The Determinants of Valuable Patents

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***Abstract*--Patent litigation has become an important strategic instrument through which firms exercise their patent rights, reflecting competition and conflicts between R&D contenders. A patent more likely to be litigated can be considered as a more valuable patent. Therefore, the objective of this paper is to investigate the patents that Non-Practicing Entities would be interested in, the characteristics of patents that they would consider valuable, and the difference between patents under litigation or not.**

I. INTRODUCTION

The advent of the knowledge economy has made innovation the key factor in a firm's survival and business profits [12]. Therefore, intellectual property rights, among which the patent is considered premier example, have played an important role in boosting development of this knowledge economy [4]. Patent protection was designed to protect core products or techniques from unauthorized use. Nowadays, patents are not confined to the design of tangible products but extend across a wider range, from manufacturing techniques to business models. However, companies have used patents not only as legal tools but also as strategic instruments to enhance competitiveness and increase profit. Patent litigation has become very important in recent years [10], and an important strategic instrument used by firms to exercise their patent rights and which reflects competition and conflicts between R&D contenders [9]. In recent 20 years, there were numerous attack and defense cases that companies fought for market share by patent litigation. Following are two attack and defense cases in LED and smart phone industries. With the popularization of the consciousness of environmental protection and the maturity of LED lightening technology, the leading international companies used patents as their competition tools to start a series of litigations from 1996 in order to achieve dominance in the marketplace. Around 2002, lots of settlements were reached through cross licensing and LED market was mutually controlled by 5 magnates –Nichia, Cree, Osram, Toyoda Gosei and Philips Lumiled. As for smart phone industry, smart phones have taken place of traditional phones to achieve the dominant position in the mobile phone market, which made the main traditional mobile phone manufacturers like Nokia, Motorola and Sony Ericsson fade out of the market and a new round of contention battle of mobile phone market began. Then patents relevant to smart phones become competition tools for these newly established leading manufacturers, such as Apple, Google, Samsung and HTC. From aforementioned cases of patent litigation in the two industries, we can observe that nowadays companies no longer only focus on the validity or litigation of patents, but desire to achieve business purpose through patent litigation and transfer patent litigation to a crucial strategic instrument for companies. In addition, it is widely accepted that one of the most important characteristics of a valuable patent is whether or not it has been involved in litigation. A patent more likely to be litigated can be considered as a more valuable patent [1]. A litigated patent is substantially superior to a non-litigated patent because the former has been used practically to protect intellectual property in court. Patents that have been through litigation where an infringement case was won are more valuable than those that have not been confirmed through litigation [16]. Allison, Lemley, and Walker [2] demonstrated that the most-litigated patents have higher market values. Litigated patents are of higher value than those that have not been litigated and their characteristics are fundamentally different. Allison et al. [1] found that valuable patents have withstood more claims and have more forward and backward citations. Therefore, the objective of this paper is to investigate the patents that Non-Practicing Entities (NPEs) would be interested in, the characteristics of patents that they would consider valuable, and the difference between patents under litigation or not.

In order to fill the gap in research, this study discusses the types of patents that NPEs would be interested in, the characteristics of patents that they would consider valuable, and the difference between patents under lawsuit and those that are not. Section 2 outlines the literature review and hypothesis development; Section 3 describes the methodology and measurements applied in this paper; Section 4 discusses the empirical results; and the final section offers the conclusions and implications of this study.

II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

A. Non-Practicing Entities

The exclusive right of a patent allows the possibility for patentees to hold a legal monopoly, that is, the prerogative to take all sales profits from patent products. Small inventors or companies can rely on one essential patent to survive in a giant market. This nature of patents has resulted in the existence of so-called "Non-Practicing Entities", which aim to maximize returns with minimum cost in the shortest possible time. These NPEs are individuals or groups who do not make products but engage in lawsuits. They rack up patents solely in order to sue potential infringers such as large

firms who refused to accept their patent licensing terms. From these lawsuits, they receive a large payoff in terms of compensation through licensing fees, or patent royalties.

In order to obtain key patents, there are NPEs specializing in various fields. These NPEs, no matter how many patents they obtain, can efficiently deliver a heavy blow to large firms through litigation, for which there is a cost of time, money, and compensation involved in the form of royalties and licensing fees. However, this behavior burdens industry development, increases costs, and shrinks benefits. NPEs initiate thousands of patent infringement actions. A high rate of winning brings them non-stopping licensing business and high compensation.

