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RESEARCH ARTICLE

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Appropriation of Innovation and Patent Behaviors of Technological Firms in the Yangtze Delta Area

Abstract In the transition from "made in China" to "invented in China," what is the motivation of Chinese firms in applying for patents? Why do some firms bypass patents? How is patenting developing within Chinese firms? This paper attempts to answer these questions using data of Chinese firms in the Yangtze River Delta region. Results indicate that, for product innovation, obtaining the lead time for market entry is of top priority in innovation protection, followed by confidentiality and patent protection. As for process innovation, confidentiality ranks first, followed by patent protection and obtaining the lead time. There is a significant and positive relationship between prior experience of patent licensing and possibility of future patent licensing. Firms with painful patent litigation experience tend to avoid it in the future. It is also found that there are great differences in patent behaviors between Chinese enterprises and their foreign counterparts.

Keywords appropriation of innovation, patent behavior, Chinese technological firms, Yangtze River Delta Area

1 Introduction

As a source of competitive advantage, patents represent a company's ability. Reitzig & Puranam (2009) argue that a patent is a capability to appropriate

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among organizational capacity. Patents help businesses gain competitive advantage in such ways as creating short-term technology lead (incumbent), protecting the brand, and shaping industry standards, as well as maintaining knowledge-based competitive advantage with the help of patent and trademark portfolio (Reitzig, 2004) .

Therefore, adoption of patents in business has gradually risen to a strategic level. However, patent behaviors of firms cannot be fully explained by the IPR (intellectual property right) law. In recent years, a growing number of firms, especially high-tech companies have started to highlight intellectual property (IP) management. Meanwhile, a patent strategy is becoming a core part of corporate technology strategy. For example, IBM, Microsoft, Dell, Gillette and many other companies are successful practitioners of patent strategies (Grindley & Teece, 1997).

Prior literature on firms' patent strategy mainly focuses on companies in developed countries such as the U.S. (Taylor & Silberston, 1973; Mansfield, Schwartz, & Wagner, 1981; Levin et al., 1987; Cohen, Nelson, & Walsh, 2000; Browyn, 2000), EU countries (Sattler, 2002; Arundel, 2001; Blind et al., 2006, Pajak, 2010), and Japan (Collinson, Kato, & Yoshihara, 2006). These studies have investigated strategic behaviors of firms related to patenting (appropriation mechanisms), licensing, and litigation. Yang, Li, & Chen (2010) conducted a preliminary analysis on China's firms and pointed out the urgent necessity to understand the reasons and ways of obtaining, using, and protecting patents in the Chinese context.

This paper aims to explore patent behaviors of Chinese firms, and to compare these behaviors with that of foreign firms in developed economies. The remainder of this paper is arranged as follows: The second section is a literature review, Section 3 presents the research design, followed by data analysis in Section 4. Conclusion and discussion are presented in the last section.

2 Literature Review

2.1 Patenting

Research on patent has two streams, namely mechanisms for innovation appropriation and the motivation of patenting and its determinants.

Mechanisms for innovation appropriation. Early studies largely focused on U.S.

companies, and highlighted the differences of mechanisms for innovation appropriation among different sectors. For instance, the pharmaceutical firms are in favor of patents (Taylor & Silberston, 1973; Mansfield, Schwartz, & Wagner, 1981), while other industries prefer trade secrets to patents due to the time-consuming process of patent application. In addition, it is difficult to prove whether an innovation meets patent requirements in the first place. Sometimes, a high cost of duplication makes patent protection easy or even unnecessary (Mansfield, Schwartz, & Wagner, 1981). Levin (1987) further distinguished process innovation from product innovation. For the former, patents are the least effective ways, as compared with lead time, learning curve advantages and trade secrets. For product innovation, although the role of patents is superior to trade secret, it is still not as preferred as lead time and learning curve advantages. Cohen, Nelson, & Walsh (2000) found, after a survey of 1,478 U.S. manufacturers, that patenting is actually the least valuable appropriating mechanisms for innovation, as compared with trade secrets and lead time.

