3 Economic Analyses of Statistical Data Relating to Patents

Intellectual property rights (IPRs) are having an increasing impact on industry in recent years due to economic globalization. Therefore, in planning out appropriate intellectual property (IP) policies in the future, it is necessary to compile basic data on IPRs and study their impact of industry as well as to sufficiently examine their economic/managerial effects on the industrial world.

In FY 2002, the Japan Patent Office (JPO) started the Survey of Intellectual Property-Related Activities that would serve as the basis for planning IP policies, and it is currently compiling the basic data for various analyses.

This report makes economic analyses of the relevance of IPRs to the macroeconomy and business management as well as their impact on industry by utilizing statistical data on patents, including the results of the JPO's Survey of Intellectual Property-Related Activities, for the purpose of contributing to creating guidelines for IP policies. Also the report studies concordances for linking the statistical data on patents and economic data. Furthermore, it examines the questions in the Survey of Intellectual Property-Related Activities based on the survey results, and reviews the questions in order to reduce the respondents' burden in answering the questionnaire.

Ⅰ General Remarks

With the growing recognition of the significant role that technology plays in increasing the competitive strength of a company, or even a nation, IPRs have come to draw increasing attention as the basic rules on development and distribution of technology.

In addition, with the rising awareness of the importance of technology, patents have also come to be recognized as an index of technology. Since it is possible to know the technology trend and various information about the company that developed the technology by observing the trend in patents, patent data has become more and more important as technical data as well as economic data.

Unfortunately however, most of the information on patents is organized in such a manner to facilitate searches on technical details, and is not necessarily easy to use as economic/statistical data. In the United States, groups of leading economists make and publish patent databases, and they have made various interesting economic analyses by linking these databases with companies' financial data. It is hoped that such data will also be compiled in Japan.

Since patents are becoming increasingly important, their meaning in corporate strategy is also changing. This also changes the roles of the IP division in a company as well. In the past, the main function of the IP division was to provide services for patenting the developed technology. Nevertheless, its core functions have expanded to: analyzing the technology trends of the competitors; identifying the segment structure of the market; identifying the capability of the proprietary technology and the status of resource accumulation by analyzing patents; and even contributing to planning the company's strategy based on these findings. In short, it has come to play the core role of planning the company's strategy from merely providing services to the R&D division.

In this manner, companies' IP-related activities are expanding and diversifying as IPRs become increasingly important for companies. In FY 2002, the JPO started the Survey of Intellectual Property-Related Activities to collect detailed data relating to companies' IP activities for the respective types of industrial property rights. The results of the survey were released by the JPO in March 2003 as the Report of the Survey of Intellectual Property-Related Activities. This survey is to be conducted on a continuous basis, and its results would certainly be invaluable data without precedent in the world, providing the whole picture of IPR-related activities of Japanese companies, universities, public research institutions, and technology licensing organizations (TLOs).

The Research Committee on Patents and Economics of IIP took up economic analyses using the data in the Report of the Survey of Intellectual Property-Related Activities, which is a goldmine of information on IPR-related activities of companies and other organizations, as one of its research themes for FY 2003. Part II of the report includes the results of these economic analyses and also a survey on concordance between patent classification and industrial classification, which would be required when conducting research/analyses of the linkage between technology and economy. Part III

examines and summarizes the various problems and points that should be improved regarding the Survey of Intellectual Property-Related Activities conducted by the JPO and its report that were identified through the analyses, in order to further improve the surveys conducted in the future. (Akira Goto)

II Economic Analyses Based on FY 2002 Survey of Intellectual Property-Related Activities

1 Determining factors for patent licensing by companies

The purpose of this chapter is to offer clarification of the characteristics of patent licensing activities of Japanese companies by industry, the development of theoretical model that explains one aspect of these characteristics, and the empirical indication of the consistency of the model with the actual data.

First of all, in section (2) the patent licensing activities of Japanese companies contained in the data of the FY 2002 Survey of Intellectual Property-Related Activities are overviewed, and their characteristics by industry are elucidated.