But do all the NPEs have the aforementioned characteristics and are all the entities with such characteristics are NPEs? Strictly speaking, all the NPEs have such characteristics, none of them engage in commercializing activities relevant to specific patents. The purpose of owning patents is not producing and selling goods to make profits but charging for licensing fees or royalties from potential infringers through litigation. But conversely, in a narrow sense, not all the firms or organizations that have such characteristics are NPEs, such as research institutes and individual inventors, they actively undertake research and development activities to apply for patents, but due to lack of resources or else, they make profits by technology transfer or patent licensing rather than commercializing patents on their own. But they are not NPEs because they are original patentees, they depend on innovative activities rather than buying activities.

The purpose of this study is to find out the characteristics of potential valuable patents whose patentees do not have complementary resources to influence value-creating capabilities of patents. So the object of the study NPEs are defined as follows: entities obtaining patents by buy-outs or licensing rather than creation activities and making profits by bringing lawsuits to potential infringers for compensation fees or royalties rather than commercializing patents.

B. The main effect of the scope of patent technology

The "patent technology scope" measures how far the field of patent technology could possibly reach [11][18]. Lerner [11], Somaya [17], Allison et al. [1], and Su et al. [18] used patent technology scope as an independent variable to analyze its correlation with the number of patent lawsuits in which a patentee was involved. Empirical studies indicate that patent technology scope has a positive correlation with the numbers of patent lawsuits [11]. Su et al. [18] found that patent technology scope is positively related to the probability of patent litigation. However, Allison et al. [1] and Nerkar, Paruchuri, and Khaire [15] did not find them to be correlated. Prior research has found that the valuable patents are highly related to patent technology scope: the more classes involved, the wider the extent of the scope, and the more value an invention has. Accordingly, this study proposes the first hypothesis as follows:

Hypothesis 1 (H1): The patent technology scope is positively associated with the probability of patent litigation.

C. The main effect of patent claims

Patent claims define the scope of protection covered by the patent, including independent claims and dependent claims. The number of independent claims under a patent indicates the number of objects being protected. The more independent claims made under a patent, the wider the extent of the protection it could confer during prosecution and litigation, and thus the higher valuation basis of compensation. Dependent claims function as barriers for opponents who attempt to surpass or design around the patent. More dependent claims mean more protection and less chances for dependent patents.

The number of claims to some extent reflects the invention's subjective value to the applicant. More claims mean more application fee, and the patent agent drafting the patent specification would charge more as well. Therefore, Nerkar et al. [15] suggested that the more claims made under a patent, the greater the delineation of the intellectual property. A large number of claims would help companies to identify potential infringers or licensees in particular fields even before such infringements take place.

In addition, independent claims and dependent claims have different functions - this study tries to verify their impact on the valuable patents respectively, which is rare in previous empirical studies. Therefore, this study implies the following hypothesis:

Hypothesis 2 (H2): The number of claims is positively associated with the probability of patent litigation.

Hypothesis 2-1 (H2-1): The number of independent claims is positively associated with the probability of patent litigation.

Hypothesis 2-2 (H2-2): The number of dependent claims is positively associated with the probability of patent litigation.

D. The main effect of backward citations

Patent effectiveness can be strengthened by increasing the number of backward citations. There are two kinds of backward citations: patent references and non-patent references (that is, scientific journal papers, conference proceedings, books, industrial standards, technical disclosures, engineering manuals, and other published material) [14]. Generally speaking, non-patent references involve cutting-edge scientific research, as opposed to patent references which are prone to reveal practical techniques. Callaert, Van Looy, Verbeek, Debackere, and Thijs [3] considered high-quality patents to be those that often cite non-patent references. The more non-patent references, the closer the patent is to frontier science. As in business, high-quality patents can stand for the power of scientific knowledge, and thus possession of more high-quality patents means a company is stronger in the field. Hence, this study

proposes the following hypothesis:

Hypothesis 3 (H3): The number of backward citations is positively associated with the probability of patent litigation.

Hypothesis 3-1 (H3-1): The number of patent references is positively associated with the probability of patent litigation.

Hypothesis 3-2 (H3-2): The number of non-patent references is positively associated with the probability of patent litigation.

III. METHODOLOGY AND MEASUREMENT

A. Sample and data collection

The firms selected are non-practicing entities as indicated by the Patent Freedom database. After adjustments for extreme values and missing data, the final sample for analysis consists of 15 firms and 1311 patents (231 litigated patents). This patent data was gathered from the United States Patent and Trademark Office (USPTO). The study data contained sufficient information about the names of assignees, technical fields, the issued dates, and so forth. This study uses the Westlaw patent litigation database to determine whether, and how often, each patent in the sample has been litigated.