Arundel (2001) surveyed appropriating mechanisms for innovation adopted by manufacturers in seven European countries, among which 54.4% of the respondents regarded lead time as the most important measure for product innovation, followed by trade secrets (16.9%), complexity (14.1%), and patent (11.2%), respectively. As for process innovation, the ranking is lead time advantages (46.7%), complexity (21.2%), trade secrets (19.8%), and patent (7.3%). Harabi (1995), based on his study on Swiss firms, also found that the lead time advantage is the most important measure for process innovation, while for product innovation, sale and service advantage are the most important appropriation measures, followed by lead time, and patents are the least effective measure for both product innovation and process innovation. Although the role of patent protection for innovation is weak, the main motivation of patenting is to increase the bargaining chips. Henrik (2002) analyzed the data of 1,844 German firms and found that although patent protection is relatively ineffective means for appropriation of innovation, there were also 20% of the sampled firms regard patents as the most effective way. Cohen, Nelson, & Walsh (2002) found that there are big differences between U.S. and Japanese firms in appropriation measures. Japanese companies view patents as more effective than other measures such as trade secrets. Hussinger (2006) argued that patents are very important for marketed products, while trade secrets are more important for innovations that have not been marketed yet.

Determinants of patenting. Although patents are not a perfect appropriation measure, a large number of patent applications are submitted and granted each year. Why patent or why not? Cohen, Nelson, & Walsh (2000) found that, for product innovation, the primary purpose of patenting is to prevent copying, followed by the avoidance of being blocked by patents of other companies. While for process innovation, to prevent copying and blocking are also the two most important reasons; the primary reason of not patenting is easy to invent around, followed by hard to illustrate the novelty of innovation, information disclosure, and application costs. Browyn & Ziedonis (2001) argued that U.S. semiconductor companies have over the years accumulated a large number of patents as a bargaining tool, and the strengthening of patent protection has led to a race of patent portfolio.

Are patents irrelevant to company size? Brouwer & Kleinknecht (1999) found that the amount of patent applications increased disproportionately with the number of employees. Small businesses tend to engage in patent applications more than large business, with a possible explanation of making up the disadvantage in market share and brand influence. Van Ophem et al. (2001) argued that the effect of firm size on patent applications is worth exploring. They revealed that large companies can obtain innovation rents by market-leading advantage, so they are less likely to conduct patent protection. Knut et al. (2006) found that firm size does play a role in the patenting incentive. The number of patents is positively correlated with company size, no matter whether the patent is to enhance the bargaining power or to evaluate the performance of RandD department. Peeters & van Pottelsberghe de la Potterie (2006) assumed that patent decisions are closely related with innovation strategies. They believed that there is a positive relationship between corporate patent portfolio and external-oriented innovation strategy. In other words, process-oriented innovators patent less than product-oriented innovators. Companies focusing more on fundamentals and applications tend to patent actively, while companies perceived higher innovation barriers usually have smaller patent portfolios.

The relationship between innovation size and patent is also discussed. Pajak (2010) analyzed CIS (Community Innovation Survey) data of French companies, and found that, in intermediate goods sectors, small innovations favor patents while large innovations emphasize business secrets. For small innovative firms, the proportion of innovative products to total sales has a negative effect on patent application.

2.2 Patent Licensing

Patent licensing has been widely discussed. Grindley & Teece (1997) studied patent licensing practices in the American semiconductor industry. They believed the U.S. semiconductor industry has created many of the methods and models of patent licensing, and companies' purposes in patent licensing vary greatly: Some want to maximize benefit via patent licensing; others want to ensure operation smoothness, and still other want both. The licensing strategies of Japanese pharmaceutical companies are more focused on purchasing the license of late-stage products and technologies from overseas markets (rather than selling license to overseas enterprises) (Collinson, Kato, & Yoshihara, 2006). By comparison, Japanese companies purchase twice as much license in the technology from outside than their UK counterparts, while Japanese companies sell only 6% more product or technology license than UK companies—the comparison clearly indicates Japanese companies' emphasis on technology purchase and adoption from outside (Pitkethly, 2001).