In section (3), the circumstances in which companies conduct licensing activities are theoretically clarified by using a simple model, in order to explain one aspect of these characteristics, which is that companies in the electronics industry tend to offer licensing a larger portion of their patents to other companies, compared to those in the pharmaceutical and other industries. Companies that own patents can reap profits from the expanded economic pie by setting licensing fees, so if their products are sufficiently differentiated, they would have the motivation to provide licenses rather than monopolizing the market of their products by dominating the technology. On the other hand, if their products are not differentiated enough, the decrease in profits induced by introduction of competition in the market of the products will not sufficiently cover the licensing fee income, so the companies would prefer to monopolize the technology. In this section, this mechanism by using a simple linear Hotelling model are indicated.

Then, in section (4), an empirical analysis of the factors that determine the vigor of the licensing activities of the Japanese manufacturing industry on an industry level is conducted. The analysis reveals that the operating profit on sales and the number of domestic patents in use per company have a positive effect on the licensing rate of a company's domestic patents in use, and that the patent maintenance cost per patent in exploitation has a negative effect on such a licensing rate. The operating profit on sales is considered to be correlated to the degree of differentiation of the

products, and this is compliant with the theoretical model. The number of patents in exploitation per company is a proxy variable for the number of patents embodied in a single product, and this is also compliant with the theory. A result compliant with the theoretical model was also obtained for the trading cost variable, but the report mentions that the actual impact of the trading cost may be much stronger than this.

Section (5) then summarizes the discussions and refers to the direction in which future study should be made. (Yoshihito Yasaki; Akira Goto)

2 Structure of unused patents and their factor analysis

A large number of IPRs owned by companies are actually not in exploitation. Therefore, this chapter focuses on these unused patents and attempts to analyze their current status and the causes for the non-exploitation. First of all, the following were revealed as a result of aggregating the exploitation rate of patents by size of company, by market (domestic/overseas), and by industry. Firstly, the larger the size of the company, the lower the self-utilization rate and the overall exploitation rate (including exploitation by other companies) would be, and the exploitation rate is lower for domestic patents than foreign patents. Next, there is a large gap in the self-exploitation rate by industry. The rate is lowest for the pharmaceutical industry and highest for the construction industry. Lastly, small and medium sized companies have a stronger tendency to exclusively exploit their own patents, and to release unexploited patents by licensing out the patents they could not exploit themselves to other companies.

Then, the report presents the following four hypotheses on the exploitation of IP.
   (1)   Superiority of complementary assets
   (2)   Inefficiency of R&D
   (3)   Non-exploitation based on preemptive patenting and cannibalization concerns (strategically dormant patents)
   (4)   Real option value
   The superiority of complementary assets increases the exploitation rate of the patents the company owns (ex-post effect), but it also has the effect of promoting R&D and acquisition of more patents (ex-ante effect). Therefore, whether or not it would increase the non-exploitation rate depends on whether the ex-ante effect exceeds the ex-post effect.

Next, the following analysis results were obtained by a simple estimate based on this theoretical model. Expansion of the size of the company (the number of employees) has a greater effect on increasing the number of patents the company owns than increasing the number of patents the company exploits, so it tends to raise

the non-exploitation rate. On the other hand, a rise in the price-cost margin has a greater effect on increasing the number of patents the company exploits than increasing the number of patents the company owns, so it tends to lower the non-exploitation rate. These suggest the following two facts: (i) with regard to the size of the company, the ex-ante effect of complementary assets is likely to be higher than their ex-post effect; and (ii) the fact that the non-exploitation rate is lower for companies with a high price-cost margin indicates that strategically dormant patents are not likely to be the cause for the lower non-exploitation rate of large companies.

