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Licensing Strategy of Japanese Firms and Competitive Advantage

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Abstract: This study defines inventions traditionally regarded as mere fruits of R&D as "internal inventions," and inventions resulting from other factors collectively as "non-internal inventions." The objective is to show that firms make inventions not only on technological factors. Also, a rough analysis method is proposed to identify how many non-internal inventions are filed for patents, and the case study clarifies the promoting factors. This study aims to demonstrate that the perspective of licensing business, completely distinct from science and technology, is also an adequate explanation of firms' behavior in relation to inventions and patent filing.
Keywords: patent, licensing strategy, case study

Introduction

The usual approach to inventions and patents is implicitly led by a science and technology perspective. However, almost all actors who are applying for patents (on inventions) are definitely doing so with a business perspective in mind. In fact, if we could hire a good patent attorney, turning ideas and inventions into patents would become "technically" feasible (Takahashi, 2002). So what drives a firm to get patents?

Traditionally, inventions are regarded as simple fruits of R&D; we call them inventions for technological strategy. In contrast to these, there exist inventions resulting from other factors, which are collectively defined as inventions for patent strategy. Then, for the top sixteen US and Japanese semiconductor manufacturers, our analysis separates out the number of inventions motivated by technological strategy within the whole set of inventions.

The "licensing business" perspective is completely distinct from the science and technology perspective (Saotome, 1987). We think that Japanese firms' behavior is better explained from a licensing business perspective. The analysis on actual usage of patents in licensing business will show the factors that promote inventions for patent strategy. We use Nichia's blue light emitting diode (LED) as a case, as it was one of the most successful semiconductor products in the twenty-first century.

It must be noted that the firm's competitive advantage cannot depend on only patents. For example, the resource-based view (RBV) of management strategy explains the (i) generation and (ii) sustainability of competitive advantage in relation to the characteristics of the firm's resources. RBV was first advocated by Rumelt (1984) and Wernerfelt (1984). The basic structure of RBV can be simplified as follows (Takahashi & Shintaku, 2002):

(i) Resource heterogeneity of the firm to generate Ricardian rents, and
(ii) Mechanisms to sustain the heterogeneity of the firm.

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Peteraf (1993) concluded that the resources fulfilling these basic conditions could yield sustainable competitive advantage. These basic conditions describe the case of Nichia's blue LED, in which patents form only a small part of the competitive advantage.

Engineers and researchers are generally quite aggressive and prefer to take straight actions against clear-cut matters such as patent infringement. However, these actions constitute a part of strategy. If the legal costs would exceed the damages, a firm would not file a patent infringement lawsuit. Alternatively, even if a firm receives a patent infringement warning, the firm has the option to obtain counter patents through their own R&D or M&A. A patent is a tool for licensing negotiation. The inventions for patent strategy would be produced on such licensing business soil.

Inventions for Patent Strategy

Patent citations

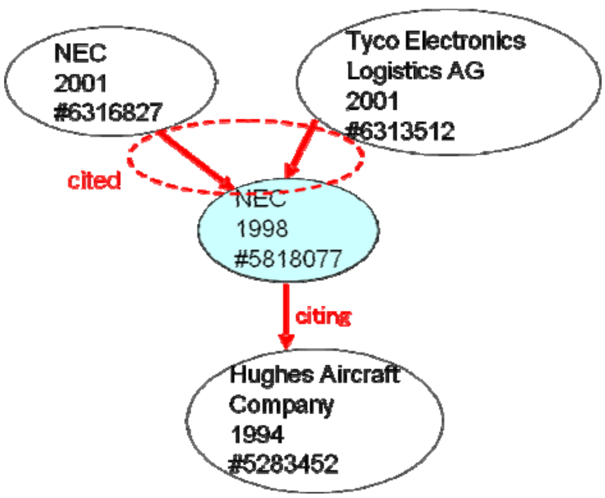
There are not only inventions for technological strategy, but also inventions for patent strategy. The genesis of this idea came from analysis of patent citations. Just as an academic paper cites existing papers, existing patents are cited in filing a patent. For example, in Figure 1, there are four U.S. patents relating to semiconductors, which have citing and cited relationships with each other. In each circle (ellipse), (i) patent owner, (ii) grant year, and (iii) registered patent number are noted. Look at the centrally located patent #5,818,077 (hereafter referred to as "patent 077"; likewise, the other patent numbers are abbreviated to their last three digits). This patent 077 was issued by NEC in 1998, and the following can be observed:

(1) Patent 077 "cites" patent 452 of the Hughes Aircraft Company.
(2) Patent 077 is "cited" by patent 512 of Tyco Electronics Logistics AG.
(3) Patent 077 is also "cited" by patent 827 of NEC itself. This type of citation is called a self-citation.