Motohashi (2008) argued that license decisions are affected by many factors. By analyzing the survey data of Japan Intellectual Property Office, he found there was a nonlinear relationship between firm size and propensity to license. Due to the lack of complementary assets such as production facilities and marketing channels, small firms tend to use licensing, and large firms also have high propensity for licensing because they tend to cross-license. Lichtenthaler (2007) conducted an in-depth study on the licensing practices of 154 European firms on their licensing out patented and non-patented technology, he concluded that the licensing scope of most companies are smaller than their business activities. The primary motivation of licensing is to get operational freedom, and access to market entry and knowledge. The second motivation of licensing is to sell complementary products, to ensure technology leadership, to gain benefits, to set up standards, then is to enhance the reputation (Lichtenthaler, 2007). Lichtenthaler & Ernst (2009) also studied the role of process and content of strategic management on licensing out technology. They found that the process and content of strategy have interacted impact on the licensing performance. The technology market is not perfect. An active technology licensing may not obtain the expected results. Characteristics of the innovation ecosystem also influence the choices of licensing types. In particular, with the distinction of proactive and reactive technology licensing (the former refers to firms with detecting

technology needs on their own, while the latter means those providing licensing to infringers), Lichtenthaler (2010) argued that environment conditions such as appropriable conditions (patent protection and chaos of technology) and technology market (the transaction frequency and intensity of competition) show different effects on proactive and reactive technology licensing.

2.3 Patent Litigation

Patent litigation studies suggest that patent management has been widely practiced in the U.S. and Japanese market. By comparison, American firms are more aggressive in patent protection, as most patent litigation cases have been filed by U.S. firms. Japanese firms tend to adopt a more defensive patent strategy. Lanjouw & Schankerman (2001) analyzed patent statistics data and a series of patent-related lawsuits. They found that patent litigation rates in different technical disciplines are significantly different. In particular, chemical patent have the lowest litigation rate and pharmacy the highest, because pharmacy innovation relies heavily on patent protection (Levin et al., 1987; Cohen, Nelson, & Walsh, 2000). Lerner (1995) found that there might be 60 cases of patent litigation out of 1,000 patents in the field of biotechnology, four times higher than the average rate. The high rate of biotechnology patent litigation may result from lack of experience dealing with conflict, or few legal references, making it hard to achieve reconciliation. Lanjouw & Schankerman (2001) identified four key factors determining patent litigation from prior theoretical models. They also found that the probability of infringement litigation increased with the number of patent's claims and citations. This result shows the patent value affects litigation decision.

Somaya (2002) examined the U.S. patent litigation cases from 1970 to 2000 and found patent litigation in the fields of medical and electronic technologies increased significantly, so did the rate of patent applications in the two fields. However, Somaya also found that most medical and electronic technology litigations are solved through early settlement, due to the heavy cost of patent litigation. Aoki & Hu (2001) argued that the cost of patent litigation including financial cost and time cost. Patent litigation always lasts several years. Ladas & Parry (1997) found that the average time length of patent lawsuit varies greatly among countries.

In Germany, the machinery industry shows a significantly higher tendency to

patent litigation, while chemical and electronics industries tend to have lower numbers of patent-related lawsuits (Cremers & Katrin, 2004). Weatherall & Webster (2010) showed that about 28% innovation is copied to a certain degree, and half of which issued a statement of infringement. 40% of the infringement statements successfully stop the infringement. He also suggested that the cost to protect patent rights should be reduced.

2.4 Patent Research in China

Chinese researchers have begun to show interests in patent behavior in recent years. Current studies are mainly concerned with the relationship between patent behaviors and competitive advantages, literature review, and comment (e.g., Liu & Tan, 2005; Ren, 2007, Mu, Wang, & Zhong, 2009). Li (2009) reviewed the literature on patent protection motivation. Xu (2008) explored the motivations behind China's patent applications from the macro-level. Liu (2009) studied the behavior of Chinese and German software firms' patent applications and its determinants. He concluded that the legal environment, firm size and product category are three key factors affecting software patent application behaviors. Albert (2010) argued that market involvement and threat of competition are the main reasons for the rapid increase of patent application. Yang, Li, & Chen (2010) investigated small hi-tech firms in the *Zhongguancun* Science Park in Beijing, and studied the relationship between intellectual property management of RandD employee and patenting propensity. Their study revealed a positive relationship between the two. Xu (2008) studied patent behavior of firms in Zhejiang province, and suggested that more patent protection could improve firms' patent awareness, and promote firms' patent activity.