It was also found that the higher the registration rate for patent applications that a company has, the more statistically significant the numbers of patents are that are owned and exploited by the company. But, because the effect of the latter is larger, the non-exploitation rate of such a company becomes lower. This result also indicates that the efficiency of R&D is also a factor that cannot be ignored, and that the evaluation of the quality of patents is important for evaluating the efficiency of R&D. (Sadao Nagaoka; Yoichiro Nishimura)

3   IP activities and the appropriability of technology

Appropriability and trading costs are considered to affect a company's IP activities to a considerable extent. The factor that decides the appropriability and trading costs is the characteristics of the technology itself. Conventional empirical analyses had used the types of industries in place of the technical characteristics due to the limitation in data, but the substitutability of the types of industries is not high. The analysis in this chapter uses the company-by-company data of the Survey of Intellectual Property-Related Activities, and aggregates the data for the 12 technical fields based on the International Patent Classification (IPC) in which companies have filed the largest number of patent applications. The analysis uses this aggregation by technical field to identify how the diversification of the R&D areas, the patenting of the R&D results, and the status of technology trading differ by technical field, and reveals what kinds of IP activities are derived by the respective technical characteristics.

The main results of the analysis are as follows.
- R&D is more diversified in the fields of textiles/paper and electricity/electronic parts/semiconductors. Premiums are aimed to be achieved through diversification of R&D as a future technology strategy in the 11 technical fields excluding the field of electricity/electronic parts/semiconductors.
- The technical fields, in which the patent licensing

income from companies outside the business group per one employee in R&D division, is high include pharmaceuticals as well as civil engineering/construction/architecture, measurement/optics/photography/copying machines, and electricity/electric parts/semiconductors.
- The proportion of patents cross-licensed to other companies in the total number of the patents owned is high in fields including measurement/optics/photography/copying machines, electricity/electric parts/semiconductors, and electronic circuitry/telecommunications.

In technical fields where technology trading is suitable and needed, patents are considered to be highly effective, because they secure appropriability. Analysis results obtained from the patent licensing income per one employee in R&D division are identical to the results of previous research that were based on the types of industries. Therefore, the extent to which a company's R&D is shifting to the technical fields where technology trading is suitable and needed is expected to become estimable by the scale of the company's R&D activities measured based on the number of employees in R&D division.

From the viewpoint of the need for technology trading, there is a large incentive to introduce technology by paying a licensing fee in fields where technological progress is fast and products become obsolete quickly. In technical fields in which products are developed by using a large number of patents and are constantly improved afterwards, multiple companies mutually own complementary technology. The proportion of patents cross-licensed to other companies in the total number of the patents owned is expected to be available as an objective index for determining that a company is carrying out R&D with high appropriability. (Fumio Funaoka; Jyoji Tokui; Fumihiko Koyata)

4   The difference in ability and trading costs as factors for determining the technology trading partner

In order to analyze the factors based on which companies select their technology trading partners, this chapter assumes domestic companies and foreign companies as potential trading partners, and empirically verifies the determining factors for choosing between them by measuring the proportion of foreign companies in all technology import/licensing partners based on the number of transactions, the trading values, and the number of partners, using individual data of the Survey of Intellectual Property-Related Activities conducted by the JPO.

The core determining factors analyzed are: (i) trading costs; (ii) the relative difference in technology level between Japan and overseas; and (iii) the capacity of the company.

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In terms of trading costs, companies in industries where patents bring less appropriability are assumed to prefer technology trading (technology licensing/import) with domestic companies that are easy to monitor, rather than foreign companies (Hypothesis 1). In terms of (ii), companies in industries where the overseas technology level is relatively higher than the domestic technology level are assumed to import more technology from overseas companies (Hypothesis 2). In terms of (iii), a higher capacity is likely to be required for importing technology from overseas companies, so companies with higher capacity are assumed to import more technology from overseas companies (Hypothesis 3).

The overseas technology level as compared to the domestic technology level was measures by weighted average of the rates of R&D intensity in Japan and the United States and the percentage of Japanese patent applications filed by foreign applicants by technical field. In addition, the capacity was measured based on the R&D intensity and the size of the company. Then a regression analysis was conducted based on them. Consequently, Hypothesis 1 was largely supported by the result, while no statistically significant result could be obtained for Hypothesis 2, and significant results could be obtained only in part for the analysis of Hypothesis 3. Meanwhile, separate analyses for technology trading within a business group and those with outside the business group indicated that Hypothesis 1 only stands for transactions with companies outside the business group, and it was presumed that trading costs do not present a big problem in the case of transactions within the business group, because they are quasi-internal transactions. (Kenta Nakamura; Hiroyuki Odagiri)

5 Attempt to create an index for the aspect of IPRs as a determining factor for innovation

This chapter attempts to design an index concerning the aspect of IPRs as a determining factor for innovation in a company, and to analyze the determining factors for innovation using the measured index. The result of the analysis suggested many assignments for future data processing.

