21 Use of Patents by Firms on Competition Strategies – Empirical Analysis Using Patent-Related Statistics – (*)

Research Fellow: Masayo Kani

This research verified the factors that have an influence on the determination of a strategy to technically exclude other firms, out of firms' patent utilization strategies. Firstly, firms were classified into those that can implement a strategy to technically exclude other firms (discrete technology product firms) and those that cannot do so (complex technology product firms), according to the technical characteristics of the products dealt with by the firm. The research empirically proved that the structure of patent utilization strategies differs between discrete technology product firms and complex technology product firms. On that basis, analysis was conducted on the patent utilization strategies of the former firms. These firms can implement a strategy to technically exclude other firms using patents in order to gain excess profits in the product market, since they lack a technically complementary relationship with other firms. On this occasion, the technology environment matters. Under circumstances where there are many firms in the technology environment a firm faces and other firms' products using substitute technologies grab the market share, the advantage of exclusive in-house use of patents in the product market is small. However, even in such an environment, firms can technically exclude other firms and maintain their market share by establishing patent blocking and preventing other firms from patenting substitute technologies. This research shows that the technology environment has an influence as one of the determining factors for a strategy to technically exclude other firms using patents.

I Introduction

According to the "2006 Survey of Research and Development," Japan's R&D expenditure in fiscal 2005 stood at a record high, amounting to 17,845.2 billion yen. Firms' research expenditures make up 71.4% thereof (12,741.5 billion yen). Seeing that firms spend such a great amount on R&D expenditures, they probably wish to secure the profits generated therefrom. One of the means of securing such profits is through utilization of the patent system.

How, then, do firms exploit the patents they have obtained? In the "Survey of Intellectual Property-Related Activities" conducted by the Japan Patent Office (JPO), the status of patent exploitation by survey targets (mainly firms) has been studied as part of efforts to understand the actual conditions of intellectual property-related activities in Japan. The survey covers a wide variety of items, including the number of patents held, the number of used patents, the number of patents exploited in-house, and the number of patents exploited by other firms. The survey thus provides important information regarding the status of patent exploitation in Japan.

Looking at patents exploited in-house using this data, 25% of all survey targets have some patents that are exploited both in-house and by other firms, meaning that 75% of them have not licensed the patents used in-house to other firms. However, the number of patents used only in-house includes those that are used only in-house because no licensee can be found, despite the intention to license to other firms (licensable rights). It is thus possible to calculate the

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number of patents used only in-house on purpose – in other words, the number of patents exclusively used in-house – by subtracting the number of licensable patents from the number of patents used only in-house. As a result, 39% of the survey targets have patents that are exploited both in-house and by other firms, or licensable patents that have been exploited in-house. However, this indicates that 60% of the survey targets still do not intend to license patented technologies that they use in-house to other firms. In recent years, firms' acts of profiting from patent licensing have attracted attention. Yet the statistics show firms' intention to eliminate other firms with regard to technologies they use in-house.

It is often pointed out that such a difference in patent utilization strategies arises from differences between types of business. From what, then, do differences between types of business arise? Moreover, what factors affect patent utilization strategies? Out of firms' patent utilization strategies, this research focuses on the strategy to technically eliminate other firms, and discusses determining factors for patent utilization strategies after considering the intentions on which strategies to technically eliminate other firms are implemented.

II Prior Research on Patent Use

How is the patent system seen in economics? Since technical knowledge, which is the result of research and development, is information, it has a special character as economic property, as argued by Arrow (1962). That is, there is the issue of appropriability, i.e. the relevant actor cannot enjoy all profits obtainable from technical knowledge due to non-competitiveness and non-exclusiveness. If appropriability is low, others may enjoy a free ride on information. This causes a decline in incentives for invention. Therefore, there is a patent system that prevents such decline in incentives by protecting inventions though the granting of exclusive rights for inventions for a certain period of time. In addition, the mechanism that makes invention information available for use has a significant influence on the economy, and, under the patent system, exclusive rights are granted on the premise of publication. Therefore, the system also functions to promote the transmission of information. Ordover (1991) mentions the patent system from two viewpoints – specifically, protection and transmission of inventions.

However, firms do not always consider protection by patents as the most effective means of achieving appropriability. For example, looking at the effectiveness of appropriability in Cohen et al. (2000), "confidentiality of technical information" exceeds "protection by patents" with respect to product innovations and process innovations. In addition, for process innovations, "prior marketing of products" ranks highly.

