專利價值何時可以被彰顯：討論技術多樣化、財務寬裕及企業規模之調節效果

When Patent Value Can Be Demonstrated: The Contingency Effects of Technological Diversification, Financial Slack and Firm Size

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Abstract

Whether an enterprise needs to accumulate more patents is a question that the modern managers need to consider. However, the findings related to the effect of the patent on firm performance are still inconsistent suggesting more research is needed. Firms do not operate in a vacuum. The situational factors may influence the performance effect of patents. This study, therefore, attempts to reexamine the relationship between patent counts and firm performance by considering the situational factors. In a sample of Taiwanese ICT 1945 firm-year observation in the period of 2008-2017, the results generated from this study show that (1) patent counts did not produce significant effect of performance, (2) the diversity of a firm’s patent portfolio negatively moderated the relationship between patent counts and performance, (3) financial slack cannot mitigate the negative moderating effect of technological diversification on firm performance, (4) large firm size can produce positive effect to mitigate the negative moderating effect of technological diversification on firm performance.

Keywords: Patent Counts, Technological Diversification, Firm Performance

1. INTRODUCTION

1.1 Research Background and Motivations

As competition intensifies, companies must constantly invent and cultivate technological capabilities for preserving a competitive position in the sector or market. The innovation is also viewed as an antecedents of enterprise to reform business strategies, technologies, products, and organizational transformation. Many companies are through innovation to pursue sustainable development and expand their own business territory. For example, the success of Uni-President Enterprises Corporation has established a number of own-brand products. In addition, with a broad science and technology innovation, TSMC can provide the most advanced technology to make Apple, Intel and other manufacturers become demanders.

Patents are the important tools for protecting innovation, also represent the innovative strength of the firm. Such as Nest, a smart home business device manufacturer was acquired by Google, apply for the patent in advance to defend itself against attacks by Honeywell. That is, patents can help enterprise stop the theft of its innovations by larger rivals. Due to the legal protection of patent monopoly, with a strong exclusion, accumulating the patent is the best weapon to consolidate the competitive advantage. However, some companies will deliberately expose their patents before product launching. Like Apple Inc. announced patents to show its innovation strength to its competitors. This implies that the patent can let enterprise declare their competitive position in the market.

In academic research and practice, the accumulation of patents is not an absolute profit guarantee. As observed by Suh and Hwang (2010) in software industry, copyright registrations have more positive effect than patent applications. Moreover, Macronix International (MXIC) is committed to creating its own technology and continuing to accumulate patents, but the profitability effect of patents is not prevailing. This means that the effects of number of patents may not bring value to the enterprise. Therefore, whether the patent has a positive impact on firm performance is worth exploring.

In the accumulation of patent process, the technology layout of the enterprise may focus on specific areas to profit "economies of scale". Such as Qualcomm, the world's largest IC design company, relying on his patent in the telecommunications to monopolize the market, further to profit amazing royalties. Conversely, some studies indicate that the development should be diversified to cope with the changing science and technology industries and receive "economies of scope". For example, Chen, Yang and Lin (2013) investigated Taiwanese smartphone firms and founds that technological diversity can profit for the company. However, the integration of most of the literature found that companies focus on specific technology are easier to get benefits. That is to say, technological diversification may weaken the positive benefits of accumulating patents.

When companies pursue diversification in technology, they may need additional resources to support this activity. For instance, by flexible use in the financial, Amazon not only continue to invest in research and development in various fields to enhance the influence but also by the accumulation of patents to block competitors. So enterprise can gain high profits through the accumulation of patents and technological diversification simultaneously, which may be also the result of other organizational factors. Many research scholars have begun to explore whether organizational factors affect the relationship between technological diversification and firm performance. For example, Chen and Yu (2012) found that diversification and firm performance are influenced by managerial ownership. Lin, Chen and Wu (2006) also indicated a firm’s technological assets and complementary resources should be treated as a whole to anticipate corporate value. Therefore, other organizational factors may mitigate the negative impact of technological diversification on the number of patents.

To consider the technological diversification, the company may need to use more resources to make strategy become effective. So whether the enterprise has the corresponding financial and human to exert its effectiveness should play a very important role. For example, Lee, Wu and Liu (2013) indicated abundant business resources can be positive to help enterprises to pursue a variety of conduct. Consequently, the purpose of this study will further to explore whether financial slack and firm size influence the moderating effect of technological diversification on the patent counts and firm performance relationship.

These arguments will be tested in the Information and Communication Technology (ICT) industry, with sample data from 2008 to 2017. These samples focus on industry-specific companies, which will make our results more accurate. The empirical results partially support the assumptions made through regression analysis in this study. The negative impact of technological diversification on the relationship between the number of patents and firm performance will be mitigated through firm size. However, the financial slack of the company will not moderate this relationship. These findings not only reveal that organizational factors influence the performance of a firm but also provide provides new thinking modes for enterprises to accumulate patents in different technological fields.