The data

This study focuses on US patents. US patent data are issued by the United States Patent and Trademark Office (USPTO). These data show the relationships of the citing and cited information. The data of three million patents issued by the USPTO between 1963 and 1999 are provided in an organized form on the webpage of the National Bureau of Economic Research (NBER)[1] and in a CD-ROM appended to a book by Jaffe and Trajtenberg (2002).[2]

Figure 1. The relationships of citing and cited patents



Source: Created by the authors based on data from the USPTO.

[1] http://www.nber.org/patents/
[2] The data was republished by Bronwyn H. Hall at http://emlab.berkeley.edu/users/bhhall/bhdata.html

The data set contains the following basic information: Patent number, grant year, grant date (number of days elapsed since January 1, 1960), application year (starting in 1967), country of the first inventor, state of first inventor (if U.S.), assignee identifier (starting in 1969), assignee type (individual, corporate, or government; U.S. or non-U.S.), main U.S. patent class, and number of claims (starting in 1975).[3]

The data set of this study contains the US patents registered from 1990 to 1999;[4] classified into USPTO primary classes 257, 326, and 438, defined as "semiconductor devices" by Hall, Jaffe, and Trajtenberg (2002); and filed by the top sixteen US and Japanese semiconductor manufacturers ranked by sales.

The sixteen semiconductor manufacturers consist of six US firms: Advanced Micro Devices (AMD), IBM, Intel, Micron Technology, Motorola, and Texas Instruments (TI); and ten Japanese firms: Fujitsu, Hitachi, Panasonic, Mitsubishi, NEC, Rohm, Sanyo, Sharp, Sony, and Toshiba.

Self-citation ratios

Table 1 shows the number of patents, the number of citations, and the number of self-citations by each firm. *The self-citation ratio* is derived by dividing the number of self-citations by the number of citations for each firm.

In table 1, the firms are arranged in descending order by the number of patents for each country. This also puts the self-citation ratio of US firms into descending order. However, for Japanese firms, this is not so. In particular, the top three Japanese firms in terms of numbers of patents—Toshiba, NEC, and Mitsubishi—have an average self-citation ratio. In order to explain this phenomenon, we propose a hypothesis.

A Hypothesis about Inventions for Technological Strategy

Table 1. Self-citation ratio by firm

		Number of patents	Number of citations	Number of self-citations	Self-citation ratio
American firms	TI	1,418	10,546	2,196	0.21
	IBM	1,331	13,691	2,534	0.19
	Motorola	1,303	9,084	1,333	0.15
	Micron Technology	1,168	12,709	1,888	0.15
	AMD	802	6,886	730	0.11
	Intel	320	2,517	177	0.07
Japanese firms	Toshiba	1,729	9,609	1,370	0.14
	NEC	1,722	8,186	743	0.09
	Mitsubishi	1,670	8,792	1,078	0.12
	Hitachi	907	5,340	912	0.17
	Fujitsu	813	4,580	403	0.09
	Matsushita	560	3,204	186	0.06
	Sony	557	3,278	213	0.06
	Sharp	440	2,208	169	0.08
	Rohm	191	795	26	0.03
	Sanyo	112	529	24	0.05

Source: Created by the authors based on the data of NBER.

[3] Moreover, the data includes information derived from the above basic information: technological category/ sub-category, number of citations made, number of citations received up to December 2002, percent of citations made by this patent to patents granted since 1963, measure of generality of a patent (how commonly it is cited), measure of originality of a patent (how often it is cited in specific field), mean forward citation lag, mean backward citation lag, percentage of self-citations made, upper and lower bounds.

[4] In December 1999, USPTO launched the Patent Application Information Retrieval (PAIR) system, which makes it possible for applicants and their designated agents or attorneys to access patent application data quickly. This study focuses on the data before this system became available. Press release #99─50.

In Japan, the contents of a patent are not open to public inspection in the patent gazette until eighteen months after patent filing. The United States has also introduced a system that lays open the contents of the patent when eighteen months have passed since the patent filing date, for patents filed on and after November 29, 2000. US patents filed on or before November 28, 2000 were disclosed at the grant. It took two years on average from application to grant (Hall, Jaffe, & Trajtenberg, 2002). Thus, the time lag to disclose the contents is considered to be the same in Japan and in US.