Although it is difficult to achieve complete appropriability through patents, the patent system still brings about considerable benefits. What purposes, then, do firms have when they aim at obtaining a patent for technology? Cohen et al. (2000) tabulates the purposes of firms' obtaining patents in two categories – product innovations and process innovations – based on the following seven items: the "prevention of copying," the "prevention of other firms' attempts to patent a related invention, 'patent blocking,'" the "earning of licensing revenue," "use to strengthen the firm's position in negotiations with other firms," the "prevention of infringement," "use as a measure of internal performance of a firm's technologists" and the "enhancement of the firm's reputation." Looking at the results, for both product and process technologies, the "prevention of copying" and "patent blocking" are the prevalent purposes of patenting. This indicates that a patent strategy, which increases the degree of freedom of a firm's own business activities and ensures its position in the product market, thereby enabling it to gain a competitive advantage, is the important purpose of patent use by firms.

Thus, patent utilization strategies are organized here, taking into consideration the purposes of use. First of all, the patents held by firms can be divided into two categories, namely used and unused patents. It is said that about half of the patents in Japan remain unused, though the percentage differs depending on the type of business and the attributes of the firm. Used patents are further divided into two categories based on the user (patentee (in-house) or other firms). Firstly, patents used in-house include those that are used only in-house and those that are also used by other firms through licensing. Furthermore, patents used only in-house include those exclusively used in-house and those used only in-house because there is currently no licensee, not because there is an intention to use them exclusively. Exclusive in-house use is aimed at gaining greater profits in the product market through the prevention of copying by other firms and differentiation from other firms in terms of technology. Secondly, patents used by other firms can be classified based on the forms of licensing, including paid licensing, cross-licensing and patent pooling. In the case of paid licensing, the purpose is licensing revenue. Cross-licensing and patent pooling are forms of technical cooperation with other firms, in which patents also play a role as bargaining chips.

On the other hand, unused patents are not unnecessary patents. According to Motohashi (2007), they can be classified into three types: patents for the "prevention of patenting of related technology (circumventing inventions) by other firms (establishment of patent blocking)," those for the "possibility of future commercialization" and those "preserved for later use with a view to future licensing activities." Firstly, patent blocking can be considered as a strategy for a firm to gain greater profits by preventing inventions that circumvent its patented technology, which serves as its core, and thus protecting the market for its own products. Next, the possibility of future commercialization is an aspect of the postponement option for patents. A patent is an exclusive right available for a certain period of time. For example, if there is great uncertainty about current commercialization of a patented technology, it is possible to postpone its commercialization to the future. In this case, if a firm obtains a patent for the technology as of this moment, the technology will never be used by any other firms. This means that the firm holds the patent while keeping it unused, in anticipation of profits obtainable from the future product market. Patents preserved for later use with a view to future licensing activities are unused patents which firms intend to license to other firms. Firms assume that they will earn licensing revenue through paid licensing or use patents as bargaining chips in cross-licensing or patent pooling in the future.

These three types of unused patents are divided into two categories based on the relationships with other firms. For the "establishment of patent blocking" and the "possibility of future commercialization," the purpose is to prevent other firms from exploiting a patent, though the patent is kept unused. These two have meaning as exclusion strategies using patents (non-use as an exclusion strategy). On the other hand, patents "preserved for later use in future R&D or licensing activities" are regarded as licensable to other firms (licensable non-use).

Do all firms face the same problems in using patents in such ways, then? In this research, out of the technical characteristics of products, patent utilization strategy is discussed by dividing products into "discrete technology products" and "complex technology products," from the viewpoint of the number of patented technologies required for manufacturing products.

A complex technology product means a product where many patented technologies are required in product manufacturing, and the technologies that constitute a product are highly likely to complement each other. In this case, there will be no problem if a firm holds all the necessary patents. However, it is not unusual that patent

holders belong to several firms, and a patent thicket arises. On this occasion, technical cooperation with other firms through cross-licensing and patent pooling becomes an effective means. This is observed in the machine-related industries, including the electric machinery industry.

On the other hand, a discrete technology product means a product where holding a certain patent leads directly to the product. It can be manufactured using relatively few patents. For example, in the pharmaceutical industry and the chemical industry, core patented technology is important, and obtaining a patent for such technology leads to the product.

