15 Do Mergers Promote Innovative Activities of Firms? Evidence from Japanese Patent Data

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The purpose of this study is to empirically analyze the impacts of merger on firms' innovative activities measured by the number of patent applications and the R&D expenses. Furthermore, we focus on the changes in firms' capability of using inventions, which is evaluated by the rate of the number of examination requests to the number of applications filed before merger.

We find that the increase in the market share caused by merger has a positive effect on the number of patent applications and R&D expenses. On the other hand, the business streamlining or rationalization associated with merger has a negative effect on them, and it also reduces firms' capability of using inventions. Moreover, various unobservable effects of merger, such as knowledge integration, shift of firms' intellectual property strategy or business disruption, decreases the number of patent applications and R&D expenses as a whole, with keeping the capability of using technology unchanged.

Our results also suggest that the technological similarity accelerates the rationalization of overlapping businesses, and enhances the efficiency of firms' patent application behaviors.

I Introduction

The number of M&As (mergers and acquisitions) has greatly increased since the late 1990s in Japan. The purpose of this study is to empirically analyze the impacts of M&As on firms' innovative activities by using financial data and patent data. This study focuses on mergers, which are considered to be more significant than any other M&A procedures in terms of their impact on corporate activities, and analyzes their effects on firms' R&D activities and patent application activity.

R&D and patent application activity of firms are affected by many factors such as the industry characteristics, firm size, and the trend in demand. Therefore, a simple comparison between pre- and post-merger would be insufficient to determine whether any change in firms' activities is truly attributable to the merger.

This study controls the effects of these factors and evaluates the effects of business reorganizations and an increase in the market share caused by merger. This study also attempts to analyze an overall effect of various unobservable factors, such as knowledge and technological integration and shift of intellectual property strategies. Furthermore, this study examines whether the impact of merger varies with the technical similarity between merged companies.

Schumpeter and other scholars pointed out the importance of innovation in the growth of companies and countries. In recent years, the importance of M&As for companies has increased as a time-saving means to achieve such goals as growing in size, acquiring new technologies, and entering new business fields.

Despite such importance, not many studies have been conducted to directly analyze the effects of merger on corporate innovation activities. There have been almost no studies on patent filing activity by Japanese companies based on the interpretation that such activity is a form of innovation output.

Merger has negative and positive effects on corporate R&D activities. For example, such activities could be impaired by reorganization and unification of overlapping research projects or could be promoted thanks to the enhanced economy of scale and scope as a result of merger. Therefore, empirical analysis is necessary to determine which effects, negative or positive, are stronger as a whole. There have been some studies, though not many, that focus on innovation input. However, these prior studies have not reached a consensus as to the effects of merger (Cassiman et al., 2005).

Companies merge with other companies for various reasons such as market share growth and technology acquisition. The primary purpose of merger would differ depending on in which country and when the merger was carried out. Therefore, while there are a small number of prior studies on mergers in the United States, it would be simplistic to interpret the Japanese situation based on the results of those studies. In this sense, this study is meaningful because it

analyzes mergers among Japanese companies and their effects on innovation activities.

Corporate innovation activities can be measured from various perspectives including the perspective of input such as R&D costs, the perspective of outcome such as profit ratios and stock prices, and the perspective of output such as patent applications. In this study, corporate innovation activities are analyzed from these perspectives with special emphasis on the perspective of output. This study analyzes corporate exploitation of technologies as well. In this sense, this study differs from other studies.

The results of this study may be roughly summarized as follows. Market share growth caused by merger increases the number of patent applications and the costs of R&D. On the other hand, business reorganization and the reprioritization and concentration of business operations carried out in conjunction with merger decrease them. Furthermore, merger introduces new technologies and increases business assets, presenting more opportunities to exploit technologies. In the meantime, merger could lead to reorganization and unification of overlapping business operations, presenting fewer opportunities to exploit technologies. Furthermore, various effects of merger that are not reflected in data (synergy of knowledge, modification of intellectual property strategies, temporary internal confusion) could lower the number of patent applications and the costs for R&D as a whole, while such effects do not influence corporate ability to exploit technologies.

Ⅱ Data Sets

In this study, analyses are conducted based on three types of data, i.e., merger case data, financial data, and patent data. For data on mergers among Japanese companies, we referred to the "M&A Data Book of Japanese Companies 1988-2002" (RECOF Corporation) and the "Qualified Stock Data (updated on June 20, 2008)" (Tokyo Stock Exchange Inc.).

Furthermore, the company-specific data on patent application and examination request were extracted from the "IIP Patent Database (updated on May 28, 2008)" (Institute of Intellectual Property) and the "Patent Gazette Database" (Alife-laboratory).