Therefore, during this time period of about eighteen months to two years, only the applicants know the patent contents. This time lag to patent disclosure has great meaning if R&D breakthroughs occur and many inventions take place continuously one after another in a short time period. Without knowing the latest other firms' patents, and without citing them, inventions are created endogenously and intrinsically in a chain reaction within a laboratory. Therefore, most of the citations would probably be self-citations.

This study refers to these inventions as "inventions for technological strategy." If inventions for technological strategy are born in a chain reaction under closed conditions in a firm without knowing about other firms' patents, this should increase the proportion of self-citations. Using this self-citation concept, the following hypothesis can be constructed in relation to these inventions for technological strategy.

Hypothesis:

For a period when a firm generates inventions for technological strategy, the higher the frequency of patent filing, the higher the self-citation ratio of the patents filed.

However, given the complicating factors, we can also easily imagine that not all the inventions are generated for technological strategy. Therefore, the purpose of this study is not only to confirm this hypothesis, but also to specify outlying firms, which are likely to generate "inventions for patent strategy."

Analysis

It must be noted that the greater number of patents granted during a specific period (from 1990 to 1999) implies a higher frequency of patent filing. The number of patents and self-citation ratio in table 1 are graphed as points in the (x, y) plane, to produce the scatter diagram of figure 2. In this figure, the firms are plotted on the coordinate system with the number of patents as the horizontal axis (x-axis) and the self-citation ratio as the vertical axis (y-axis).

In the coordinate plane, the black dots "●" represent US firms, and the hollow dots "○" represent Japanese firms. In figure 2, the relationship may be clear from the plot of the data. The three Japanese firms on the right side of the coordinate plane—Toshiba, NEC, and Mitsubishi Electric—are clearly outliers. The other thirteen firms excluding these three fall nearly along a straight line. The most widely used method for fitting lines to data is the least-squares regression analysis. Using the self-citation ratio as a dependent variable y and the number of patents as an independent variable x, a regression analysis gives the following result (Kishi & Takahashi, 2008),

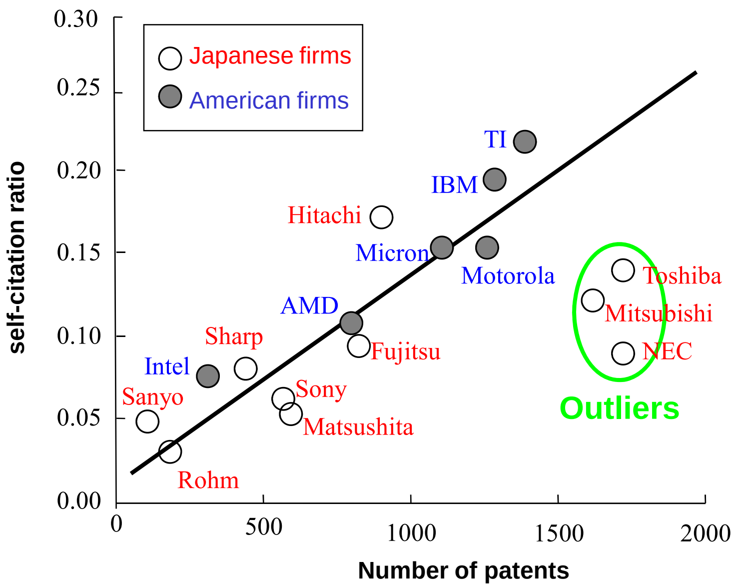
$$y = 0.000120x + 0.0161 \qquad \text{Adjusted } R^2 = 0.8453.$$

Adjusted R^2 is 0.8453, which is significant at a level of 0.1%. In other words, the self-citation ratio increases in proportion to the number of patents during a specific period. This supports the hypothesis, that is, these thirteen firms are considered to generate mainly inventions for technological strategy.

Of these thirteen firms, US firms show a tendency to have both a high number of patents and a high self-citation ratio, except for Intel. By contrast, Japanese firms show a tendency to have both a low number of patents and a low self-citation ratio. Therefore, compared with Japanese firms, US firms probably have a higher rate of R&D, which results in a higher self-citation ratio. Generally speaking, a high self-citation ratio implies a quick pace of R&D.

On the other hand, the three Japanese firms, Toshiba, NEC, and Mitsubishi, having the greatest numbers of patents in figure 2, are actually outliers. They are nearly equal in terms of the greatest numbers of patents, but their self-citation ratio is not particularly high. This characteristic strongly suggests the possibility of inventions for patent strategy being

Figure 2. The relationship between the number of patents and the self-citation ratio



generated by these firms. The deviation from the regression line in figure 2 could show that patents filed by these three firms are probably patents of "inventions for patent strategy."