Other research studied issues concerning patent licensing and litigation, such as micro-economic analysis of patent licensing transactions (Bao, 2004), category and model of patent licensing (Yue & Gu, 2005). For example, Wang and Ren (2009) addressed the Zhejiang manufacturers' patent licensing practices. Li (2009) summarizes the motivation of patent litigation; Zhu, Yuan, & Yu (2010) analyzed characteristics of patent litigation on financial business method.

It is not difficult to conclude that research on patent behaviors of Chinese firms has been steadily increased over the recent years. However, research concerning patent behaviors in China is still relatively preliminary. Large-scale survey and empirical research is lacking.

3 Theoretical Framework and Sample

3.1 Conceptual Framework

Based on the above literature review, we can summarize corporate patent behavior in Chinese firms into three areas, namely patent acquisition, patent licensing and patent litigation. The antecedents of patent behavior are under-explored. In this paper, we divide factors affecting a firm's patent behavior into external environment, internal strategies and capacity aspects. This paper only addresses China technical firms' patent behaviors. The Conceptual framework of this paper is shown as below.

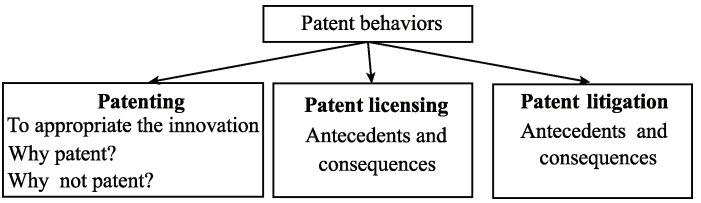

Fig. 1 Conceptual Framework

Based on the above framework, we argue that Chinese firms' patent behavior is unique due to the following reasons: First, the majority of Chinese firms are latecomers, their motivations to acquire patents are likely to avoid being blocked; second, in patent licensing, as many Chinese firms are upgrading in the value chain, with the accumulation of technological capabilities and complementary assets, they may tend to license in more advanced technology from abroad; third, due to Chinese cultural and IPR legal environment, Chinese firms tend to avoid litigation in patent protection.

3.2 Sample

In order to address the research questions, this paper, based on the work of Cohen, Nelson, & Walsh (2000), Arundel (2001), Pitkethly (2001) and Ren (2008), designed a 5-point Likert-type questionnaire on Chinese firms' innovation and patent behavior, where 1 means the least important (or unlikely, or scarcely happened) and 5 means the most important (or very likely, or frequently happened).

A survey was carried out in Shanghai and Zhejiang province locating at

Yangtze Delta Region, East China. We collected 213 valid responses, with 85 from Zhejiang province (including 28 by mail and 57 collected in the field) and 128 from Shanghai city (including 75 mailed and 53 collected in the field).

Among the 85 responses from Zhejiang province, 28 were certified national-level high-tech firms and 31 certified provincial-level high-tech enterprises, accounting for 33% and 37% of the total samples, respectively. Among 128 responses from Shanghai city, 9 were certified national-level high-tech firms, 44 were certified provincial-level high-tech firms, 20 were certified district-level high-tech firms, and 51 were high-tech firms without certificate, accounting for 7.3%, 35.5%, 16.1%, and 41.1 % of the total responses, respectively. The number of employees in most of the responding firms was less than 1,000, therefore the sample firms were mainly small and medium sized high-tech enterprises.

Descriptive statistical analysis and correlation analysis were conducted in turn. With independent samples *t*-test, we found that there was no significant difference (at the 5% significance level) between regional grouping (Shanghai or Zhejiang). Therefore, we report the overall sample mean, standard deviation without distinguishing Shanghai samples from Zhejiang ones. The missing values were substituted with the mean value.