This study analyzes mergers (1) carried out during the period from 1988 to 2000 between Japanese companies (2) whose financial data such as sales, R&D costs, and tangible fixed assets are fully available for the four years before and after merger and (3) who filed at least one patent application during the period subject to analysis.

The beginning of the period mentioned in the above-mentioned criterion (1) was set to be 1988 based on the recording period of the data source. The end of the period was set to be 2000 because this study analyzes trends in the number of patent applications filed for a period of four years before and after each merger and the latest patent application year fully covered by the IIP Patent Database happens to be 2004. The strictest criterion adopted in this study is the above-mentioned criterion (2), which requires full availability of data on R&D costs. Due to this criterion, the number of mergers analyzed in this study significantly dropped to a mere 24. However, this criterion is necessary because the data on R&D costs is indispensable in analyzing corporate innovation activities. The number of mergers eligible for our analysis would rise if the criterion was relaxed in such a way that accepts companies whose data on R&D costs for the years subject to the analysis are partially unavailable. However, such a relaxed criterion would make the interpretation of estimates more difficult.

Ideally, the effect of a merger of a company should be examined by making a comparison with another company that has truly identical attributes. In reality, however, it is difficult to find a company with truly identical attributes. Instead, for each merged company subject to the analysis in this study, we have selected a set of companies that "belong to the same industry and have similar corporate size." In this way, for each of the 24 mergers, we have created a group of companies consisting of the merged companies and similar companies selected for comparison (such group is hereinafter referred to as "group"). We have evaluated the effects of merger by conducting a regression analysis in which the differences in attributes within each group and the differences among groups are controlled.

For the purpose of making a comparison, we have selected companies that (i) belong to the same industry and therefore have the same three digit NEEDS industry code as the merged companies, (ii) whose tangible fixed assets were within plus/minus 50% of the merged companies as of the day one year prior to the merger, and (iii) whose financial data such as sales, R&D costs, and tangible fixed assets for the four years before and after the merger are fully available.

Based on these criteria, companies have been selected for comparison with the companies involved in each of the 24 merger cases. Among the selected companies, three companies turned out to have been nonexistent one year prior to the merger, which is a point of time subject to the comparison. These three companies are excluded from subsequent analysis. In addition, one of the selected companies is also excluded from analysis because its financial figures are considered to be abnormal. Consequently, the number of merged companies and number of comparative companies finally stand at 20 and 191, respectively.

A data set concerning merged companies and comparative companies can be created by matching patent data by using applicants' names as a key. The patent data used in this study is basically extracted from the IIP Patent Database (hereinafter referred to as IIP-DB). The following points must be taken into consideration when using this database.

First, IIP-DB allocates different applicant codes to the same applicant in some cases due to variation in the indication of his or her name. In other cases, the database allocates the same applicant code to different companies located in different places because they share the same company name. Therefore, name identification is necessary for accurate counting. In this study, we identified names based on the result of name identification processes conducted by Oonishi and Okada (2005) and Yamauchi and Nagaoka (2008).

In general, the name of a right holder tends to be replaced with that of another person due to a merger, etc. In the case of IIP-DB, the pre-merger name of the applicant was often replaced with the post-merger name of the applicant (for example, the name, *Mitsubishi Petrochemical* Co., Ltd., was replaced with the post-merger company name, *Mitsubishi* Chemical Corporation.). In the case of a patent application filed prior to the merger, in order to determine which company actually filed a patent application, it is necessary to refer to a database that contains the name of the applicant as of the application filing date. In this study, regarding the applicant's names contained in the patent application data extracted from IIP-DB, we used the Patent Gazette Database to identify their names as of the application filing dates.

In some cases, IIP-DB indicates the post-merger name of an applicant side-by-side with its pre-merger name as if the post-merger name were that of a joint applicant (for instance, the post-merger company name, *Mitsubishi* Chemical Corporation, was additionally indicated in a patent application filed by *Mitsubishi Petrochemical* Co., Ltd., as if *Mitsubishi* Chemical Corporation were a joint applicant.). In this study, this problem was solved by counting the number of patent applications proportionately to the number of joint applicants (partial count). This solution would not ensure accurate counting if the post-merger company name has been additionally indicated in a joint application filed with a third party (for example, the post-merger company name, *Mitsubishi* Chemical Corporation, was additionally indicated in a joint application filed by *Mitsubishi Petrochemical* Co., Ltd., and Futamura Chemical Co., Ltd.). Despite this limitation, since the number of such joint applications filed with a third party account for only a fraction of the total, partial count is a reliable means to reduce the margin of error caused by double counting.