Therefore, a follow-up interview was conducted on two of the three outlying Japanese firms. The inquiry revealed that during the sample period, management urged the R&D department to increase the number of patent filings and assigned a quota for the number of patent applications for each researcher.

In the next section, the factors used to promote inventions for patent strategy are identified through the case of Nichia's blue LED.

Patents as a Tool for License Negotiation

When a firm requires a license, the simplest and easiest way is to pay for the patent rights held by another firm. However, this type of peaceful license negotiation is extremely rare. This is because a typical license negotiation begins with a patent infringement warning. If a firm receives a patent infringement warning and is pressured for a decision on whether or not to accept the licensing, then the firm should consider the following costs (Takahashi & Nakano, 2007a):

(a) The costs of R&D to avoid that patent. For example, the firm must consider how much of its R&D budget should be allocated to get around that patent within a fixed time limit.
(b) The cost of submitting an appeal-for-invalidation claim about that patent.
(c) The legal costs needed when the patent owners file a patent infringement lawsuit.

If these "avoidance costs" for the patent would be more than the license fee, the firm should decide to accept licensing. Otherwise, the firm should promote inventions for patent strategy in order to slip through the existing patents.

Alternatively, as seen in the consumer electronics industry, multiple patents, including other firms' patents, are needed to manufacture one product. It is usual and inevitable that the manufacturers in the same market will make the similar products, infringing on competitors' patents mutually. Thus, other factors also promote inventions for patent strategy. In this type of industry, agreements to mutually use multiple patents are made, or firms commonly pursue cross-licensing agreements in order to cancel out mutual licensing fees.

At the time of negotiating a cross-licensing agreement, the number of patents filed by firms becomes important. In each case, the negotiating firms count the respective numbers of patents and charge license fees based on the difference in those numbers. Of course, many firms not only count the number of patents, but also consider the number of journal papers and academic reports. Some firms enter the partner's research laboratory to evaluate the research capabilities. However, the number of patents keeps the importance in negotiations. As a result, when the number of patents exceeds a certain range, the license fees often cancel each other out and become close to zero. The cross-licensing agreement is like a "mutual nonaggression treaty" in the context of a legal battle.

Patents abandoned after the conclusion of a contract

Moreover, if the first priority was to complete a cross-licensing contract, after the conclusion of the contract, there is an option on abandonment of patents except for key patents. An impressive example is the so-called "patent 404," or "method of growing a semiconductor crystalline film of nitride compounds" (Japanese patent number 2628404, hereafter referred to as patent 404). The "blue LED lawsuit" fought over this patent commanded public attention from 2004 to 2005. One of the inventors of the blue LED, Shuji Nakamura, sued his former employer, Nichia Corporation (hereafter Nichia), in August 2001. On January 30, 2004, the first trial in Tokyo District Court awarded the incredible amount of 60.4 billion yen as compensation for the invention and ordered Nichia to pay Nakamura the entire amount of the 20 billion yen he claimed.

Nichia attacked the judgment of the Tokyo District Court and appealed to the Tokyo High Court.[5] One of the authors submitted an opinion document from the Nichia side (Takahashi, 2005a; 2005b). The court advised both sides to compromise, and on January 11, 2005, Nichia agreed with Nakamura to pay 840 million yen, including a 600 million yen inventor's reward, to settle out of court. The news of the day described that the amount of the inventor's award was settled as one percent of the 60.4 billion yen sentenced by the Tokyo District Court.[6]

The story does not end here. Almost one year after the settlement, on March 8, 2006, Nichia officially announced that it would abandon all rights to patent 404. According to Nichia, not only patent 404, but all patents without the need for further maintenance have lapsed or were abandoned for the purpose of cost reduction in its business practice of patent management.[7] In 2005, Nichia abandoned 50 patents, including national and international patents.

The management decision about whether or not to sustain patent rights is a business decision independent of the scientific value of the invention, and it is nothing more than a problem of balancing (1) the need to maintain the patent right and (2) the cost of maintenance. In fact, this was well described in the explanation of the official announcement by Nichia (Takahashi, 2006).

The need to maintain the patent right. Nichia itself had entirely ceased use of patent 404 by the first half of 1997, and it was confirmed that the four counterpart firms, which Nichia had cross-licensed in or after 2002, Toyoda Gosei, Osram, and Lumileds, and Cree, were not using patent 404 in the manufacture of blue LEDs. Moreover, the blue LEDs manufactured without using patent 404 became brighter than ones using patent 404. In the case that patent 404 was abandoned, it was hard to believe that the other firms would use patent 404.