4 Results

4.1 Patent or Not?

Patent has its characteristic advantages and disadvantages. The most important advantage of a patent lies in its essence of legal protection. The biggest disadvantage is information disclosure that may result in imitation and difficulty for future appropriation of innovation rent. As a matter of fact, there are many other measures to protect innovation and appropriate innovation rent besides patenting, such as trade secrets, first to market for obtaining market-leading time, or complementary assets like sales, service, and manufacture. These different mechanisms for the protection of product innovation and process innovation often lead to different results. Our survey found that, for product innovation, the most important mechanism is patent, followed by the first for market obtaining lead time, and trade secret; for process innovation, the most important appropriation measure is secret, followed by lead time, and patent, as shown in Table 1.

Table 1 Appropriation Mechanism of Innovation

Appropriation mechanism of innovation	Product innovation		Process innovation	
	Mean	S.E.	Mean	S.E.
Patent	4.319	1.058	4.145	1.085
Secret	4.267	0.991	4.257	0.988
Lead time	4.286	0.975	4.171	0.913
Complementary sale or service	3.706	1.024	3.543	1.026
Complementary manufacture or know how	3.663	1.002	3.841	0.944
Complexity of product or process	3.575	1.088	3.707	0.959
Other legal (design registration / copyright)	3.446	1.121	3.390	1.116

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

Why patent or why not? Scholars generally believe that a firm's motivation to patent includes the following: to measure the performance of RandD personnel, to obtain licensing revenue, to enhance the bargaining chips in cross-licensing, to prevent others patent litigation, to prevent copy and imitation, to block, to improve reputation, to attract venture capital, or to increase the capital of joint venture. Our survey found that, China technical firms' motivations for patent are, for product innovation, to block (patent to prevent competitors' patenting), to prevent patent litigation, to improve reputation, to prevent copying, to improve the bargain power in the negotiation of cross-license, and to increase capital in joint venture. It is obvious that the most important purpose of patenting for product innovation is to protect, while the least important purpose is to obtain licensing revenue; for process innovation, the most important purpose of patenting is to prevent competitors' patent block, followed by preventing copying, improving reputation, strengthen negotiating power (cross-license), and increasing the capital in joint venture and cooperation, as shown in Table 2.

It is well known that in many cases, firms refused to file for a patent. There are many reasons for this: The novelty of innovation is difficult to demonstrate, easy to invent around the innovation, fear of information disclosure in patent applications, the high cost of patent application, the high cost of patent defense in the court, and the imperfect legal system (low reliability).

Our survey found that, for product innovation, the reason of refusing to patent is that, the most important thing is information disclosure in patent applications, followed by afraid of competitors' invent around the patent innovation, and the

Table 2 Motivations for Patenting

Motivations for patenting	Product innovation		Process innovation	
	Mean	S.E.	Mean	S.E.
Measuring the performance of R&D personnel	3.152	1.176	3.208	1.122
Obtaining licensing revenue	3.386	1.250	3.349	1.177
Enhancing the bargaining chips in cross-licensing	3.676	1.051	3.599	1.031
Preventing others' patent litigation	3.994	0.936	3.845	0.937
Preventing copy and imitation	3.924	1.095	3.874	1.001
Blocking	4.066	0.927	3.957	0.956
Improving reputation	3.979	0.997	3.854	1.022
Attracting venture capital	3.206	1.139	3.069	1.089
Increasing the capital of joint venture	3.390	1.148	3.398	1.081

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

weakness of IPR law system. With regards to process innovation, the situation is similar, the most agreed reason is that the information disclosed in patent applications, and the third is difficult to explain the novelty of innovation. The cost of patent application is the least agreed reason leads to no patenting for both kinds of innovation.

Table 3 Reasons for Not Patenting

Reasons for not patenting	Product innovation		Process innovation	
	Mean	S.E.	Mean	S.E.
The novelty of innovation is difficult to show	2.908	1.139	2.977	1.086
Easy to invent around the innovation	3.034	1.037	3.060	0.992
Fear of information disclosure in patent applications	3.049	0.985	3.091	0.971
The high cost of patent application	2.446	1.036	2.336	0.940
The high cost of patent defense in the court	2.705	1.091	2.636	0.997
The legal system is not perfect (low reliability)	2.940	1.074	2.895	1.030

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

IPR actually encourages innovation. Similarly, there are many factors that ultimately lead firms to choose other appropriation measures. Our survey found that, over the past three years, more patents concerning product innovation and

process innovation have been submitted. The percentage of patented product innovation is higher than that of process innovation.