1.2 Research Objectives

In terms of long-term development, the layout of patents in different areas is necessary for enterprise development. However, whether the impact of technological diversification on patent accumulation and firm performance will change because of other organizational factors is worth exploring.

With that motivation, our research aims at three main objectives:

- To explore the relationship between the number of patents and firm performance.
- To test the moderating effect of technological diversification of the patent and firm performance relationship.
- To further examine whether and what extent of organizational resources influence the moderating effect of technological diversification on the patent and firm performance relationship.

1.3 The Structure of This Study

This study is organized as follows. Chapter one is the research background, motivations and objectives. Chapter two provides the literature review of patents, technological diversification, firm size, financial slack and hypotheses development. Chapter three is related to the research methods. Chapter four is devoted to the empirical result. In the final chapter, theoretical implication, managerial implications, and research limitations are presented. The above structure is organized as shown in Figure 1.

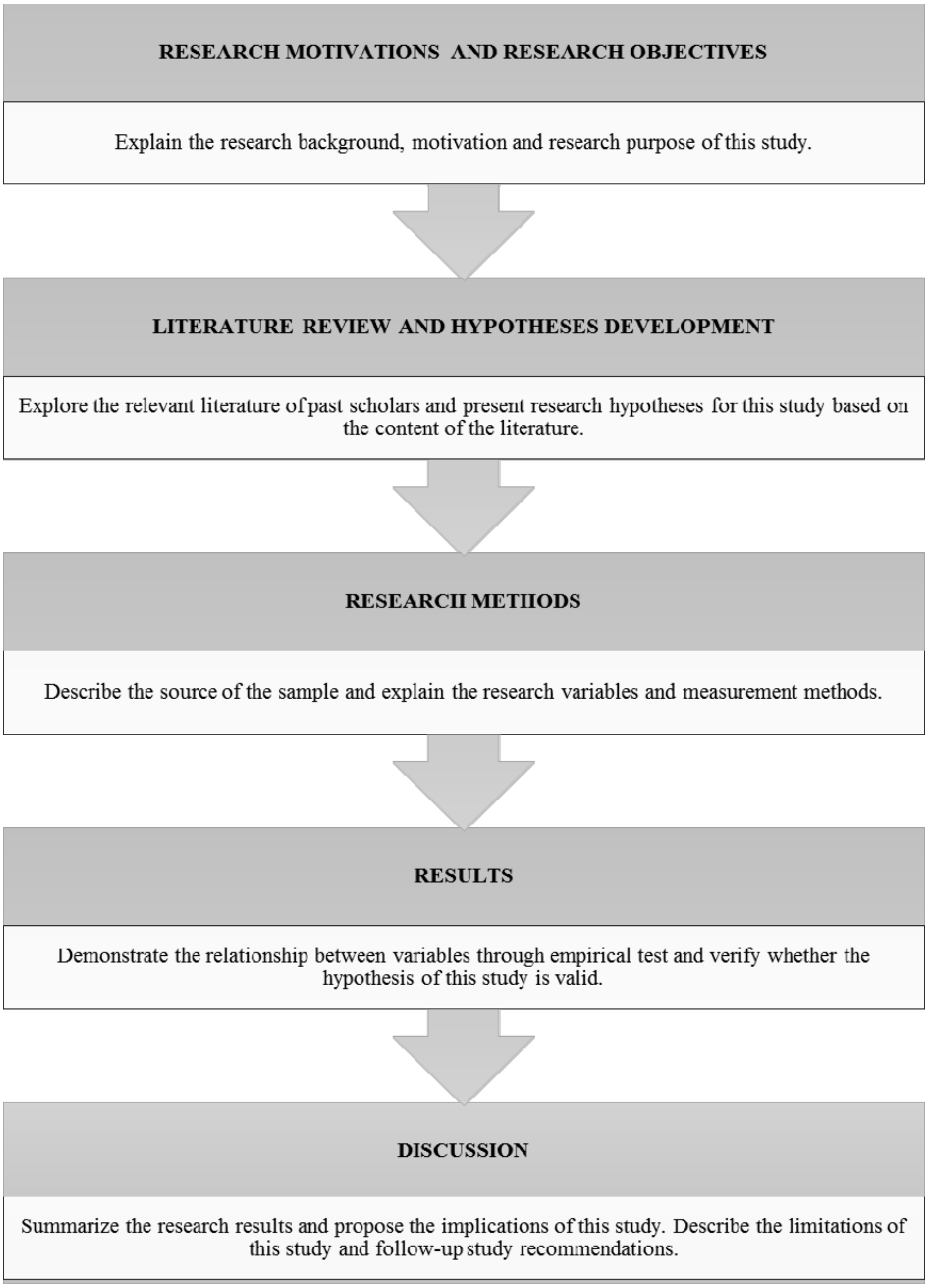

Figure 1. Research flow chart

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

According to the theme proposed by this study, this section separately discusses literature on patent counts, technological diversification, financial slack and firm size. Through the literature discussion and put forward the hypothesis of this study.

