises. However, small and medium-sized enterprises with patents often have relatively small sales for patent-holding activities compared to ordinary small and medium-sized enterprises. Unlike previous studies that focused on the quantity of patents in the analysis of patent rights and management performance, this study has a distinction that it analyzed using the qualitative value of patents. It is also differentiated in that it analyzed whether patents can predict future sales growth, not past sales, through discriminant analysis between companies that hold and those that do not hold patents. Therefore, using this study, future sales figures for small and medium-sized enterprises holding patents can be identified. The purpose of this study is to provide information to stakeholders in the financial sector so that future sales of patent-holding small and medium-sized enterprises can be properly evaluated and used for loans.

2. Related Works

2.1 Previous studies in foreign country

Looking at the previous study on the management performance of companies based on patent activities, 365 out of Fortune 500 companies in the U.S. were selected and the effects of patent registrations on revenue, sales growth and profit rates were researched. It has been confirmed that the number of patent registrations has a positive relationship with sales growth rate and that there is a positive impact on profits from the increase in sales[7].

In addition, an analysis of 57 pharmaceutical companies in the United States confirmed that both the number of patent applications and that of patent registrations had an impact on sales, and in particular, the number of patent applications was confirmed to have a greater impact on sales[8].

In the case of Germany, 50 manufacturers of electric tools were analyzed and the study looked at the relationship between company's performance in two aspects: "patent activity" and "quality level of patent technology" of companies. The relationship between two variables was verified and found to be highly correlated, with the company's performance index (average sales growth rate, sales per employee, etc.) as dependent variables and the patent index (number of patent applications, number of patent applications per employee, effective patent ratio, etc.) as independent variables[9].

2.2 Previous studies in Korea

In one study, 89 out of the top 150 patent-registered companies from 1998 to 2002 were sampled and analyzed empirically. The number of patent applications affected the growth of the company, and the number of patent applications per employee was analyzed as having an impact on productivity, indicating that the quantitative aspect of the patent was a significant variable in the company's performance[10].

In a study of 62 general companies and 38 venture firms, regression analysis confirmed that the number of patent registrations had a significant effect on sales and net profit margins[11].

A researcher sampled 200 venture companies based on sales at the end of 2008. Based on the rating data of the patent evaluation system, the quality level was assigned, and the analysis revealed that the quality level had a significant relationship with sales and net profit[12].

In another study, researcher analyzed how the quantitative and qualitative value of patents affected company's performance. In this study, the quantitative value of patents did not have any special impact on the company's

management performance, but qualitative value was analyzed as having a positive relationship with increased sales[13].

The companies studied were 1,269 companies that received credit guarantees using intellectual property guarantee products from the Korea Credit Guarantee Fund in 2016 and ultimately raised loans from financial institutions such as banks. The study confirmed that patent creation is difficult to find statistical significance in relation to the aggregate asset growth rate and sales growth rate, which are indicators of an entity's financial growth, while intellectual property financing utilization has a positive impact[14].

A panel analysis using data that combines cross-sectional and time-series data showed that each employee has a large intellectual property rights, and that the more combined rights, the larger the sales compared to the number of employees[15].

In a study conducted to find out the impact of intellectual property applications and utilization on product competitiveness, the higher the number and utilization of intellectual property rights, the higher the product competitiveness. It also showed that product competitiveness has a significant positive effect on financial performance[16].

A study was conducted on 103 domestic medical device manufacturers on how R&D activities and patents affect management performance. The study found that research and development costs had a positive effect on intangible assets and patents had a positive effect on net income growth[17].

According to an analysis of patent-based start-ups and major start-up performances of 353 start-ups, patent-based start-ups showed high growth rates in terms of product sales and short-term employment, while they were ineffective in sales performance[18].

3. Materials and Methods

3.1 Selecting of sample company

Most previous studies targeted larger companies than small and medium-sized enterprises, and the number of samples was small because of the restriction of data. In addition, the focus was on the correlation between patents and the management performance of company through regression analysis based on past financial data to analyze the impact of patent rights on management performance. In this study, we analyzed the relationship between patents held by small and medium-sized enterprises, which play a big role in the national economy, and future management performance. To this end, the analysis was conducted on non-listed small and medium-sized enterprises with patents that received loans through the guarantee of the Korea Credit Guarantee Fund. Patents are generally held by companies in the manufacturing industry rather than wholesale ones. Therefore, in this study, small and medium-sized enterprises operating in patent-holding manufacturing industries and small and medium-sized enterprises operating in non-patented manufacturing industries were analyzed.