Ⅲ Outline of Data

While it is difficult to determine what the best indicator of innovation activities is, we use R&D costs as an indicator of input and the number of patent applications as an indicator of output. It does not necessarily mean that all of the R&D activities lead to innovation or that all of the results of innovation lead to patent application. In this sense, these indicators have their own limitations. However, it would be possible to grasp corporate innovation activities with a certain level of accuracy by analyzing data from both perspectives of input and output.

The graphs created based on the data reveal the following tendencies. Merged companies have, in comparison with non-merged companies, seen a significant reduction in the number of patent applications and R&D costs. Even a greater reduction was caused by merger in R&D concentration levels. These reductions suggest the significance of the business reorganization and reprioritization of patent applications and R&D projects carried out in conjunction with merger.

This study also pays attention to the exploitation of the results of innovation, analyzing changes in exploitation based on the final ratio of examination requests for patent applications filed prior to merger. This is an indicator showing the final ratio of examination requests for patent applications filed seven years prior to each point of time (hereinafter referred to as the "ratio of

examination requests for prior inventions"). Creation of this indicator is made possible by the existence of an examination request system in Japan. This is one of the advantages of limiting the subjects of this analysis to Japanese companies.

An examination of the ratio of examination requests for prior inventions has revealed that merged companies have shown, though not so clearly, a greater reduction than non-merged companies. An analysis of the effects of merger on corporate ability to exploit inventions suggests that, as a whole, negative effects generated by business reorganization outweigh positive effects generated by an increase in business assets.

Furthermore, merger greatly reduces tangible fixed assets, while significantly increasing market shares. This suggests that merger leads to drastic business reorganization and greatly enhances market control power.

Ⅳ Empirical Analysis

In this chapter, we analyzed four aspects of corporate innovation activities, i.e., input, output, exploitation, and performance, and identify the effects of merger on each of those aspects through regression analysis. We used the number of patent application as an indicator of output, the ratio of examination requests for prior inventions as an indicator of exploitation, R&D costs as an indicator of input, and ROA (return on assets) and ROS (return on sales) as indicators of performance.

We used these five variables as explained variables and made an estimate by attributing changes in them to the fact that the company in question experienced or did not experience a merger and also made a separate estimate by attributing those changes to the technical similarity and the application ratio in particular technical fields (the application concentration level).

In making an estimate to examine the effects of merger or of the lack of merger, we took into consideration such explaining variables as the R&D concentration level, tangible fixed assets, share in the total sales of the industry, and cross term between a merged company dummy and an age (elapsed years) dummy.

The higher the R&D concentration level of a company, the more innovative the company is considered to be. The R&D concentration level of a company plunges after merger. This variable shows the restraining effect of merger on R&D activities. The tangible fixed assets of a company, which indicate the size of the company or its business assets, significantly decrease after merger. This variable shows the effect of business reorganization carried out in conjunction with merger. The share in the total sales of the industry, which is an indicator of market share, greatly increases after merger. In the meantime, the cross term between a merged company dummy and an age (elapsed years) dummy functions as a variable that reflects the difference between merged companies and non-merged companies. This variable shows complex effects of merger that are not reflected in other explaining variables. In other words, this variable shows comprehensive effects of various consequences of merger such as synergy between technology and knowledge, confusion in the course of transformation into a new organization and resolution of such confusion, and modification of intellectual property strategies caused by unification of patent application policies.

By making an estimate of the effects of technical similarity, we examined whether the technical similarity between two companies promotes synergy in technology development or impairs corporate ability to develop technologies as a result of rationalization of overlapping business operations.

Furthermore, by making an estimate of the effect of application ratio (application concentration level), we examined whether the effects of merger on corporate innovation activities are particularly great in key technical fields.

These estimates have revealed as follows. First, the coefficients of the R&D concentration level, tangible fixed assets, and share in the total sales of the industry had a positive and significant effect on patent application filing activity. Furthermore, the coefficient of the cross term between a merged company dummy and an age (elapsed years) dummy consistently had a negative and significant effect, which suggests that the business reorganization and the unification of R&D projects in conjunction with merger reduce the number of patent applications. On the other hand, the growth of market share as a result of merger is considered to promote the filing of patent applications. The comprehensive effects of merger that are not reflected in these variables have a downward pressure on the number of patent applications as a whole. This

suggests that negative effects such as reprioritization of applications caused by the modification of intellectual property strategies is greater than positive effects such as synergy between knowledge and technology.

In the meantime, technical similarity has a positive and significant effect on the number of patent applications immediately after merger. In other words, patent applications would decrease in number if two companies with different technologies merge. This suggests that it is primarily in new technical fields (non-overlapping technical fields) that the filing of patent applications is likely to be restrained immediately after merger. The effect on the pre-merger application ratio is clearly negative and significant four years after merger. In other words, the pre-merger core technical fields (technical fields with high application ratios) suffer a particularly sharp decrease in the number of patent applications as a result of merger. Such a decrease is observed not immediately after merger but a while after merger.