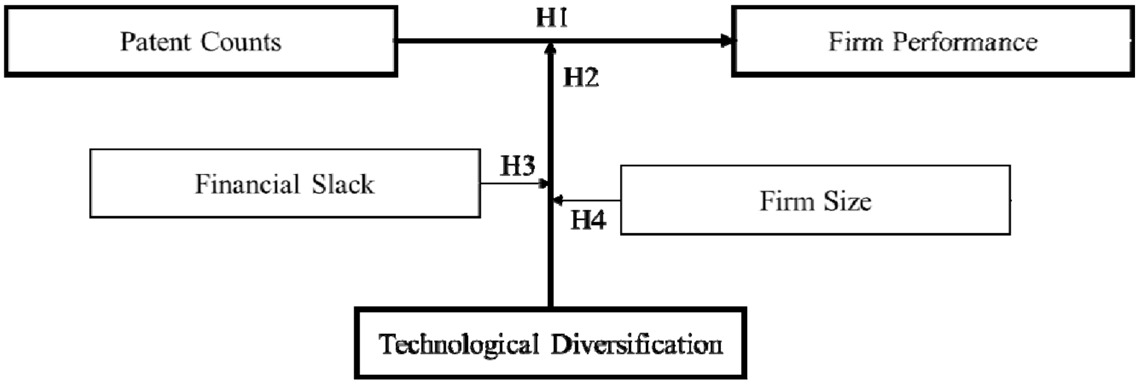

Figure 2. Research framework.

2.1 Patent Counts

Competitive countries often encourage and protect innovation by providing strong patent rights. Patents play an important role in the knowledge economy because companies use patents, which provide a protection period in the market to protect new technologies and fight against competitors (Trappey, Trappey, Wu and Lin, 2012). For example, Maresch, Fink, and Harms (2016) pointed out that patents can tap economic potential that let companies generate huge economic benefits, and patented inventions can provide unique sales propositions that allow companies to successfully defy competitors.

With patent data, which embodies the novelty of the technology, companies can learn about changes in the competition across the industry, further grasp the information and develop strategies for confrontation (Shih, Liu and Hsu, 2010). Moreover, the patent portfolio can be used as an indicator of business information to further illustrate the company's technology strategy (Lin et al., 2006). In other words, businesses apply patents to consolidate their position in the market. Somaya (2003) further pointed out that having a stronger patent status would be better able to resist the threat posed by the systems products industries and have greater advantages in the process of licensing negotiations. In addition, many scholars also use the patent citation as a technical capability indicator. Such as Chang, Chen and Huang (2012) study has further confirmed that high patent citations can reflect high knowledge spillover and economic value.

Based on the above situation, cumulative patents become an important strategy for many companies. Giuri and Torrisi (2010) indicated that innovations are also characterized by different levels of accumulation, that is, new innovations may be to absorb and combine previous capabilities. In addition, Artz, Norman, Hatfield and Cardinal (2010) also found that the number of patents owned by a company increases, the return to R&D spending would follow growth accordingly.

Consequently, the more the number of patents owned by the company, the better its business performance, and thus, we propose the following hypothesis:

H1: The number of patents has a positive effect on firm performance.

2.2 Technological Diversification

In recent years, the impact of technology diversity on business competition has become one of the focuses to which entrepreneurs and scholars pay attention. From a conceptual point of view, technological diversification, including business exploration of new technologies and the comprehensive expansion of existing technologies (Chen, Jang and Wen, 2010). Through a variety of technical combinations and reorganization, companies can activate their potential innovation capabilities. Moreover, enterprises rely on the accumulation of the past efforts to benefit from the dynamic economies of scope and make the related technologies mutually complementary (Cantwell and Piscitello, 2000; Breschi, Lissoni and Malerba, 2003). This also gives the company a better return on business performance when it comes to a similar knowledge base across different technology areas (Leten, Belderbos and Van Looy, 2007).

In addition, diversification of technology is different from the diversification of production. Breschi et al. (2003) highlight that the prerequisites for production are actually a wide range of technologies that enable businesses to predict the diversification of products and markets. Enterprises can also improve their profitability by managing multiple technologies to develop specific products or by investing more technical complexity into existing products (Lee, Yen and Chia, 2017). Based on the above discussion, we can find that the accumulation of technology and expand the scope of technology, can bring positive benefits to the enterprise and economies of scope.