3.2 Selecting variables

As independent variables, the quantitative value of patents and the qualitative value of patents that were widely used in prior research were used. The quantitative value means the number of patents owned by the company and utilizes the number of valid patent registrations. Because of the characteristics of small and medium-sized enterprises, almost all of them hold fewer than 10 patents. Therefore, the distribution of patents has left-leaning skewness and high kurtosis, so the number of patents has been replaced by natural logarithmic values.

Among other independent variables, the qualitative value of a patent refers to the qualitative level of a patent. In this study, SMART3 (System to Measure, Analyze and Rate patent Technology 3) score, a patent-specific rating data of the patent evaluation system built by Korea Invention Promotion Association with the Korean Intellectual Property Office, was used as the quality value of patents. In other words, the qualitative value was used to average patent score divided by the number of patents of the total SMART3 score. The SMART3 score is a comparable relative value to other companies, consists of the sum of patent rights, technicality, and usability scores, and exhibits normal distribution, making it an appropriate variable to represent the qualitative level of the patent rights[13].

Among the various indicators of a company's management performance, the dependent variable was selected as the average sales growth rate, which was analyzed to be mostly related to patents in the previous studies.

In 2012, 278 small and medium-sized manufacturing companies with patents that took out loans through guarantees from the Korea Credit Guarantee Fund were selected as samples. The relationship between the average sales growth rate of these companies over the next five years and the quantitative and qualitative value of patents was analyzed.

4. Empirical analysis

4.1 Research project

Average sales growth rate for small and medium-sized enterprises from 2012 to 2016 is 4.28%. Average sales growth rate of small and medium-sized companies holding patents is around 8%. Therefore, we would like to analyze whether small and medium-sized enterprises that hold patents show an average sales growth rate of 9% or more, more than double the average sales growth rate of all small and medium-sized enterprises. In other words, through a discriminant analysis using the statistical program SPSS22, we will examine whether the quantitative value of a patent, 'the number of patents', and the qualitative value of a patent, 'the average score of patents', are useful in distinguishing between less than 9% increase in average sales and more. Also, we would like to examine which independent variables have significant discriminant power, and which independent variables have great discriminant power.

4.2 Statistical analysis

For discriminant analysis, independent variables must follow a normal distribution. The number of patents followed the normal distribution through replacing by natural logarithmic values, and SMATR3 scores were confirmed to be normal distribution through the site of 'the patent evaluation and analysis system'. The assumption of multicollinearity between independent variables were confirms that the VIF value is less than 10, which is less collinearity. The assumption of equality in the covariance matrix is verified by Box's M verification in Table 4. And the assumptions about the linearity of the dependent and independent variables are confirmed by the classification function in Table 8.

Table 1 shows the mean and standard deviation of two independent variables in two groups. Both the two variables, 'number of patents LN' and 'average score of patents', were higher than group 1 (a group whose average sales growth rate is less than 9%) in group 2(a group with an average sales growth rate of 9% or more).

Table 1. Group Statistics

classifying		Mean	Std. Deviation	Valid N (listwise)	
				Un-weighted	Weighted
Group 1	Number of patents LN*	.888	.8394	126	126.000
	Average score of patents	67.370	2.6729	126	126.000
Group 2	Number of patents LN	1.288	1.0538	152	152.000
	Average score of patents	69.702	2.6221	152	152.000
Total	Number of patents LN	1.107	.9813	278	278.000
	Average score of patents	68.645	2.8852	278	278.000

* Natural logarithmic value

Table 2 shows results of ANOVA. As a result of the difference verification, the difference in 'the number of patents LN' and 'the average score of patents' between the two groups was significant. Where Wilks' lambda is the ratio of 'intra-group variance / (intra-group variance + inter-group variance)' and the greater 'inter-group variance' compared to 'intra-group variance', the closer it is to zero and vice versa, to 1. It has the opposite direction to the F value in ANOVA. Of the two variables, Wilks' lambda of the average score of patents is small and the F value is large. It can be said that the average score of patents means a high determinant power. That is to say, the difference between two groups means that the average score of patents is the largest.

Table 2. Tests of Equality for Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Number of patents LN	.959	11.890	1	276	.001
Average score of patents	.838	53.546	1	276	.000

Table 3 represents the covariance matrix of the groups that are classified respectively.

Table 3. Covariance Matrices

classifying		Number of patents LN	Average score of patents
Group 1	Number of patents LN	.705	−.205
	Average score of patents	−.205	7.144
Group 2	Number of patents LN	1.110	−.492
	Average score of patents	−.492	6.875
Total	Number of patents LN	.963	−.129
	Average score of patents	−.129	8.324

Table 4 shows the results of the verifying of the assumption of equality in the covariance matrix. Box's M verification results show no violation of the assumption(Box's M =7.248, p=0.066).