Also, the cost of maintaining rights in Japan, the United States, Germany, the United Kingdom, France, the Netherlands, and Italy from 2005 to the patent expired would be a total of 5.19 million yen. The total maintenance cost would be double or triple the amount including the costs of other patents associated with patent 404.

Therefore, as long as a cross-licensing agreement is reached, there is no surprise in patent abandonment except for key patents.

Patent applications abandoned after filing

The case of Nichia shows that it is reasonable not to make costly requests for examination of pending patents except

[5] Nakamura also appealed to the Tokyo High Court against Nichia, claiming an additional 100 million yen on top of the initial 20 billion yen.

[6] However, it must be noted that the subject of dispute in this lawsuit was patent 404 only. Based on the settlement recommendation, the inventor's compensation for this patent 404 was said to be worth 10 million yen at most. From a licensing business perspective, the out-of-court settlement amount of 600 million yen covered the 191 patents registered (including patent 404) and 112 patent applications in Japan for inventions independently or jointly invented by Nakamura, four registered utility models, and the corresponding foreign patents and foreign patent applications, as well as internal know-how left unfiled for confidentiality.

[7] In Japan, there were about one million patents at the end of 1999, but only one third of them were carried out.

for key patents. In fact, all patents filed are not examined. The Japan Patent Office examines only those patent applications that have been requested to be examined with the charge of examination by the applicant or a third party. The request for examination can be made by anyone at any time in three years after the filing date (within seven years from the date of patent filing for applications on or before September 30, 2001). During this period, almost all patents become unnecessary after concluding cross-licensing agreements. In respect of patent applications required just to make up the numbers to negotiate a cross-licensing agreement, it is a reasonable option to neglect the patent applications without examination due to the much higher cost of the request for examination.

In fact, the cost of filing is no more than several hundred thousand yen, whereas the cost of requesting examination and registering a patent, especially as an international patent through the Patent Cooperation Treaty (PCT), is at least ten times more. Therefore, it is a smart business option to use many patent applications of little value as a tool only to cancel out cross-licensing fees. Thus, once a cross-licensing agreement is reached, it is reasonable to abandon patent applications without requesting costly examination except for key patents. In other words, when entering into a cross-licensing agreement, it is a legitimate business option to encourage hair-splitting inventions that slip between existing patents (and therefore have a low self-citation ratio) for the principal purpose of canceling out license fees.

Patents needed for a lawsuit

Still, there is a question. As described above, although it was a reasonable choice to abandon patent 404, why did Nichia fight in court with Nakamura regarding the ownership of patent 404?

There was a bitter dispute about the patents of the blue LED between Nichia and Cree. Cree had backed up the trial of Nakamura. If Nakamura had ownership of patent 404, it was highly likely that the patent right would be transferred to Cree. If that happened, Nakamura would file lawsuits to get patents for his other inventions one after another.

However, before the Tokyo District Court ordered Nichia to pay Nakamura 20 billion yen on January 30, 2004, it issues an “intermediate” decision that Nichia had the ownership of patent 404 on September 19, 2002. This intermediate court decision did not give the ownership to Nakamura. In response to this decision, Nichia and Cree made a cross-licensing agreement on November 6, 2002, regarding the patents for gallium nitride optoelectronic technology. They reached an amicable settlement of the dispute between them (Takahashi, 2006).

This is why there was no other option but to fight for ownership, even if patent 404 was not needed technologically. Nichia could abandon patent 404 soon after the agreement on this cross-licensing contract. However, as long as a supplementary lawsuit remained over the inventor’s compensation, abandonment of patent 404 would raise the risk that the judge would suspect that Nichia had abandoned the patent in order to reduce the sentenced 20 billion yen. Hence, Nichia had a long wait for abandonment of patent 404 until the out-of-court settlement on January 11, 2005.