However, the situation is not always the same even among the industries for discrete technology products, and a distinctive patent use may arise depending on whether substitute technology is easily generated. Reitzig (2004) indicates the number of patents necessary for protecting one innovation (patent bulk), based on questionnaire survey results. Comparing the chemical, pharmaceutical, machinery, electric and transport equipment industries, the greatest number of patents is necessary in the chemical industry. This is because, among the industries for discrete technology products, it is an industry in which substitute technology is easily generated, and thus firms take action to hold down peripheral patents (establishment of patent blocking) in order to prevent other firms from patenting substitute technology. In other words, for the industries for discrete technology products, a large patent bulk means difficulty in technically eliminating other firms by the core patented technology alone.

As just described, the problems that a firm faces when conducting production activities using its patented technology differ based on the technical characteristics of its products. Therefore, there arise differences between firms' patent utilization strategies. A firm producing complex technology products develops a patent strategy in consideration of technical cooperation with other firms. On the other hand, a firm producing discrete technology products is not constrained by technical cooperation with other firms and, on the contrary, can adopt a strategy that technically excludes other firms.

The purpose of this research is to clarify the strategy for achieving competitive advantage in the product market by excluding other firms, with regard to firms' patent utilization activities. Therefore, in what follows, verification will be conducted with a focus on corporate activities regarding discrete technology products.

III Determining Factors for Patent Utilization Strategies: In the Case of Discrete Technology Products

Discrete technology products are characterized by the situation where there is a core patented technology and manufacturing products using said technology lacks complementarity with other technologies. Consequently, in contrast to the case of complex technology products, technical cooperation with other firms is unlikely to become a constraint on patent strategies. That is, patented technology is likely to affect competitive advantage in the product market. Going to extremes, a firm may monopolize the product market by its patent if there is no competitive product using other patented technology in the same product market. On the other hand, there is a threat that competitive products will be introduced in the same product market if another firm obtains a patent for technology related to the core patented technology.

First, out of the methods of patent use, patent strategies regarding exclusive in-house use and paid licensing are verified.(*1) The model of Arora and Fosfuri (2003) is used, in which the patent holder

(*1) To focus attention on discrete technology products, this research does not consider cross licensing and patent pooling, which are forms of technical cooperation.

decides the number of firms to whom it will license the patent by comparing two factors: the license revenue effect and the rent dissipation effect. The latter effect reduces the profit because of heightened competition from the licensees' entry into the same product market. This is a model by which the patent-holding firm determines how many licensees it will have. It is not a model used directly for exclusive in-house use; however, by inducing conditions under which the ideal number of licensees is 0, this model can express exclusive in-house use as well. From those conditions, hypotheses are formulated with regard to the incentive for exclusive in-house use and for paid licensing. Only the major hypotheses are presented below.

Regarding factors in the product market, firstly, the number of products using different patented technologies in the same product market becomes an issue. This is because the production quantity of products other than product i has an influence in the inverse demand function, unless product i is a completely differentiated product. Therefore, the more products in the same market, the smaller the excess profits and rent dissipation effect due to licensing. This is because the market is shared by those products.

If there are now several kinds of products in the product market, it means that there are several patent-holding firms in the product market, since a product and a patented technology correspond one-on-one in the model. Patented technologies in the same product market fall under the same or a similar class of technology classification. Therefore, for firms, low concentration of the technology market (the technology market is congested) indicates the possibility of the presence of many products that can be competitive in the product market.

<Hypothesis 2>

If the technology market for a patent held is congested (low concentration of the technology market), the incentive for exclusive in-house use will be lower while the incentive for paid licensing will be higher.

The second factor in the product market is the degree of differentiation of a product. If a product is completely differentiated from other products in the same product market, it is possible to completely ignore the influence of other products in the inverse demand function. Therefore, a patent-holding firm may gain monopoly profits in the product market unless it licenses the patent. Licensing under such circumstances has a large rent dissipation effect.

<Hypothesis 3>

The stronger a product is differentiated, the higher the incentive for exclusive in-house use and the lower the incentive for paid licensing. (*2)

Hypothesis 2 and 3 imply that the other products are important factors affecting the decision whether to license a patent or not. The larger the effect of the other products is – that is, increasing the kinds of products (Hypothesis 2) or difficulty in product differentiation (Hypothesis 3) – the lower the incentive for exclusive in-house use and the higher the incentive for paid licensing. Moreover, it is shown that the total profit of a patent holder is decreasing in the number of product varieties. (*3)

One way of reducing the effect of other products is a product differentiation strategy. The degree of differentiation of a product will be lower if another product using substitute technology exists in the same market. Said product will be treated as the same product as said other product in the inverse demand function if said other product is a complete substitute for said

(*2) This hypothesis is not subject to empirical analysis because it is difficult to measure the degree of differentiation of a product in empirical analysis. However, it is closely linked to Hypothesis 4, mentioned later.