4.2 Patent Licensing

Our survey showed that firms have not been actively involved in patent licensing activities. About 30% technical firms have experience in licensing in patented technology. As for licensing out patented technology, about only 18% Chinese technical firms have this experience. These facts reflect that Chinese firms are still dominated by introducing advanced technology into their operation. As most Chinese firms are latecomers, they rely heavily on the absorption of outside knowledge to improve their technological innovation capabilities.

Along with the shortening of technology life cycles and the strengthening of research and development, Chinese firms have actively involved in activities of patent licensing. By inviting firms to estimate their possibility of involving in patent licensing deals in the past and next five years, we found that the possibility of patent licensing activities will increase while the possibility of licensing in local technology remains rather low. Chinese firms as a whole are not fond of participating actively in patent licensing. As shown in Table 4, expected behavior with the highest possibility is licensing in from abroad, but it only scored a mere 2.05.

Table 4 Participation in Patent Licensing

License in or license out	In last 5 years		Plan in next 5 years	
	Mean	S.E	Mean	S.E
License in locally	1.349	0.8269	1.908	0.9727
License in abroad	1.450	0.8723	2.050	0.9328
License out locally	1.433	0.8808	1.956	0.9406
License out abroad	1.407	0.9537	1.842	0.9664

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

There are many factors affecting Chinese firms' participation in patent licensing activities, including the lack of technology intermediaries, scarcity of talent in technology transfer, underdeveloped technology transfer legal system and technology transfer market. Our survey showed that underdeveloped market for technology transfer and underdeveloped legal and regulation regime are the

two most important factors, as shown in Table 5.

Table 5 Factors Affecting Firms to Participate in Patent Licensing Activities

Factors affecting China's firms to participate in patent licensing activities	Mean	S.E.
Lack of technology intermediaries	2.612	1.069
Scarce of talent in technology transfer	2.727	0.983
Underdeveloped technology transfer legal system	2.846	1.051
Underdeveloped technology transfer market	3.331	1.068

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

4.3 Patent Litigation

With the development of technology and the awareness of intellectual property right, more firms begin to strengthen the protection of intellectual property right, and regard intellectual property as important resources. In our survey, more than 30% of sample firms experienced patent litigation. Our survey also show that over the past five years, the number of patent-related litigation cases remained relatively low; and in the next five years, there would be a slight increase in patent litigation. Firms predicted the possibility to be plaintiff significantly higher than to be defendant. Even the possibility of patent litigation was expected to increase in the future. Sampled firms as a whole expected patent litigation would not happen frequently, as shown in Table 6.

Table 6 Experience and Expectation of Patent Litigation

Kinds of Litigation	In last 5 years		Plan in next 5 years	
	Mean	S.E.	Mean	S.E.
Litigated by other firms	1.175	0.493	1.408	0.641
Litigate other firms	1.495	0.849	1.909	0.878
Litigated by others and failure	1.230	0.594	1.387	0.652
Litigate other firms and success	1.740	1.178	2.027	1.075

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

When Chinese firms are confronted with patent infringement, they often seek other solutions rather than patent litigation. Long time of duration and high cost

of patent litigation are the two main factors for not filing a lawsuit, as shown in Table 7.

Table 7 Factors Affecting Firms' Participation in Patent Litigation Activities

Factors affecting firms to participate in patent litigation activities	Mean	S.E.
High cost of litigation	3.037	1.212
Long time of patent litigation sustained	3.353	1.206
Imperfect IPR legal system	2.969	1.174
Judge's level	2.475	1.056
Other solutions	3.373	1.121

Note: In the 5-point questionnaire, 1 means the least important, and 5 means the most important. S.E. = standard error.