On the contrary, some scholars proposed that specialization so that enterprises will not waste resources. A study of logistics firms, for example, shows that diversification has a negative impact on firm performance and emphasizes that not all firms diversify to improve performance (Nath, Nachiappan and Ramanathan, 2010). As technology becomes more diversified, integration and coordination costs will increase. In the earlier literature, Lang and Stulz (1994) proposed the phenomenon of "diversified discounts," indicating that Tobin's Q is lower in diversified firms than in specialized firms. On the other hand, in the perspective of standard-essential patents, Baron, Pohlmann and Blind (2016) pointed out that highly concentrated patent ownership in the ICT industry has a positive effect on the efficiency of technological progress. One point raised by Huckman and Zinner (2008) is whether or not GE Aviation is managed through a specialized aerospace industry will have better business performance rather than by General Electric a diversified conglomerate.

Based on the above discussion, whether the diversified costs of an enterprise have exceeded the benefits derived from diversification. This means that if a company's patent portfolio is diversified, then the cost may exceed this benefit. In order to know exactly the result of patent counts on the diversification of technologies, this research explores the diversity of companies by distribution status of patented technology in information, communication and technology industry. Therefore, we propose the following hypothesis:

H2: Technological diversification has a negative moderating effect on the relationship between patent counts and firm performance.

2.3 Financial Slack

Organizations developing new technology areas are complex, may involve high risk of failure, and require substantial support from corporate resources such as financial, technical and human capital. From the perspective of corporate venture capital, when corporate investors are financially constrained, it will moderate the relationship between portfolio diversification and value creation (Yang, Narayanan and De Carolis, 2014). That is to say, financial resources in the technological diversification of business development is a very important factor. The study of Natividad (2013) shows that financial slack is freely available resource amount of liquidity for the company's management. In addition, Gruner and Raastad (2015), in the case of the German economic downturn, comprehend financial slack as a superabundance of financial resources, such as debt capacity and cash reserves, it will also be referred to financial flexibility. Therefore, financial slack is equivalent to the company's savings, which may help enterprises through the difficult financial crisis.

The empirical results of Liu, Ding, Guo and Luo (2014) on high-tech enterprises in China show that if enterprises can skillfully devote unabsorbed slack resources and put them into the innovation process, they will have the better output of innovative products. In other hands, for some technology-based small businesses, using unabsorbed and unplanned financial resources can also create the highest performance and ensure future innovative competitiveness (Parida and Ortqvist, 2015). In addition, the findings of Lee, Wu and Pao (2014) also show that financial slack can not only mitigate organizational risk in exploring new areas, but also higher levels of financial slack also represent a higher level of R & D for the business.

Although many studies conclude on the positive effects of financial regulation. However, there is no research showing whether financial slack can reduce the negative impact of technological diversification on patent counts and the performance of enterprises. Therefore, this study includes financial slack as one of the factors influencing technological diversification and propose the following assumptions:

H3: Financial slack can reduce the negative moderating effect of technological diversification on the relationship between patent counts and firm performance.

2.4 Firm Size

In addition to the financial slack will adjust technological diversification, firm size of the enterprise may also affect its development. Companies of all sizes have different strategies to face the challenges and technologies of the future.

In terms of small-scale enterprises, Darnall, Henriques and Sadorsky (2010) point out that although small-scale companies have scarce resources, they have simplified decisions and greater propensity to innovate, so the face of pressure from stakeholders and changes in the environment will be more sensitive and take the initiative to actively respond. Moreover, Gong, Zhou and Chang (2013) pointed out core knowledge workers have the better performance in small-scale companies and produce benefits for the company. That is to say, small-scale enterprises will seek competitive advantage in other ways to achieve the proper use of existing resources because they do not have the extra resources to waste.

On the other hand, large-scale companies can take more risks because they have enough resources, so they have more capital to diversify their technology than small companies. Lin and Chang (2015) showed that large companies can achieve better corporate performance when technology is diversified. Chen et al. (2010) also pointed out that small organizations cannot easily diversify their surplus resources as large organizations do. In other words, large companies can easily diversify and accumulate a large number of patents compared with small businesses by using the original organizational units. Even the cost of investment is far smaller than the small-scale enterprises.

Based on the above viewpoints, when companies want to maintain their competitive advantages over the long term, they must try to expand their technological capabilities and increase the complexity of their own technologies. Under these circumstances, the impact of firm size may be more pronounced. Exactly speaking, the costs and benefits of diversification are likely to depend on the size of the company. Therefore, we make the following assumptions:

H4: Firm size can reduce the negative moderating effect of technological diversification on the relationship between patent counts and firm performance.