(*3) See Appendix C in Arora and Fosturi (2003) for $V_N^i < 0$.

product – that is, there is absolutely no difference between these products. On the contrary, if a product is independent, it is completely differentiated, and other products do not have any influence on the inverse demand function.

On the other hand, patenting related inventions is an effective way of clearing the threat of substitute products. As mentioned in Section II, patent bulk is large in the chemical industry according to Reitzig (2004). This is because firms in the chemical industry intend to establish patent blocking to prevent substitute technology to their own core patented technologies from being patented by other firms. That is, it can be said that establishing patent blocking is a strategy of excluding rival firms technologically.

The strategy of patent blocking prevents the production of substitute products by rival firms, since another firm can not use the patented technology in its production. It is important that no firm uses it. However, in Arora and Fosfuri (2003), the presence of unused patents is not recognized in their model. The preemptive patenting theory of Gilbert and Newbery (1982) constitutes research that theoretically indicated the presence of unused patents. From the implication of an exclusion strategy in the model, patents unused due to such preemptive patenting are considered to fall under those for the "establishment of patent blocking" and the "possibility of future commercialization" (non-use as an exclusion strategy).

When, then, does the incentive for increasing the degree of differentiation increase? It has been said above that the decrease in excess profits due to licensing will be small if there are many products that are based on other technologies in the same product market. Based on this, the degree of concentration of the technology market and incentive for exclusive in-house use in Hypothesis 2 were derived. However, if complete differentiation of a product can be aimed at by the inverse demand function, a firm can ignore the presence of other firms. Therefore, the firm can monopolize the product market unless it grants licenses.

<Hypothesis 4>

If a large number of entrants exist in the (patent) technology market, and the degree of competition is high, incentives for non-use as an exclusion strategy will be high. (*4)

IV Data Used

The data used in this research is taken from the IIP Patent Database, in which individual patent data is recorded, and the questionnaire of the JPO's "Survey of Intellectual Property-Related Activities" in 2003 and 2004 concerning firms' intellectual property-related activities. (*5) The data from these sources is linked on a firm level, and a data set is thereby prepared with respect to each firm, consisting of the status of use of patents, technical factors and firm factors of the firm. (*6) For details of the data, see the main body.

V Estimation

This research empirically indicates factors that have an influence on three types of strategies out of firms' methods of patent use: exclusive in-house use, paid licensing and non-use as an exclusion strategy. That is, the rate of exclusive in-house use (calculated by subtracting the number of patents

(*4) Although Arora and Fosfuri (2003) assume the innovation market, technology market and product market, preemptive patenting corresponds to the innovation market. firms

(*5) However, the 2003 survey data is used for only one item. Therefore, in what follows, the 2004 survey data is described.

(*6) From the individual data of the "Survey of Intellectual Property-Related Activities," an applicant code subject to the survey can bespecified. In the IIP Patent Database, an applicant code is attached to each patent for which an application was filed. Therefore, bothpieces of data can be linked with each other by using the applicant code. Consequently, it is possible to know what patents a surveytarget holds. Incidentally, although the "Survey of Intellectual Property-Related Activities" contains 5,247 samples (total number of patents held: 766,733.1), 2,924 samples (total number of patents held: 716,355.4) were used through matching with the IIP Patent Database.

exploited by other firms from the total number of patents exploited and then dividing this by the number of patents held), the rate of paid licensing (calculated by dividing the number of patents licensed for value by the number of patents held) and the rate of non-use as an exclusion strategy (calculated by dividing the number of unused patents for defense purposes by the number of patents held) are used as explained variables, and the following factors are verified as explanatory variables: (i) technical factors reflecting the characteristics and environment of technology (patent-based appropriability, technology cycle and the degree of concentration of the technology market), (ii) technical factors of a firm itself (the number of patents held, the number of classes of technology classification and the degree of technological diversification) and (iii) firm factors (the number of employees, R&D intensity and the profit rate for the previous fiscal year).

As is obvious in the prior research mentioned in Section II, the products dealt with by firms do not have the same technical characteristics. Given this factor, it is first confirmed by statistical means whether there is a structural difference between discrete technology product firms and complex technology product firms in the determination of patent utilization strategies. In this research, firms that belong to the machinery industry, electric machinery and apparatus industry, or communications/ electronics/electric measuring instrument industry are deemed ad hoc to be complex technology product firms. The null hypothesis that determining equations for the three types of strategies fulfill the zero-coefficient restriction at the same time is significantly rejected, and a structural difference between discrete technology product firms and complex technology product firms in the mechanism for patent utilization strategies is recognized.