Sources of Competitive Advantage Other than Patents

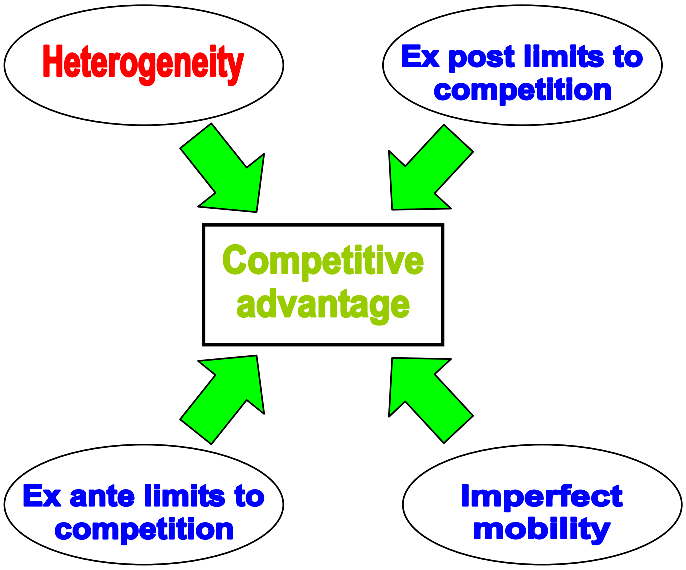
Cornerstones of competitive advantage

The ownership of patents does not promise perfect monopolistic profits. In fact, it is difficult for a licenser to bind a licensee with only the patent rights or a license contract. This is one of the most important motives to choose advanced alliances or capital tie-ups to bind licensees (Takahashi & Nakano, 2007b).

In 1984, two memorable papers in strategic management were published (Rumelt, 1984; Wernerfelt, 1984). The performance is known as the resource-based view (RBV). RBV attempts to explain the competitive advantage from the resource side of the firms (Takahashi and Shintaku, 2002). In the field of strategic management, a “rent” is an above-average return. Before RBV, the rent was considered to be produced by monopolies and oligopolies in the market, as was suggested by economists (Porter, 1980, etc.). This “monopolistic rent” is created (1) when industrial concentration progresses and firms intentionally reduce output to create an artificial scarcity, and (2) when monopolistic profits are made through government regulation and by firms’ mutual agreement.

Demsetz (1973) showed the evidence that a rent was not a result of monopoly, and termed such a rent, created from

Figure 3. Cornerstones of competitive advantage



Note: Additions made by the authors to Peteraf (1993).

the uniqueness of a firm, "Ricardian rent." While monopolistic rents are created by suppression production, Ricardian rents are created by the possession of resources of exceptional value and the unavailability of such resources due to their inherent scarcity (Ricardo, 1817).

Researchers have begun to search for rent sources that are not in the market but within firms. Lippman and Rumelt (1982) sought the creation of rents in "uncertain imitability." They stated that uncertainty creates initial heterogeneity and, at the same time, prevents homogeneity due to imitation; they believed that this is what creates rents. Moreover, Rumelt (1984) termed the mechanisms that sustain these rents "isolating mechanisms." According to Rumelt (1984), isolating mechanisms work as barriers to entry at the industrial level as well as at the corporate level. Moreover, they serve to prevent imitation and substitution of unique resources held by a firm. The isolating mechanisms also make their appearance in a variety of areas of literature: management strategy, economics of organizations, and industrial organizations (Mahoney & Pandian, 1992).

Based on these debates, the basic structure of RBV can be simplified as follows (Takahashi & Shintaku, 2002): (i) resource heterogeneity of the firm to generate Ricardian rents, and (ii) mechanisms to sustain the heterogeneity of the firm. In sum, the sustainable competitive advantage results from these factors. Peteraf (1993) proposed points (b) to (d) as the mechanisms of (ii) and organized them in the following manner:

(a) resource heterogeneity of the firm that creates rents;

(b) ex ante limits to competition, or the securing of resources, whether by foresight or good fortune, by a firm without prior competition, allowing it to gain above-average profits;

(c) ex post limits to competition, or the sustenance of rents secured by a firm by subsequent limitations on competition, a concept similar to uncertain imitability (Lippman & Rumelt, 1982);

(d) imperfect resource mobility, or the assurance that rents will remain with a specific firm (Teece, 1980).

Peteraf (1993) concluded that the resources fulfilling the characteristics of the abovementioned four cornerstones (basic conditions) could yield sustainable competitive advantage, as shown in figure 3. In other words, firms that are able to fulfill these four conditions can enjoy sustainable above-average profits.

The Nichia Case

These four cornerstones (a) to (d) illustrate the case of Nichia's advantage in the blue LED market. It can be concluded that Nichia's competitive advantage was only partially supported by patents, that is, the possession of a single patent right cannot secure the future sales and profits of a firm.