3. METHODS

3.1 Sample

In order to verify the relevant assumptions proposed in this study, the ICT industry in Taiwan was selected as a sample for this study. The reason is that since the 1990s, the ICT industry has become the focus of Taiwan's industrial development. That is to say, the ICT industry has an important economic value to Taiwan.

Dedicated to make the experimental results more accurate, we chose the observation period from 2008 to 2017 as the sample for analysis. These data as our panel data are provided by the Taiwan Stock Exchange (TWSE) information. In addition, this study also evaluates the results of technology diversification based on the distribution of patents owned by enterprises. Among them, the patent information is obtained from the Taiwan Intellectual Property Office (TIPO) patent database. Excluding some companies without complete information, the final sample size was 417 companies.

3.2 Measurement

3.2.1 Dependent Variable

In this study, we use Return on Assets (ROA) to measure the performance of enterprises. We can understand the company's profitability by comparing net income with average total assets. Specifically, by analyzing the company's ROA we can further know how efficient the company is using investment funds. ROA is calculated as follows:

$$\text{Return on Assets (ROA)} = \frac{\text{Net Income}}{\text{Average Total Assets}} \qquad (1)$$

The search scope of ROA is measured by the three-year average, which include the focal year and after two years (i.e. t to t + 2). Managers can use ROA to measure the benefits generated by the organization's assets and make further decisions (Boz, Yiğit and Anıl, 2013). We thus use ROA as our performance indicator.

3.2.2 Independent Variables

Patent counts

According to Hagedoorn and Cloodt (2003), the number of patents is still a good indicator to explore the company's innovative technology activities. Following Ciftci and Zhou (2016), we also use a five-year cycle to measure patent counts, but the difference is that we are exploring the firm's patent in last five years. For example, the patent counts for a firm in 2015, then we will total the number of patents from 2010 to 2014. In addition, this study uses the natural logarithm of patent counts as the data for analysis.

Patent classification is based on International Patent Classification (IPC), which is the current international common. The IPC is classified according to five levels, Sectional, Class, Subclass, Main Group, and Group. Popp (2005) also pointed out that a detailed patent classification system allows us to understand its development directly in specific technical fields. Therefore, we identify the technical categories of patents in accordance with the four-digit code of the IPC.

Technological diversification

This study follows the previous study to measure the degree of diversification by the distribution of patents in the field of technology (Lee et al., 2017). Indeed, Herfindahl index (HI) is widely used in the study of diversification (e.g. Tuckman and Chang, 1991; Chikoto, Ling and Neely, 2016). It also called the Herfindahl-Hirschman Index (HHI) or the concentration index. In order to have a clearer understanding of the degree of corporate technology diversification. We use the method proposed in the previous research, the "1- Herfindahl index" (Tallman and Li, 1996; Lin et al., 2015; Lee et al., 2017). The formula is as follows:

$$\text{Technological diversification} = 1 - \text{Herfindahl index} = 1 - \sum_i p_i^2 \qquad (2)$$

(Pi, the proportion of patent portfolio of a firm in a particular technical area i.)

In addition, the value of technology is quickly being replaced, so we are measured by the five-year average (i.e. t-5 to t-1). Therefore, this measure considers the number of patents the firm receives and the relative importance of each industry.

Financial slack

With respect to financial slack, Quick Ratio has been extensively used to proxy financial slack (e.g. Kim, Kim and Lee, 2008). Therefore, Quick Ratio was employed to measure Financial Slack in this this study.

Quick Ratio formula are:

$$\text{Quick Ratio} = \frac{\text{Current Assets} - \text{Inventorie}}{\text{Current Liabilities}} \qquad (3)$$

From the Quick Ratio, we can understand the ability of a company to repay debt. When the Quick Ratio is greater than 100%, it means that companies have better financial resources to engage in more technical activities.

Firm size

We use the number of employees in the company to measure the size of the company. This has been widely used in many previous studies to measure firm size (e.g. Santoro and Chakrabarti, 2002; Cho, Arthurs, Sahaym and Cullen, 2014; Arnegger, Hofmann, Pull and Vetter, 2014)

3.2.3 Control Variables

In addition, in order to improve the reliability of this study, this study also controlled some variables that would affect firm performance, including firm age, R&D intensity, and growth opportunity.

Firm age

Older firms may have accumulated more patents and have a solid foundation, so we control that to reduce the impact of firm age. Therefore, this control variable is measured from the year the company was founded until to the focal year *t*.

R&D intensity

The degree of investment in different R&D will result in different performance. Therefore, as a controlled variable, we use the rate of R&D expense to annual sales (Lee et al., 2017).