Table 4. Test Results

Box's M		7.248
F	Approx.	2.397
	df1	3
	df2	106384207.576
	Sig.	.066

Table 5 provides information on canonical discriminant function. This shows Wilks' lambda and $x2$ verification results. $x2$ verification confirms that there are differences between two groups across independent variables, and the null hypothesis (H_0) is as below.

H_0: The means of all independent variables are the same among groups.

The results of the verification showed significantly(p=0.000). Two independent variables can be said to be significant in separating the group with an average sales growth rate of 9% or more and a group of less than 9% in combination.

Table 5. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.788	65.403	2	.000

Table 6 shows standardized canonical discriminant function coefficients. This coefficient of standardization shows the relative importance of the two variables in describing a group of companies with an average sales growth rate of 9% or more and less than 9%. In this case, 'the average score of patents' of the two variables was found to be more important, and the discriminant power was greater.

Table 6. Standardized Canonical Discriminant Function Coefficients

	Function
	1
Number of patents LN	.532
Average score of patents	.926

Table 7 describes the structure matrix. The structure matrix shows the correlation between each variables and the standardized canonical discriminant function. Here again, the correlation between the average score of patents and the discriminant function was higher. Discriminant loading is usually significant if it is ± 0.40 or higher[19,20]. Therefore, it can be said that the discriminant power is useful in order of 'average score of patents', 'number of patents LN'.

Table 7. Structure Matrix

	Function
	1
Average score of patents	.850
Number of patents LN	.401

Table 8 shows classification function coefficients, which can be used to derive classification functions between groups.

Classification function of group 1
$$=4.816*X_1+9.877*X_2-335.552$$

Classification function of group 2
$$=5.389*X_1+10.240*X_2-361.050$$

Group 1 : a group with an average sales growth rate of less than 9%

Group 2 : a group with an average sales growth rate of 9% or more

X_1: number of patents LN, X_2: average score of patents

The above two classification functions allow us to predict which group to belong to and are classified into groups that appear to be large values by inserting the value of variables in the classification function[6].

Table 8. Classification Function Coefficients (Fisher's linear discriminant functions)

	Classification	
	Group 1	Group 2
Number of patents LN	4.816	5.389
Average score of patents	9.877	10.240
(Constant)	−335.552	−361.050

Table 9 explains how accurately the classification function predicts 278 companies analyzed statistically. 89 out of 126 companies with an average sales growth rate of less than 9% and 107 out of 152 companies with an average sales growth rate of more than 9% were correctly classified. Overall, 196 of the 278 are correctly classified with a hit ratio of 70.5%.

Table 9. Classification Results

Classification			Predicted Group Membership		Total
			Group 1	Group 2	
Original	Count	Group 1	89	37	126
		Group 2	45	107	152
	%	Group 1	70.6	29.4	100.0
		Group 2	29.6	70.4	100.0

5. Conclusion

In this study, we looked at how the quantitative and qualitative value of patent rights, which are intellectual property rights, affect management performance of company. An empirical analysis was conducted using 'the number of patents' as the quantitative value of patents, 'the average score of patents' as the qualitative value of patents, and the average sales growth rate as the management performance of company. As a result, both independent variables used in this study were significant for distinguishing between companies with an average growth in sales more than twice that of general small and medium-sized enterprises and those with less than twice the average sales growth rate.

In previous research, large companies such as listed companies were analyzed to focus on their past management performance and the quantitative value of patent rights. In this study, it is meaningful that the empirical well as quantitative value of patents affect the volatility of future sales of small and medium-sized companies, which accounting for a large portion of the national economy. Using this study, future sales figures for small and medium-sized enterprises holding patents can be identified. Therefore, in practice, it is also meaningful that the research model provide information to stakeholders in the financial sector so that future sales of patent-holding small and medium-sized enterprises can be properly evaluated and used for loans.

The purpose of this study is to provide information to financial institutions to facilitate loans by properly evaluating the future sales of patented small and medium-sized enterprises, so there is a limit to analyze only the sales growth rate of the company's management performance. Depending on the purpose of the study, it is necessary to analyze the relationship between profitability-related indicators such as operating profit or net profit among the management performance of the company and patent rights. In addition, some companies without patents may not have obtained patents because they do not need patents, but there are limitations of analyzing them without distinguishing them. In other words, there is a limit to analyze companies that do not hold patents voluntarily and companies that do not hold patents involuntarily without distinguishing them from each orther.

REFERENCES

[1] S. C. Kil & S. M. Kang. (2008). The study of an analysis on patent management affecting the company performance. *Journal of Korea Technology Innovation Society, 11(2)*, 171-193.