The analysis on the R&D intensity suggested that the ability to enforce patent rights, whether by exclusive use or licensing to other companies, would have the effect of reducing the R&D incentive. If this seemingly unreasonable result is truly statistically significant, it should be taken as an element that encourages review of the negative aspect of the patent system. Before that, however, there is still inconsistency between data of the exclusive utilization rate and that of the licensing rate even after narrowing down the data to 132 valid

samples, so there is a need to further check for any abnormal values.

In the factor analysis for product innovation using the patent utilization rate as a proxy index, the result suggested that the model that uses patent concentration as an explaining variable was not relevant. However, patent concentration is only a proxy index related to the extent of dispersion of patents, so it is too hasty to make any determination on occurrence of a "tragedy of anti-commons" based on this result.

This chapter tried to trace the past research that was conducted based on original survey data, but there are limits in making similar analyses using proxy indexes obtained from the data in the Survey of Intellectual Property-Related Activities. Nevertheless, when IP management was compared between industries by using the proxy indexes designed in this chapter, interesting differences were observed. Thus, it was indicated that the data in the Survey of Intellectual Property-Related Activities still has much value to be utilized in designing such indexes that help in discovering new facts. (Akiya Nagata)

6 Factors that determine the types of patent licensing contracts

This chapter aims at clarifying the determining factors for patent licensing. Despite the progress of theoretical analyses in economic studies, sufficient empirical analyses have not been made in this field due to lack of data. This chapter analyzes the determining factors for licensing by using the individual data of the Survey of Intellectual Property-Related Activities, which is an approved statistical survey conducted by the JPO since FY 2002. The analysis focuses on the manufacturing industry, because patent licensing is considered to be mainly carried out in the manufacturing industry. Arora and Fosfuri (2003) suggest a licensing model that places stronger emphasis on the association with empirical analysis. According to their model, a decrease in trading costs pertaining to the licensing and a rise in royalty income due to pro-patent policy have the effect of increasing the frequency of licensing as structural factors, but product differentiation reduces a company's incentive for licensing. They also derive a conclusion that a company with a high market share in the product market is more negative about licensing, because the licensing will have a considerable rent-reducing effect.

According to the result of the estimate in this chapter, the market share has a positive impact on the number of licensing contracts, while the self-utilization rate has a negative impact. Meanwhile, the percentage of

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researchers in the total employees has a positive impact on the number of licensing contracts. Product differentiation has a negative impact on licensing. In contrast, the number of licensing contracts is larger for industries with high accumulation of technology. (Koichiro Onishi; Yosuke Okada)

7 The relationship between a company's profit margin and technology trading/environmental activities

This chapter makes empirical analyses on the following two points targeting manufacturing companies: (i) the relationship between profit margin and technology trading/environmental activities; and (ii) the determining factors for the tendency of owning foreign patents.

Firstly, the impact on profit margin is estimated by the normal least-squares method. Although the market share, which is an important variable, is found to have no significant impact, a positive relationship is found between profit margin and R&D intensity. With regard to the impact of technology trading on profit margin, the per capita royalty income has a negative relationship and the self-utilization of the company's own patents in Japan has a positive relationship, but these are not significant for large companies. In the meantime, acquisition of ISO14001 certification, which is the environmental management standards for companies, is found to have a positive correlation with the profit margin in the case of large companies. Although the issue of simultaneity remains, if introduction of environmental management leads to increasing a company's profit margin, it would be desirable to implement a policy to assist introduction of environmental ISO also from the corporate earnings perspective.