(a) Heterogeneity

First, in Nichia's case, circumstances were not yet anticipated when patent 404 was invented, such as (i) the explosive popularity of mobile phones with color liquid crystal displays, (ii) the phosphor technology in which Nichia had traditionally been strong leading to the development of the white LED, and (iii) the subsequent demand for the inclusion of white LEDs in mobile phones, which created excess sales and profits. The development of the white LED is the key to the above. A common understanding was that a white light is made from the three primary colors of light: red, blue, and green LEDs. The invention of the blue LED was thus awaited. However, the idea behind Nichia's white LED was as simple as the idea in Columbus's egg story, or to make a white light from the blue LED and yellow-light-emitting phosphor. This is a unique product (invention) that only a phosphor manufacturer could develop. The development of the white LED can be judged in terms of the RBV as a typical example of mechanism (a), namely, the uniqueness and heterogeneity of resources that create rents.

(b) Ex ante limits to competition

Next, Nichia's foresight or luck in being able to target its R&D investments on gallium nitride must be acknowledged, while other competitors were still focusing on zinc selenide for development. This led to the second cornerstone (b), namely, ex ante limits to competition. This provided Nichia with the first-mover advantage to enjoy the resulting profits even though it had been said to be impossible to commercialize during the twentieth century. However, this is only one side of the coin; the other is the considerable business risk that Nichia took in choosing to follow this course of action.

Furthermore it cannot be emphasized enough that an important prior investment had been made: the clean building of the semiconductor factory. Since LEDs are small, the machines to make small LEDs are also small. A machine on casters is very easy to move and make. However, a clean building for semiconductors in which such machines are installed requires a lengthy period of construction. Nichia proceeded and built it at a time with uncertain demand. The president of Nichia put his house into security of a debt and raised the construction fund of a factory building. This prior investment enabled Nichia to catch up with explosively growing white LED demand from the market of color liquid crystal cellular phones. As a result, Nichia could cover the white LED demand monopolistically, and that led to its overwhelming share of the white LED market.

(c) Ex post limits to competition

Moreover, in the field of engineering invention, a pioneer patent is usually not enough to succeed in business. Even if patent 404 is a pioneer patent, as the Tokyo District Court declared in its decision, related patents and improvement patents must guard the pioneer patent, and other business resources must be mobilized in support of the pioneer patent, in order to create conditions in which business opportunities brought about by the pioneer patent can be put to effective use. In the cases of the white and blue LEDs, Nichia's advantage in the market is not solely supported by patent rights. The manufacture of such products is made feasible only with various forms of know-how. In this regard, we identify the third cornerstone (c), uncertain imitability.

(d) Imperfect resource mobility

Furthermore, by building its own blue LED chip manufacturing facilities, Nichia was able to create (d), non-transferability. This is extremely important in the semiconductor industry. Although it was at one time a world leader, the Japanese semiconductor industry has over the years lost its edge. One of the reasons for its downfall is believed to be that semiconductor manufacturers did not build their own semiconductor manufacturing facilities, and instead, for example, relied on steppers supplied by outside manufacturers such as Nikon Corporation and Canon Inc. When these manufacturers sold the same types of machines to Korean and Taiwanese semiconductor manufacturers, the advantages that had been enjoyed by the Japanese manufacturers quickly disappeared. Therefore, it is natural to assume that the fact that Nichia made its own manufacturing facilities for the blue LED chip by itself, regardless of the business risks, which helped it sustain its advantage in the market more than the patent rights did.

Conclusions

After World War II and until the 1970s, Japanese firms were more than eager to incorporate foreign technologies; in particular, the period from 1955 to 1964 was an era of fierce competition for foreign technology imports. There were two reasons for such fierce competition (Wakumoto & Nakano, 2005).

The first was that there was a vacuum in the civilian technologies in Japan due to the concentration of development in military technologies during the war, while the United States had extremely advanced civilian technologies. This fact led to the conclusion that the ability to import superior US technologies during this era would directly increase competitive advantage in Japan.

The second was that during this period, imports of foreign technologies were regulated by the Act on Foreign Capital and had to be individually reviewed by the Foreign Investment Council before being approved. This was because the level of foreign currency reserves in Japan was not high at the time, and the Ministry of International Trade and Industry set guidelines to regulate technology imports; for example, one firm could receive a license for 60-cycle power generators, and two firms for 50-cycle models. The mere existence of these regulations encouraged even greater competition with respect to the introduction of foreign technologies.

In such cases, an effective strategy is to establish a business alliance with the foreign firm and to compete with other Japanese firms in their own market. In fact, this strategy is said to have been considerably popular among Japanese firms in the past. However, Japanese firms came to compete in the overseas market, and this strategy has already become less effective. Instead, it is necessary to make up a new strategy for dealing with patents.