B. Measurement

The definitions and measurements of the variables were further defined as follows:

- Dependent variable

Litigated/Non-litigated patents: The dependent variable is a categorical variable and is coded as 1 if a patent has ever been litigated and 0 if a patent has never been litigated. This study used "litigated patent" as the proxy variable for a "valuable patent."

- Independent variables

Patent technology scope: This study selects the US patent classification (UPC) to measure patent technological scope. Patent technology scope is computed as the number of different patent subclasses (or second-level patent classes) in the application document.

Number of patent claims: The sum of independent claims and dependent claims.

Number of backward citations: The sum of patent references and non-patent references, where the number of patent references consists of the number of US patent references and foreign patent references.

- Control variables

This study included a number of control variables in the empirical model that may influence probability of patent litigation: patent family size and number of forward citations. Patent family size: Most define patent family as a set of either patent applications or publications taken in multiple countries to protect a single invention by a common inventor(s) and then patented in more than one country. The more countries that have applied, the greater the value of the family [6][7][8]. Allison et al. [1] showed a positive relationship between patent family and litigation possibility. Family size of the patent can be referred to as the number of jurisdictions in which patent protection was sought for the same invention.

Number of forward citations: A high degree of forward citations can reflect that a patent is highly valued by other inventors. The more times a patent is cited by others, the higher the innovative value of the patent [5][19]. Allison et al. [1], Marco [13] and Su et al. [18] showed a positive relation of forward citations and litigation possibility. Number of forward citations can be referred to as the number of citations a patent has received within the USPTO.

IV. RESULTS

A. The result of the t-test

The descriptive statistics of this study are shown in Table 1. This study applied a t-test in order to compare the mean of litigated patents with that of non-litigated patents, as reported in Table 2. The averages of litigated patents are superior to those of the non-litigated patents. Regarding the mean of patent claims, independent claims, dependent claims, backward citations, patent references, US patent references, foreign patent references, non-patent references, forward citations, and patent family size, litigated patents have larger values than that of non-litigated patents. However, Table 2 shows that the mean of patent technology scope of litigated patents was not significantly larger than that of non-litigated patents. Testing of the mean reveals a difference between the litigated patents and non-litigated patents.

TABLE 1 DESCRIPTIVE STATISTICS

Variables	Min	Max	Mean	S. D.
Litigated/Non-Litigated patents	0	1	0.18	0.381
Patent Technology Scope	1	21	4.50	2.902
No. of Patent Claims	1	254	21.47	18.076
No. of Independent Claims	1	37	3.21	2.980
No. of Dependent Claims	0	238	18.27	16.851
No. of Backward Citations	0	1091	30.56	72.918
No. of Patent References	0	424	22.81	36.628
No. of US Patent References	0	401	19.55	32.783
No. of Foreign Patent References	0	78	3.29	6.981
No. of Non-Patent References	0	669	7.88	40.231
No. of Forward Citations	0	416	23.14	35.150
Patent Family Size	0	124	16.35	26.604

TABLE 2 CHARACTERISTICS OF LITIGATED PATENTS AND NON-LITIGATED PATENTS

Variables	Litigated patent	Non-Litigated patent	t-value	p-value
Patent Technology Scope	4.81	4.43	1.797	0.073
No. of Patent Claims	28.36	20.00	6.479	0.000**
No. of Independent Claims	4.07	3.03	4.874	0.000**
No. of Dependent Claims	24.29	16.99	6.059	0.000**
No. of Backward Citations	50.51	26.29	4.617	0.000**
No. of Patent References	35.40	20.12	5.827	0.000**
No. of US Patent References	30.73	17.15	5.782	0.000**
No. of Foreign Patent References	4.68	3.00	3.330	0.001**
No. of Non-Patent References	15.10	6.33	3.018	0.003**
No. of Forward Citations	45.58	18.33	11.190	0.000**
Patent Family Size	30.07	13.41	8.893	0.000**

Note: **p<0.01, *p<0.05

B. The result of logit regression

This study applies logit regression models to verify the hypotheses in the research framework. The empirical results in Table 3 indicate that the patent technology scope is negatively associated with its probability of patent litigation. This means that the smaller the patent technology scope is, the higher the probability of patent litigation is. Hence, hypothesis H1 was not supported in this study.

Table 3 shows that the number of patent claims is positively associated with the probability of patent litigation. That means that the higher the number of patent claims, the more probable it is that there will be patent litigation. Hence, hypothesis H2 was significantly supported in this study. In addition, this study explores the influence of the number of independent claims and the number of dependent claims upon the probability of patent litigation. As shown in Table 3, this paper reveals that number of independent claims and dependent claims have a significantly positive effect on the probability of patent litigation. Therefore, these two hypotheses, H2-1 and H2-2, were significantly supported in this study. The coefficient of number of independent claims is comparatively greater than that of the number of dependent claims, as illustrated in Table 3. Therefore, the results show that the extent of the positive influence of the number of independent claims for a patent on the probability of patent litigation is stronger than that of number of dependent claims.