Next, in analyzing the determining factors for the tendency of owning foreign patents, estimates are made by negative binomial regression, using the same samples. The tendency of owning foreign patents increases as the size of the company becomes larger, and the tendency is strong for companies that have acquired environmental ISO. One of the assumptions is that they have active transactions with overseas and conduct vigorous business activities in other countries. Meanwhile, companies with a high self-utilization rate within Japan are negative about utilizing foreign patents. On the other hand, companies with high per capital royalty income tend to own foreign patents. The negative impact and positive impact are clearly divided between industries, and the industry attribute is found to have a large influence on the tendency of owning foreign patents. (Yukihiro Hiraiwa; Yosuke Okada)

8 Ex-post costs and ex-ante costs for settling patent disputes—determining factors for dispute settlement costs and application filing costs in overall IP costs

In the FY 2002 Survey of Intellectual Property-Related Activities, a valuable statistical survey was conducted on patent disputes, including lawsuits and warnings. The results indicated that the number of lawsuits was reported to be large in technology-accumulating industries including the electric machinery and apparatus industry and the machinery industry. It was also indicated that the proportion of patent application filing costs is large in overall costs. This chapter reviews these results by taking into account peripheral information, and investigates the factors that affect the patent-related costs, particularly dispute settlement costs and application filing costs.

The number of lawsuits, warnings, and oppositions is found to be large per patent in the chemical industry, rather than the electric industry, when comparing the number by technical field and by industry. When the determining factors for the number of disputes for each company are investigated by regression analysis, large companies owning many patents tend to be subject to a large number of oppositions. However, the number of patents owned is not significantly correlated to the number of warnings. When the determining factors for the dispute settlement costs of companies are similarly investigated by regression analysis, the dispute settlement costs are found to be high for companies owning a large number of patents. It is also found that the number of employees in charge of dispute settlement is large when the number of warnings is large.

The determining factors for application filing costs and those for the number of patent applications filed per year are also investigated by regression analysis. As a result, patent application filings of a company are considered to become more active when the company faces a large number of disputes. However, the above analyses are based on the assumption that mutually independent regression analyses can be made. Thus, improvements must be made in the future regarding the quantitative analysis method.

The problem awareness underlying this research is a concern that if patents are registered in a narrow domain in a packed manner, it may increase the patent management costs and increase the risk of companies being involved in lawsuits, warnings, and oppositions. If companies file a large number of defensive applications as a countermeasure against such a risk, and that further complicates the patent situation, social costs will increase by self-circulation. None of the results obtained this time strongly support such self-circulation. However, the current increase in

application filing costs does not solely mean that an increasing number of socially beneficial inventions are being published, so it is necessary to continue watching the trend and the determination factors in the future. (Tetsuo Wada)

9 The patent system and innovation of R&D-intensive small and medium sized enterprises (SMEs)

The patent system is an important system for R&D-intensive SMEs, which lack managerial resources related to production and sales and focus their activities on R&D, in securing appropriability of technology. On the other hand, however, SMEs are considered to be in a relatively disadvantageous position in patent licensing negotiations and patent-related disputes.

In this chapter, empirical analyses are made on the patent system and innovation of R&D-intensive SMEs using the data on patent exploitation status and patent disputes in the Survey of Intellectual Property-Related Activities conducted by the JPO.

With regard to the exploitation of the patents owned, smaller and younger companies are found to exploit their own patents less and have other companies exploit their patents more. Conversely, they exploit other companies' patents less actively compared to large companies. This shows that SMEs lacking managerial resources are actively licensing out their R&D results to other companies since it is difficult for them to increase business profitability by exploiting their R&D results by themselves. The patent system is important particularly for SMEs lacking managerial resources as a system for establishing such an external technology market.

In addition, as a result of an analysis on patent disputes, smaller and younger companies are more likely to be involved in disputes. As indicated in the result of the analysis on patent exploitation, SMEs need to actively license out their patents to other companies. Therefore, they would naturally be more inclined to be involved in patent disputes. The quality of patents could not be controlled in the results of the analyses in this chapter, but they suggest the possibility that SMEs are in a weak position in licensing negotiations. (Kazuyuki Motohashi)

10 Trial development of a concordance and its comparative analysis

Concordances, which link the IPC, a classification of technology, and industrial classifications, have been made by the Organisation for Economic Co-operation and Development (OECD) and other organizations for effectively and efficiently calculating technology-related economic effects.