Engineers are generally quite aggressive and prefer to take straight action in clear-cut matters such as patent infringement. However, it is a part of the strategy to consider whether to issue an infringement-warning letter. In addition, if the legal costs would exceed the damages, a firm would not file a patent infringement lawsuit.

Wakumoto and Nakano (2005) referred to a case in which Toshiba experienced difficulties in the 1980s for its magnetic resonance imaging (MRI) business of medical equipment. At that time, Toshiba was a world-class player in the medical equipment industry and was regarded as the biggest opponent by General Electric Company (GE) and Siemens AG. There were very few firms engaged in the MRI business, and Toshiba and GE were each other's main competitors. At that time, Electrical and Musical Industries, Ltd. (EMI), GE, and others held the key patents relating to MRI, but EMI's MRI business had been unsuccessful and they had already exited from the business. The license for the key patent held by GE was thought to be indispensable for manufacturing MRIs. However, Toshiba was not licensed by GE.

Toshiba had never received any infringement warning from GE, and was planning to acquire US firm called Diasonics Inc. (Diasonics) whose patent was strong enough to be effective against GE's patent. Toshiba's American subsidiary, Toshiba America Medical Systems, Inc., bought the MRI Division of Diasonics and established Toshiba America Medical, Inc. Although the main purpose of this acquisition was the reinforcement of its American MRI business, Toshiba was able to obtain a powerful patent as a result. In short, if GE had issued an infringement warning to Toshiba, Toshiba would already have possessed the ability to issue a counter-infringement warning to GE. Toshiba and GE were both aware of the possibility of infringement but did not take any actions to correct it, including cross-licensing negotiations.

Patents act as a deterrent even without the rights being exercised. There are some cases in which patents do not become a subject of dispute at court and are not used in license negotiations, and no warnings are even issued for infringement, but they still serve as a deterrent to contain the enemy's attack. This is because infringement warnings often claim everything possible and waste expensive legal costs and time in beating back a counterattack against patent validity. Neither party wants to suffer injuries to their key patents in cross-licensing negotiations. Nevertheless, new cross-licensing complicates a relationship with existing licensees and may bring very little profit to either side if they conduct business operations on the almost similar scale.

Even if a firm receives a patent infringement warning, it has the option to obtain counter patents through its own R&D or M&A. A patent is a tool of the licensing business. Inventions for patent strategy can be produced on such licensing business soil.

This study examined the hypothesis that the higher the frequency of patent filing, the higher the self-citation ratio in the patents filed for a period in which a firm generates inventions for technological strategy. Furthermore, it became clear from the follow-up research that the outliers in figure 2 may well be engaged in inventions for patent strategy. The primary factor in promoting inventions for patent strategy is to prepare for cross-licensing negotiations, whereas cross-licensing negotiations are normally carried out in secret. However, our analysis may probe effectively into this secret activity.

Moreover, the increase in the number of patents over a certain period is accompanied by an increase in the self-citation ratio. From the regression analysis of figure 2, if inventions are generated at a frequency of 8,000 cases over 10 years (a pace of 800 cases per year), then almost 100% of the citations will be self-citations. This tendency indicates that the internal capacity and resources of the firm impose severe constraints on inventions when development is accelerated. In the semiconductor industry, the internal resources were critical when the speed of innovation was high. In fact, Stuart and Podolny (1996) proved that R&D depended on the existing technological position in the accumulative and complicated semiconductor technology. In such an industry, communication with other firms may influence performance relatively less than internal resources, as suggested by RBV. On the other hand, if the speed of innovation is relatively slow, communication with other firms may become the critical factor in succeeding. These considerations have important implications in innovation research. In the latter half of the 1960s, it became common to take up the pursuit of all success factors through the "grand approach." Since the latter half of the 1970s, the "focus approach," has developed, which concentrates on a specific aspect of innovation such as the communication research initiated by Allen (1977) (Takahashi, Kuwashima, & Tamada, 2006).

Brown and Eisenhardt (1995) suggested three classifications as trends of product development research: a rational plan, a communication web, and disciplined problem solving. In the research on communication webs, Allen has actually depicted the network of engineers in the research laboratory and found the "gatekeeper" who plays a central role in the network and is the key person for external communication. However, as shown by our study, the high speed of innovation reduces the external communication effects on performance. In other words, this might imply that the data must be controlled by the pace of development and the frequency of patent filing in order to obtain a causal relationship between external communication and innovation.

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