Research and development expense rate formula is:

$$\text{R\&D Expense Rate} = \frac{\text{R\&D Expense}}{\text{Annual Sales}} \times 100\% \tag{4}$$

Growth opportunity

Finally, in order to prevent the value of the company by the impact of future growth opportunities. We control the return on total assets ratio. Its formula is:

$$\text{Return On Total Assets Ratio} = \frac{\text{Total Profit} + \text{Interest Expenses}}{\text{Average Total Assets}} \times 100\% \tag{5}$$

Among them, the formula for average total assets is:

$$\text{Average Total Assets} = \frac{\text{Total Assets at The Begining of The Period} + \text{Total Assets at The End of The Period}}{2} \tag{6}$$

3.2.4 Descriptive Statistics and Correlation Matrix

Table 1 shows the descriptive statistics and correlation matrix of this study. The variables that include the patent counts, technology diversification and firm performance, which are used in the study.

3.2.5 Panel Data with Fixed Effects

The study chose the Fixed Effects Regression Model as the analytical method because the sample for this study is a company of a particular industry and the patent counts of the firm may not be varied over time.

4. RESULTS

4.1 Sample Analysis

The sample of this study is divided into six major electronic industries and other related electronic industries, includes semiconductor, electronic parts and components, optoelectronics, computer and peripheral equipment, communications and the internet, electronic products distribution and information services, other electronics industry (e.g. e-commerce and electronic access industry). The selected companies are listed at stock exchange market, over-the-counter market, and emerging stock market. As shown in Figure 3, the percent of sample firm-year observations after excluding the data with missing values. The vast majority of companies belong to the semiconductor industry, followed by electronic parts and components.

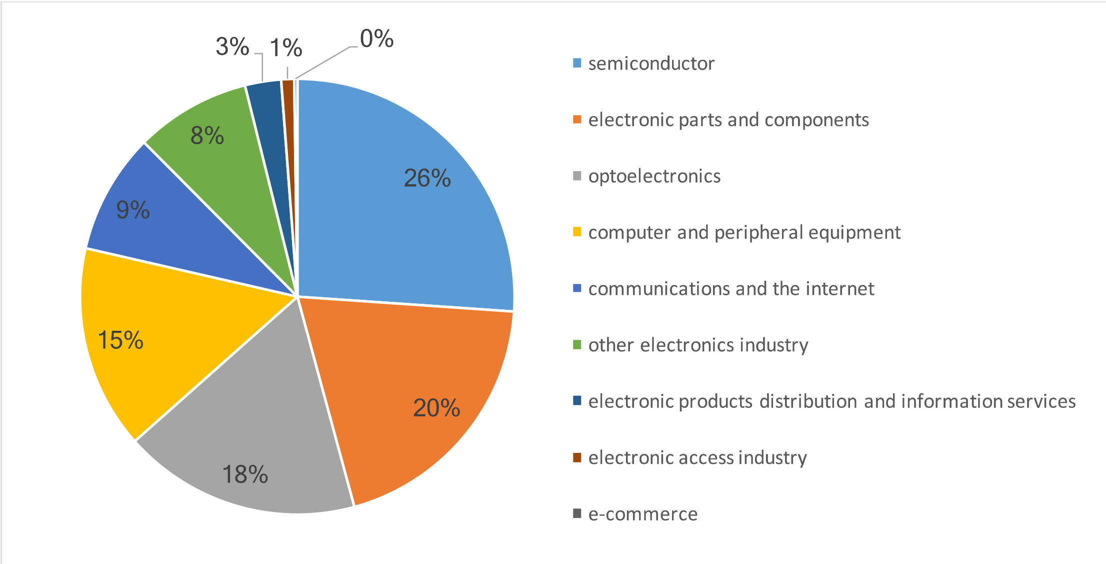

Figure 3. Sample industry distribution.

4.2 Research Hypothesis Analysis

Table 1 is a statistical analysis of variables for all samples in this study, including the mean, standard deviations and correlation of variables. There are 2189 sample data in this analysis. From the Table 1, the relationship between independent variables is significant. However, according to the rule of thumb, the concern of multilinear will be not an issue when the correlation coefficient less than 0.8 suggesting that the multilinear between our variables of interest should be acceptable (Imdadullah, Aslam and Altaf, 2016).

Table 1. Descriptive statistics and correlations matrix.

N=2189	Mean	SD	1	2	3	4	5	6	7	8
1. ROA	3.521	8.641								
2. Firm Age	20.04	9.110	-0.010							
3. R&D Intensity	7.364	9.937	-0.288****	-0.166****						
4. Growth Opportunity	0.586	8.146	0.134****	-0.010	0.007					
5. Patent Counts	2.533	1.595	0.042*	0.027	0.072***	-0.013				
6. Technological Diversification	0.565	0.265	-0.015	0.017	0.165****	-0.021	0.448****			
7. Financial Slack	202.244	183.028	0.121****	-0.127****	0.434****	-0.051**	-0.063***	0.040*		
8. Firm Size	7.295	1.521	0.077****	0.268****	-0.349****	-0.029	0.480****	0.107****	-0.371****	

*p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Then we verify the hypothesis by using the hierarchical multiple regression analysis in Table 2. Model 1 is a basic model where we enter the control variables. The results show that the control variables, firm age (Coef. = -0.182****, P<0.001), R&D intensity (Coef. = -0.201****, P<0.001) and Growth Opportunity (Coef. = 0.137****, P<0.001), have a significant effect on firm performance. Among them, the firm age and R&D intensity have a negative impact on firm performance, while growth opportunities have a positive impact on firm performance.