In this chapter, a comparative analysis of three concordances is made. One is the OECD Technology Concordance (OTC) made by the OECD. This is the most commonly used concordance at present. The OTC has converted the industrial classification of the Yale Technology Concordance (YTC) created by a Yale University team from Standard Industrial Classification (SIC) to International Standard Industrial Classification (ISIC). YTC is originally based on the industrial codes called the Industry of Manufacture (IOM) and Sector of Use (SOU) that were assigned by examiners of the Canadian Intellectual Property Office to the patents registered between 1972 and 1995.

However, the OTC cannot be applied directly to Japanese patents due to the differences of the country and the year of development, so a roughly classified concordance (IP-statistics-based concordance) was developed based on the Survey of Intellectual Property-Related Activities, and some differences from the OTC and YTC are indicated. For example, in the seventh edition of the IPC, the OTC barely covers the service industry and does not cover the nano-technology field and G06T, which are Japan's strong fields. Thus, if it is used as a basic material for economical analyses of the technical structure of Japan, it may lead to underestimation.

Furthermore, IP-statistics-based concordance has restrictions itself in terms of the classification level. Therefore, a concordance of the IPC class level was developed by using the patent gazette for publications of unexamined patent applications (Kokai-publication-based concordance). When the IP-statistics-based concordance and the Kokai-publication-based concordance are compared, large differences are observed for industries with a small number of samples, but they show more or less similar tendencies in aggregate. This indicates that the IP-statistics-based concordance is sufficiently applicable in conducting an analysis to superficially understand the IPC filing trend by industry. (Tatsuo Nakamura; Makiko Harada)

11. Current status and future prospects of concordances in Europe and the United States

It is important for future policy planning to quantitatively understand the impact of reinforcement of the IP system (pro-patent policy) on the macroeconomy and business management.

In addition, it has been pointed out in recent years that patent-related economic analyses and patent databases to that end are needed in considering how the patent system should be designed.

One of the means for economic analysis would be to estimate the economic impact of patent rights.

The first necessary step for such estimation would be to learn the classification of the industries in which the individual patent rights would be exploited. It would also be necessary to link the patent data with economic statistical data based on that industrial classification.

Meanwhile, patent rights have been classified according to the patent classifications represented by the IPC. These patent classifications classify the technical subject matter from a technical perspective, so the patent data cannot be directly linked with economic statistical data based on these classifications.

Therefore, in order to clarify the effects of the pro-patent policy on the macro economy, a concordance that describes the relationship between the patent classification and industrial classification will be needed.

At present, research on concordances is under way in countries advanced in patents around the world. In particular, the OECD concordance[*1] and a concordance jointly developed by three European research institutes (Fraunhofer ISI [Germany], Observatoire des Sciences et des Techniques (OST) [France], and Science and Technology Policy Research (SPRU) [U.K.])[*2] were made public recently and are drawing the attention to the field.

This chapter summarizes the current status and the problems in the above concordances, examines the points that should be taken into consideration when Japan creates a full-fledged concordance in the future, and prospects the future picture of such a concordance. (Akira Kumasaka)

Ⅲ Examination of a desirable questionnaire for the Survey of Intellectual Property-Related Activities

In order to reflect on the results of the FY 2002 Survey of Intellectual Property-Related Activities in the surveys for FY 2004 onward, the committee members were asked to give their opinions on the desirable survey on IP-related activities, mainly on the questionnaire.

These opinions were summarized into a table by largely classifying them into "1. Questionnaire," "2. Survey method," and "3. Weighted aggregation method," and by further dividing each class into subclasses.

Furthermore, the following reference materials were created based on the opinions of the committee members.

[Reference material 1] "A desirable Survey of Intellectual Property-Related Activities in the future (draft)"

[Reference material 2] "Questionnaire of intellectual property-related activities (draft) (Form for complete survey)"

[Reference material 3] "Supplement"

(Akira Kumasaka)

(Senior Researcher: Akira Kumasaka)

(*1) http://www.olis.oecd.org/olis/2002doc.nsf/linkto/dsti-doc(2002)5
   http://www.wellesley.edu/Economics/johnson/oecd_wp2002-05.pdf
(*2) http://www.isi.fhg.de/ti/Projektbeschreibungen/us-development_Concordance_e.htm

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