As shown in Table 3, this paper demonstrates that the number of backward citations is positively associated with the probability of patent litigation. This means that the more backward citations there are, the larger is the probability of patent litigation. Hence, the hypothesis H3 was supported in this study. Furthermore, this study has separated backward citations into patent references and non-patent references. Table 3 shows that the number of patent references has a significantly positive effect on the probability of patent litigation. Therefore, hypothesis H3-1 is significantly supported in this study. However, Table 3 shows that the number of non-patent references is not positively associated with the probability of patent litigation. Hence, hypothesis H3-2 is not significantly supported in this study. Moreover, this study has divided patent references into US and foreign references. Table 3 shows that the number of US patent references for patents has a significantly positive effect on the probability of patent litigation. However, Table 3 shows that the number of foreign patent references does not have a significantly positive association with the probability of patent litigation.

The empirical results in Table 3 indicate that the number of forward citations and the patent family size are positively associated with the probability of patent litigation. This means that the higher the number of forward citations and the patent family size, the higher the probability of patent litigation.

TABLE 3 RESULTS OF LOGISTIC REGRESSION ANALYSIS

Variables	Model 1	Model 2	Model 3	Model 4
Intercept	-2.514**	-2.611	-2.611**	-2.550**
Independent variables				
Patent Technology Scope	-0.062*	-0.067*	-0.067*	-0.067*
No. of Patent Claims	0.014**	0.012**	0.012**	
No. of Independent Claims				0.051*
No. of Dependent Claims				0.010*
No. of Backward Citations	0.002**			0.003**
No. of Patent References		0.011**		
No. of US Patent References			0.011**	
No. of Foreign Patent References			0.010	
No. of Non-Patent References		-0.005	-0.005	
No. of Forward Citations	0.018**	0.018**	0.018**	0.018**
Patent Family Size	0.017**	0.016**	0.016**	0.017**
Log Likelihood	-524.9318	-520.9569	-520.9593	-523.7387
Wald χ^2	168.57	176.91	176.90	170.56
Prob > χ^2	0.000	0.000	0.000	0.0000

Note: **p<0.01, *p<0.05

V. CONCLUSIONS AND DISCUSSION

The objective of this paper was to investigate the patents that NPEs would be interested in, the characteristics of patents that they would consider valuable, and the difference between patents under litigation or not. There are several interesting findings in this study. First, the negative relationship between the patent technology scope and the probability of patent litigation means the centralization of technological field scope is beneficial for the probability of patent litigation. If patents have more concentrative technological capabilities, they can take advantage of their core competences to increase their probability of patent litigation.

Second, this study pointed out that number of patent claims has a positive effect on the probability of patent litigation. Additionally, this paper reveals that number of independent claims and dependent claims have a significantly positive effect on the probability of patent litigation. Moreover, the results show that the positive effect of number of independent claims on the probability of patent litigation outperforms that of number of dependent claims on the probability of patent litigation. This paper suggests that their first priority is to pay attention the number of independent claims, rather than dependent claims, because the extent of the positive influence of independent claims of a firm upon the probability of patent litigation is better than that of dependent claims upon the probability of patent litigation.

Third, this study indicates that the number of backward citations has a significantly positive effect on the probability of patent litigation. Furthermore, this study has separated backward citations into patent references and non-patent references. In addition, this study has divided patent references into US and foreign references. Therefore, the results show that the number of patent references and US patent references have a significantly positive effect on the probability of patent litigation. However, the number of non-patent references and foreign patent references do not have a significantly positive association with the probability of patent litigation.

This paper is conducted in the non-practicing entities, but the results are also applicable for practicing entities. Because practicing entities engage in commercializing patents, how much value a patent can bring to them is related to the pure value a patent has internally as well as their distribution channels, brands, reputation, customer relationships, the relations with manufacturers and supplier, marketing, service, complementary technology and other complementary resources. Hence, even though a patent is of low value in its own, it can also play a great role if the company has complementary resources matched to it. It can be concluded that patents that are valuable to NPEs with no complementary resources are absolutely valuable to practicing entities. Thus, practicing entities can use the model to assess patent value and take precautions against potential patent litigations.

Future studies can focus on other industries or other countries to explore the relevant topics, and compare to this study. Finally, these research results can hopefully be beneficial to managers, researchers, or governments, and can contribute to relevant studies and future research as reference material.

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