5 Discussion

5.1 Discussion of Patent Decision

We conducted correlation analysis of the proportion of product innovation which is not protected by patent, with firms' perception of appropriation mechanism of innovation and reasons for not patenting for product innovation. The proportion of product innovation which is not protected by patent is negatively correlated with A (A denote innovation is protected by patent). A positive correlation exists between the proportion of product innovation not protected and *NA* (difficult to explain the novelty of an innovation), *ND* (the high cost of patent application), *NE* (the high cost of defense), and *NF* (the imperfect of IPR system).

The proportion of process innovation which is not protected by patent is negatively correlated with *B* (protected by secret). There are positive correlations between the proportion of process innovation which is not protected and *NA*, *NC*, *NE*, and *NF,* as shown in Table 8.

We can also make a comparative study with relevant foreign data. For product innovations, Chinese firms view patents as the most important appropriation mechanism, followed by lead time and trading secrets. For process innovation, secret is the best protection mechanism, followed by lead time and patent. This is different from the result of Levin et al. (1987) and Cohen, Nelson, & Walsh (2000). Levin et al. (1987) found that, for the process innovation, patent is the most ineffective measure, while lead time, learning curve advantages and secret are the preferred measures; for product innovation, the role of patents is slightly

Table 8 The Proportion of Innovation Not Patented and Related Factors

Correlation	*A*	*B*	*C*	*D*	*E*	*F*	*H*
CP	–0.227**	0.023	–0.019	0.100	0.058	0.001	0.112
GP	–0.025	0.136*	0.079	0.017	0.102	0.100	0.070
Correlation	*NA*	*NB*	*NC*	*ND*	*NE*	*NF*	*NA*
CP	0.183**	0.060	0.108	0.175*	0.204**	0.192**	0.183**
GP	0.235**	0.109	0.173*	0.128	0.165*	0.182**	0.235**

Note: ** and * denote significant at the 0.01 and 0.05 level, respectively (2-tailed). A–H denote appropriation mechanism for innovation (Table 1), NA denotes *the novelty of innovation is difficult to show*, NB denotes *easy to invent around the innovation*, NC denotes *fear of information disclosure in patent applications*, ND denotes *the high cost of patent application*, NE denotes *the high cost of patent defense in the court*, NF denotes *the legal system is not perfect (low reliability)*.*CP* = product innovation, *GP* = process innovation.

better than a secret, but still ranks after lead time and learning curve advantages. Cohen, Nelson, & Walsh (2000) also found that the patent is actually the least important mechanism for innovation appropriation, secret and lead time deserves more attention.

The main motivations for Chinese firms to patent a product innovation are to block or prevent to be blocked, to enhance reputation, and to prevent patent litigation and copying. The motivations for Chinese firms to patent a process innovation are to block, to prevent copying and to enhance reputation. Compared to Cohen, Nelson, & Walsh (2000), for product innovation and the process innovation, the first motivation to patent is to prevent from copying, followed by to avoid to be blocked by other companies. Other studies also found that companies attach great importance to lead time and secrets. (Arundel, 2001; Sattler, 2002). The main reasons of Chinese firms' not to patent are information disclosure, invention around and imperfect IPR system, which is also slightly different from Cohen, Nelson and Walsh's findings.

Chinese firms' behaviors actually reflect their real business situation. They want to break away from the domination of the multinational corporations and to strengthen their own competency, and to be more actively involved in their business development. First, most Chinese firms are late-comers, which means that they often have to face the challenge of leader's patent. Second, there are many encouraging policies to urge firms to patent. Third, with the rapid growth of Chinese firms and industry, many firms want to enhance their reputation to win more market shares.

5.2 Discussion of Patent Licensing

We analyzed factors influencing the propensity of firms' patent licensing in or out by regression method. The results showed that there is significantly positive relationship between the experience of patent licensing in and the possibility of future local patent licensing in (Table 10). This result indicates that, to a certain degree, firms have benefited from buying technology outside. The possibility of future foreign patent licensing in is inversely related to past local patent licensing in or out, and is positively related to experience of licensing, past foreign patent licensing in and future local licensing in or out (Table 11).