In sum, merger would promote reprioritization and concentration of patent applications in the fields where both companies excel (the fields in which both companies have filed patent applications). As a next step, the major technical fields would undergo rationalization as a whole.

Second, the coefficients, i.e., the R&D concentration level, tangible fixed assets, and share in the applications pertaining to certain technical fields have a positive and significant effect on the ratio of examination requests for prior inventions, which shows corporate ability to exploit technologies. This indicates that merger leads to the reorganization of business and the unification of R&D projects, decreasing not only the number of patent applications but also the corporate ability to exploit technologies. The effect of tangible fixed assets can be interpreted to be reflecting the fact that an increase in business assets after merger enhances the ability to exploit technologies. Merged companies' ability to exploit technologies increases in the technical fields where they have a greater capacity for technological development than other companies. On the other hand, unlike in the estimates related to patent applications, the cross term between a merged company dummy and an age (elapsed years) dummy has no significant effect. In sum, the various effects of merger do not change corporate ability to exploit technologies as a whole because the positive effects and the negative effects set off each other.

In the meantime, technical similarity has a negative and significant effect on the ratio of examination requests for prior inventions. However, it has no effect on the application ratio. In other words, the ability and opportunities to exploit technologies are increased by merger with a company that has different technologies regardless of whether those technologies are in main technical fields. This suggests that the acquisition of new technologies and assets through merger has a synergistic effect on corporate ability to exploit technologies and that the reorganization and unification of overlapping business operations decrease opportunities to exploit inventions made in the past.

Furthermore, the coefficients of tangible fixed assets, cash flow, and share in the total sales of the industry have a positive and significant effect on R&D costs, while the coefficient of in-house application concentration level has a negative and significant effect. The coefficient of the cross term between a merged company dummy and an age (elapsed years) dummy has consistently had a negative and significant effect since immediately after merger. This indicates that the business reorganization and rationalization through reprioritization and concentration carried out in conjunction with merger inhibit R&D activities. On the other hand, an increase in market share caused by merger promotes R&D activities. Other various effects of merger lower R&D costs as a whole.

Technical similarity has had a negative and significant effect on R&D costs since one year prior to merger, whereas the application concentration level has no significant effect. In other words, regardless of the concentration level prior to merger, the higher the technical similarity, the greater the reduction in R&D costs after merger. This suggests that a reduction in R&D costs after merger may be attributable to the reprioritization and unification of overlapping research projects.

Finally, the coefficient of tangible fixed assets has a negative and significant effect on the ROA (return on assets) and ROS (return on sales), whereas the cross term between a merged company dummy and an age (elapsed years) dummy does not have any significant effect. This indicates that business reorganization and market share growth as a result of merger increase profit ratio. This finding contradicts much of the prior research that did not recognize such effect of merger. On the other hand, other effects of

merger do not increase the profit ratio as a whole.

The effect of merger on profit ratio is not affected by technical similarity and the application concentration level prior to merger.

This suggests that profit ratio is affected more by the market share growth and rationalization achieved after merger than by the choice of the company to merge with.

Ⅴ Conclusion

In this study, we analyzed the effects of merger on firms' innovative activities from four perspectives, input (R&D costs), output (the number of patent applications), capability of using technologies (the ratio of examination requests for pre-merger applications), and performance (profit ratio).

An examination request system in Japan enables us to analyze the capability of using technologies. This is a great advantage of using Japanese patent data, and this type of analysis could not be conducted with U.S. patent data.

Merged companies compared to non-merged companies, show lower patent applications and R&D expenses. Furthermore, merger significantly decreases the tangible fixed assets, whereas it greatly increases market share. This suggests that the purpose of merger of Japanese firms is survival, by increasing their market share in existing markets and streamlining their business, rather than technological acquisition or new business entry.

Our empirical analysis suggests that such business reorganization and concentration caused by merger not only decrease the number of patent applications and R&D costs but also decrease the capability of using technologies.

In contrast, an increase in market power assosiated with merger has a positive effect on the number of patent applications, R&D expenses, capability of using technologies, and profit ratio.

Furthermore, an overall effect of other unobservable factors has a strong negative effect on the number of patent applications and the R&D expenses. On the other hand, the overall effect does not influence firms' capability of using technologies and profit ratio, since the positive and negative effects of unobservable factores are offset.

In this study, we also examine how technological similarity affects the impacts of merger. The analysis indicates that technological similarity has a positive effect on the number of patent applications, whereas it has a negative effect on the capability of using technologies and the R&D expenses. This suggests that merger promotes the streamlining of overlapping business lines and research projects, enhancing the efficiency of firms' patent application behaviors.