[2] S. J. Kang. (2006). *An analysis on the contribution of intellectual property rights to corporate productivity.* Science Technology Policy Institute.

[3] S. H. Kim, S. H. Kwak & M. C. Kang. (2005). A positive study on the result of patent management using patent indicator. *Journal of Finance & Knowledge Studies, 3(1)*, 106-128.

[4] M. B. Yeom. (2018). An economic paradigm shift and new economic policy in the era of the 4th industrial revolution. *Journal of Economic Research, 36(4)*, 23-61.

[5] S. Klaus. (2016). *The fourth Industrial Revolution.* Crown Business.

[6] C. Yang & Y. Y. You. (2020). An empirical study on the default prediction model in small and medium-sized enterprises using financial ratios. *Research in World Economy, 11(2)*, 129-135. DOI : 10.5430/rwe.v11n2p129

[7] F. M. Scherer. (1965). Corporate inventive output, profit and growth. *Journal of Political Economy, 73(3)*, 290-297.

[8] W. S. Comanor & F. M. Scherer. (1969). Patents statistics as a measure of technology change. *Journal Political Economy, 77(3)*, 392-398.

[9] H. Ernst. (1995). Patenting strategies in the German mechanical engineering industry and their relationship to company performance. *Technovation, 15(4)*, 225-240.

[10] J. Y. Oh. (2003). *An analysis on factor of company's industrial property right affecting the company's development.* Master's thesis. Yonsei University.

Seoul.

[11] K. H. Lee & B. S. Yoon. (2006). The effects of Patents on firm value. *Journal of Technology Innovation, 14(1)*, 67-99.

[12] Y. S. Ahn. (2010). An empirical analysis about the effect on performance of firm's patent competency. *Knowledge Management Research, 11(1)*, 83-96.

[13] K. H. Jung. (2019). *A study on the effect of the value of patents on business performance. Master's thesis.* Seoul National University. Seoul.

[14] W. C. Kim. (2020). *A Study on the impact of intellectual property management activities on management performance of companies.* Master's thesis. Korea University. Seoul.

[15] K. N. Kang. (2019). Intellectual property rights and firm performance. *Innovation Studies, 14(4)*, 179-199.

[16] T. K. Kang. (2018). A study on the influence of management activities using intellectual property rights on the management performance of small and medium-sized enterprises. Master's thesis. Hansung University. Seoul.

[17] D. S. Kim, J. S. Lee, S. H. Cho, M. S. Kim & N. H. Kim. (2018). A study on the effects of R&D activities and patents on the corporate performance of medical device firms in Korea. *Korea Academy Industrial Cooperation Society, 19(11)*, 157-165.

[18] D. H. Chung, G. P. Lee & J. H. Shin. (2019). The influences of intellectual property-based entrepreneurship on major entrepreneurial performance. *Asia-Pacific Journal of Business Venturing and Entrepreneurship, 14(3)*, 1-11.

[19] J. F. Hair, R. E. Anderson, B. J. Babin & W. C. Black. (2010). *Multivariate data analysis: A global perspective (Vol. 7)*.

[20] H. S. Lee & J. H. Lim. (2018). *Manual of SPSS24.* JHJbook.

양 창 용(Changyong Yang)　　　　[정회원]

· 2001년 2월 : 고려대학교 경제학과(경제학사)
· 2004년 8월 : 고려대학교 경제학과(경제학석사)
· 2019년 9월 ~ 현재 : 한성대학교 지식서비스&컨설팅학과 박사과정
· 관심분야 : 금융, 중소기업
· E-Mail : dreamer0401@hanmail.net
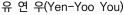
홍 정 완(Jung-Wan Hong)　　　　[정회원]

· 1988년 2월 : 서울대학교 산업공학과(공학사)
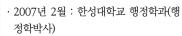· 1990년 2월 : 서울대학교 산업공학과(공학석사)
· 1994년 2월 : 서울대학교 산업공학과(공학박사)
· 1996년 3월 ~ 현재 : 한성대학교 교수
· 관심분야 : Process Innovation, Service Science, Smart Factory
· E-Mail : jwhong@hansung.ac.kr

유 연 우(Yen-Yoo You)　　　　[정회원]

· 1996년 2월 : 숭실대학교 정보과학대학원(산업경영학석사)
· 2007년 2월 : 한성대학교 행정학과(행정학박사)
· 2008년 9월 ~ 현재 : 한성대학교 교수
· 관심분야 : Consulting(Strategy, PM, 성과평가), 지식재산, 기술가치평가, Management Innovation
· E-Mail : threey0818@hansung.ac.kr