Table 10 Regression Results of the Possibility of Future Local Patent Licensing in

Result of regression	Unstandardized coefficients		Standardized coefficients	*t*	Sig.
	B	Std. Error	Beta		
Constant	0.453	0.108		4.196	0.000
Past local patent licensing in	0.749	0.077	0.556	9.666	0.000
Experience of licensing in	0.489	0.166	0.170	2.957	0.003

Table 11 Regression Result of the Possibility of Future Foreign Patent Licensing in

Result of regression	Unstandardized coefficients		Standardized coefficients	*t*	Sig.
	B	Std. Error	Beta		
Constant	0.122	0.084		1.453	0.148
Past local patent licensing in	–0.225	0.069	–0.165	–3.260	0.001
Experience of licensing in	0.210	0.116	0.072	1.810	0.072
Future local patent licensing in	0.372	0.058	0.367	6.431	0.000
Past foreign patent licensing in	0.671	0.050	0.532	13.412	0.000
Past local patent licensing out	–0.324	0.070	–0.259	–4.593	0.000
Future local patent licensing out	0.364	0.074	0.359	4.914	0.000

Compared with firms in developed countries such as Japan reported by Collinson, Kato, & Yoshihara (2006), which attaches greater importance to licensing-in technology, the enthusiasm of Chinese firms in patent licensing is still low. Regarding to its technology lead, Japanese firms also carry more foreign patent licensing-out than licensing-in. Chinese firms should pay more attention to patent licensing.

5.3 Discussion of Patent Litigation

We adopted regression analysis to investigate Chinese firms' possibility of patent litigation in the future. Regression results show that it is related to their experience of patent litigation. The firms which have experience of being litigated tend not to litigate other firms.

International experience shows that patent litigation propensity in different technical areas is significantly different. Low patent litigation propensity usually appears in the chemical sector and high patent litigation propensity exists in pharmaceutical and healthcare industries. According to the U.S. patent litigation data between 1975 and 1977, about 45% of the patent litigation occurred seven years after the patent application, and 75% happened 11 years after the application. These percentages are similar to that of in Japanese firms (Lanjouw & Schankerman, 2001).

Table 12 Regression Results of the Possibility of Filing Patent-Related Lawsuits in The Future

Result of regression	Unstandardized coefficients		Standardized coefficients	*t*	Sig.
	B	Std. Error	Beta		
Constant	0.075	0.097		0.775	0.439
experience of being litigated	–0.287	0.102	–0.144	–2.820	0.005
future possibility of being litigated	0.632	0.070	0.466	8.988	0.000
experience of litigate other	0.378	0.058	0.295	6.492	0.000
success possibility of litigate other	0.332	0.042	0.387	7.930	0.000

Based on the data of 824 patent litigation cases in Germany over the period 1993 to 1995, the industry having the highest litigation rate was the machinery sector, accounting for about 36.79% of the total litigation cases (Cremers and Katrin, 2004).

In contrast, Chinese firms usually have a low tendency to file patent litigation. It is probably due to the underdeveloped patent litigation system and Chinese culture which prefers settlement to conflicts. Japanese firms also share the similar culture.

As Chinese firms are upgrading in the global value chain, patents play an increasingly important role in maintaining their sustainable competitive advantage. Therefore, from a dynamic view, Chinese firms will be more actively involved in patent licensing and patent litigation.

6 Contribution and Limitation

This paper presents evidence for firms' patent behaviors in China. It also revealed the typical Chinese firms' patent behaviors, that is, for strengthening their patent licensing.

By contrasting the patent behavior of Chinese firms with their foreign counterparts, we hope to help Chinese firms realize the importance of patenting and therefore become more active in patent behaviors to improve their competitive advantage. According to the resource-based view, patents serve as resources, capability and knowledge for firms. Therefore, Chinese firms should deal with patent at a strategic level.

Due to the complexities of the investigation in this study, the scope of our survey was limited to Shanghai and Zhejiang, which both are economically developed regions in China. Future research could be carried out in other regions. In addition, we hope future studies explore the relationship between patent behavior and firm performance, so as to fill another research gap in China.

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