Next, we enter the effect of the number of patents in Model 2. This shows that the number of patents is negatively correlated with firm performance and not significant (Coef. = -0.136, P=0.455), which means that when considering the performance of a company, only discussing patent counts cannot explain the variation of performance. Therefore, hypothesis 1 is not supported.

In Model 3, we further explain the role of technological diversification. The results indicate that there is a negative relationship between technological diversification and firm performance and it is not significant (Coef. = -0.140, P=0.867). Similarly, this factor alone discuss technological diversification is unable to explain performance variation.

Based on the results of the above model, in Model 4, we tested the interaction effects of technological diversification and patent counts. From the results of Model 4 can be drawn that technological diversification has a significant negative moderating effect on the relationship between the number of patents and firm performance (Coef. = -0.972^{*}, $P<0.1$), supporting the Hypothesis 2.

To verify hypothesis 3, we use the average of the financial slack to distinguish the sample for high financial slack and low financial slack. Then, further test the regression results of the two groups. The results are shown in Model 5 and Model 6. We can find that the Patent Counts × Technological Diversification is more significant at high financial slack (Coef. = -2.730^{**}, $P<0.05$); but it is negatively correlated. The Patent Counts × Technological Diversification at the low financial slack is not sinificant effect (Coef. = 0.583, P=0.361). This result does not meet our assumptions. Therefore, Hypothesis 3 is not supported.

In Models 7 and Model 8, we distinguish the sample into two groups based on the average of firm size. They are high firm size group and low size group. With Model 7 and 8, we find that only when the firm size is small, the Patent Counts × Technology Diversification will have a negative impact (Coef. = -2.394^{**}, $P<0.05$). When the firm size is large, the relationship is still negative, but not significant (Coef. = -0.585, P=0.378). This is sufficient to illustrate the effect of scale on patent counts and technological diversification, so the results partially support the hypothesis 4.

In summary, the four hypotheses of this study are tested in the regression model of Table 2 and Table 3, and the results are compiled in Table 4. The test results support the Hypothesis 2 and Hypothesis 4 of this study, but do not support Hypothesis 1 and Hypothesis 3. The theoretical application of this result will be explained in more detail in the next section.

Table 2. Regression results of the fixed effects model

Y = ROA	Model 1		Model 2		Model 3		Model 4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Firm Age	-0.182****	(0.046)	-0.173****	(0.047)	-0.173****	(0.047)	-0.169****	(0.047)
R&D Intensity	-0.201****	(0.021)	-0.202****	(0.021)	-0.202****	(0.021)	-0.204****	(0.021)
Growth Opportunity	0.137****	(0.011)	0.137****	(0.011)	0.137****	(0.011)	0.137****	(0.011)
Patent Counts			-0.136	(0.182)	-0.125	(0.194)	0.457	(0.386)
Technological Diversification					-0.140	(0.837)	1.407	(1.220)
Patent Counts × Technological Diversification							-0.972*	(0.558)
R^2								
within	0.141		0.141		0.141		0.143	
between	0.010		0.010*		0.010*		0.094	
overall	0.078		0.079		0.079		0.074	
F	96.65****		72.61****		58.06****		48.95****	

*p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Table 3. Regression results of fixed effect models

Y = ROA	Model 5		Model 6		Model 7		Model 8	
	High Financial Slack Group		Low Financial Slack Group		High Firm Size Group		Low Firm Size Group	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Firm Age	-0.382****	0.099	-0.055	0.054	-0.125**	0.051	-0.230***	0.075
R&D Intensity	-0.094****	0.025	-0.661****	0.047	-0.546****	0.050	-0.168****	0.025
Growth Opportunity	0.127****	0.021	0.119****	0.014	0.198****	0.016	0.109****	0.014
Patent Counts	1.908**	0.852	-0.701	0.447	-0.338	0.402	1.826***	0.633
Technological Diversification	1.336	2.504	-0.267	1.402	3.121*	1.381	1.715	1.860
Patent Counts × Technological Diversification	-2.730**	1.201	0.583	0.637	-0.585	0.573	-2.394**	0.933
R^2								
within	0.151		0.211		0.277		0.127	
between	0.045		0.187		0.018		0.068	
overall	0.054		0.122		0.035		0.065	
F	14.08****		52.35****		48.31****		22.43****	