This research pays attention to patent use by discrete technology product firms. Therefore, estimations are conducted on samples excluding complex technology product firms.

With regard to the main estimation results, the rate of exclusive in-house use tends to increase where the technology market is highly concentrated (supporting Hypothesis 2). In a highly concentrated technology market, it is considered very advantageous to technically exclude other firms without licensing and adopt a strategy for competitive advantage in the product market. On the other hand, when the technology market surrounding a patent held is congested (low concentration of the technology market), there will be a high possibility that many other products exist in the same product market. In this case, the rent dissipation effect due to licensing will be smaller, and thus the incentive for exclusive in-house use will be lower. However, regarding the relationships between the degree of concentration of the technology market and the rate of non-use as an exclusion strategy, it is possible to confirm that the rate of non-use as an exclusion strategy is higher when the technology market is congested, as indicated in Hypothesis 4. This indicates that where the incentive for exclusive in-house use is low due to the situation of the technology market, non-use as an exclusion strategy is used as patent blocking – that is, as a strategy for differentiation in exclusive in-house use.

VI Discussion: Influence of Patent Use on the Profit Rate

Discussions on firms' patent strategies have been conducted theoretically and empirically thus far. What influence, then, do differences in firms' patent portfolios have on corporate profits? In this section, empirical analysis is conducted on the influence of exclusive in-house use, paid licensing and non-use as an exclusion strategy (patent utilization strategies dealt with in this research) on the profit rate.

Factors that have influence on the profit rate can probably be divided into market

actors and firm factors. Market factors are those that have influence on the market structure, and firms are making efforts to increase their profit rate by combining the establishment of barriers to entry and differentiation strategies. Patent strategies comprise part of such efforts. Patent strategies examined in this research take into account the rent in the market. Therefore, the profit rate is used as an explained variable, and three types of patent strategies (the rate of exclusive in-house use, the rate of paid licensing and the rate of non-use as an exclusion strategy), the number of employees and R&D intensity are set as factors. 2 Stage Least Square (2SLS) estimation is then conducted.

In the first stage of 2SLS, estimation of the three types of patent utilization strategies, which are endogenous variables, is conducted using the instrumental variable. This is not different from the estimation of determining factors for patent utilization strategies, as mentioned in the previous section. In the second stage, the influence on the profit rate is estimated. This process has something in common with the firm's decision-making process. That is, a firm decides on its patent strategy in consideration of technical factors and firm factors, and its profit rate is determined based on its patent strategy and various other management efforts.

From the estimation results, it is possible to understand that the rate of exclusive in-house use has a positive effect on the profit rate. That is, the result shows that the higher a firm's rate of exclusive in-house use is, the higher its profit rate is. In addition, R&D intensity is also positive and significant, and the profit rate tends to be higher for firms that actively carry out R&D. However, the result shown here was obtained by only taking patent strategies and just two firm factors into account as determining factors for the profit rate. It is thus necessary to pay attention to the point that various other factors are mutually related to the corporate profit rate.

VII Conclusion

Out of firms' patent utilization strategies, this research verified factors that have an influence on the determination of a strategy to technically exclude other firms. In doing so, it was indicated that there are firms that can implement a strategy to technically exclude other firms (discrete technology product firms) and those that cannot do so (complex technology product firms), according to the technical characteristics of the products that they deal with. In addition, it was empirically indicated that the structure of patent utilization strategies differs between discrete technology product firms and complex technology product firms.

Firms that deal with complex technology products require many patented technologies to produce their products, meaning that they are constrained by technical cooperation with other firms. On the other hand, firms dealing with discrete technology products lack a technically complementary relationship with other firms, and rather aim at excluding other firms technologically. Therefore, they carry out exclusive in-house use and non-use as an exclusion strategy. In that regard, the condition of the technology market has great relevance as a determining factor. Specifically, there is little advantage in exclusive in-house use in a product market where there are many substitute technologies in the technology market, enabling substitute products to be put on the market. However, hypothetically speaking, firms in such an market will adopt a strategy to prevent substitute technologies from being patented by other firms, through the establishment of patent blocking. Empirical analysis proved that exclusive in-house use and non-use as an exclusion strategy are determined under the influence of the technology market.

In this manner, strategies are mutually related in a patent portfolio. Although this research also mentioned this point in empirical analysis, the analysis of determining factors for each strategy did not

go beyond estimated calculation of individual equations. Empirical analysis in consideration of the relevancy between patent strategies is left as a future task.