*p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Table 4. The verified results of research hypothesis

Research hypothesis		Model	Coef.	P-Value	Result
H1	The number of patents has a positive effect on firm performance.	1	-0.136	0.455	Invalid
H2	Technological diversification has a negative moderating effect on the relationship between patent counts and firm performance.	4	-0.972	0.082	Valid
H3	Financial slack can reduce the negative moderating effect of technological diversification on the relationship between patent counts and firm performance.	5	-2.730	0.023	Invalid
		6	0.583	0.361	
H4	Firm size can reduce the negative moderating effect of technological diversification on the relationship between patent counts and firm performance.	7	-0.585	0.378	Valid
		8	-2.394	0.010	

5. DISCUSSION AND CONCLUSIONS

In previous studies, cumulative patents were generally considered to be necessary activities for companies to stabilize their market position. However, there is still no clear conclusion in the existing empirical evidence on whether cumulative patents can really bring positive performance to the company. In this study we empirically tested previous arguments that cumulative patents are an important activity for business development. In order to verify this relationship, this study considers the effects of technological diversification and further considers the effects of financial slack and firm size about the firm. The results show that technological diversification will weaken the positive effect of the number of patents on firm performance. This relationship can be positively adjusted through the larger scale of the company. However, unlike the previous literature, companies have more abundant financial resources but cannot adjust the negative relationship between technological diversification and firm performance. These results reveal what organizational factors influence the technology strategy.

5.1 Theoretical Implications

Our findings have some theoretical significance. First, technological diversification will weaken the discovery of the positive effect of the number of patents on firm performance. This result shows that when companies participate in different technology areas, they will weaken the benefits of patents. In other words, companies should focus on specific areas of expertise to accumulate patents to achieve economies of scale. This finding may help explain why successful companies often have expertise that other competitors can't replace, which was rarely confirmed in previous researches.

Second, we find that the company's financial slack will not adjust to the negative impact of technological diversification. In other words, for a company with a high degree of financial slack, it will not obtain firm performance through technological diversification. This finding may contradict the previous view that many literatures show that financial resources have a positive effect on firm performance (Vanacker, Collewaert, and Zahra, 2017). However, one of the explanations proposed by Tekçe (2011) is that the financial slack is that the company has higher financial income and cannot bring benefits for future investment. Therefore, this will not be reflected in the performance of the company. In short, financial slack is not one of the important conditions for companies to diversify their technology (Chitsaz, Liang and Khoshsoroor, 2017).

Third, in order to more specifically consider the background factors of enterprises, this study further explored the effects of technological diversification through the regulatory role of firm size. Evidence of the regulatory effect of firm size suggests that large-scale firms can be more advantageous to do technological diversification activities. Therefore, this study not only echoes the previous literature, that is, the company with large scale can have more resources to engage in technical activities in different fields, but also proves that large companies can establish higher-intensity technology (Santoro et al., 2002).

5.2 Managerial Implications

Our research results have certain management implications for companies that are committed to accumulating patents. Through our conclusions, managers should realize that accumulating patents does not necessarily have a significant impact on the company. Based on this, our research allows managers to understand that accumulating patents in different fields does not guarantee high efficiency. In other words, technological diversification will weaken the benefits of patents for companies.

In addition, companies must not only consider their firm size and financial slack to assess whether they are focused on developing specific technology areas. In terms of financial slack, business owners should control their financial slack. Financial slack does not guarantee that companies can exchange profits for future investments. Therefore, it is necessary to make good use of its financial resources.

Furthermore, large companies often have the resources that small companies lack, which is also the key to large companies' ability to mitigate the negative relationships that arise from technological diversification. Therefore, small businesses must be more cautious than large companies, whether or not they want to diversify their technology. This means that managers must consider the impact of the company's size on the layout of science and technology strategies before they can get multiplying effect.

5.3 Research Limitations and Recommendations

There are some limitations on this study. First of all, our research is aimed at specific technology industries. However, there are different organizational factors in the technological diversification activities of different industries. Therefore, future research should examine whether other industries have the same result in accumulating patents. Even the differences generated in different regions can be included in the study and discussion to enhance the universality of the study.

In addition, this study only discusses companies that have applied for patents, but in reality not all companies will apply for patents to present new technological developments. Therefore, it is impossible to measure companies that are using other methods to protect new technologies. Despite these limitations, I believe that the conclusions of this paper provide some valuable insights for managers and scholars.

Finally, what other organizational factors and circumstances may promote or hinder enterprises from accumulating patents and pursue technological diversification is also worthy of further exploration. For example, human resources, director structure, and so on.

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