

14 Did Modifications of the Japanese Patent System Lead to a Reduction in Price Competition and the Promotion of R&D Activities? : The Impacts of Some Modifications between 1998 and 2013 on the Japanese Automobile Industry^(*)

Research Fellow: Miyuki TANIGUCHI

This study tests the hypotheses that modifications of the Japanese patent system between 1998 and 2013 led to reduced price competition and the promotion of R&D activities in the Japanese automobile industry using econometric methods. First, this study focuses on the modifications to the Japanese patent system which have the possibility of influencing R&D activities. It is found that the modifications in 1998, 1999, and 2003 have the possibility of promoting R&D activities. Then, this study examines whether these modifications have promoted R&D activities in the Japanese automobile industry, by comparing these R&D activities with R&D activities in the German automobile industry. It is expected that the German automobile industry has not been greatly influenced by modification of the German patent system because there has been little change in the German patent system in the last fifteen years. The results of the econometric analysis show that the modification of the Japanese patent system in 2003 influenced the quality of the technologies to which patents have been applied for. The number of forward citations per patent application has fallen considerably since 2003. On the other hand, the number of forward citations per patent application has not changed in the German automobile industry. The results of the econometric analysis also show that the profits per patent application have increased since 2003. One possible reason for this is that the constant modifications to strengthen patent protection rights have increased profits since 2003. Finally, this study examines whether price competition has been reduced in the Japanese automobile market since 2003. The results of the econometric analysis confirm that price competition has tended to be reduced.

I Introduction

The level of protection of patent rights influences the R&D activities of firms through market competition. Theoretically, when the protection of patent rights is strong enough, a patentee can obtain monopolistic profits by selling his/her patented products without price competition in markets. On the other hand, when the protection of patent rights is not sufficient, the patentee will fail in obtaining profits by selling his/her patented products because not only the patentee but also other firms can earn profits from the patented products. The price of the patentee's products must be higher than that of other firms because the patentee needs to recover R&D costs through the sales of the patented product. As a result, a patentee loses in the price competition with other firms. Thus, in the situation where a differentiation strategy does not work, firms might stop their R&D activities.

The Japanese patent system has been modified with the intention of providing more incentives to the R&D activities of firms. If we focus on the modifications between 1998 and 2013, there are three modifications which have possibly influenced R&D activities. They are: (1) the strengthening of the penalties for infringements of patent rights and the lowering of patent fees to maintain patent rights in 1998; (2) the enforcement of relief against the infringement of patent rights in 1999; and (3) the lowering of fees for patent applications, patent examinations, and patent maintenance in 2003. Strengthening penalties or enforcing relief against patent infringements could prevent patentees from losing profits due to patent infringements. Lower patent fees makes patenting easier. Thus, there is a possibility that these modifications led to the promotion of R&D activities.

In order to discuss policy implications to promote R&D activities in Japan through the

(*) This is an English translation of the summary of the report published under the Industrial Property Research Promotion Project FY2014 entrusted by the Japan Patent Office. IIP is entirely responsible for any errors in expression or description of the translation. When any ambiguity is found in the English translation, the original Japanese text shall be prevailing.

Japanese patent system, this study investigates the impacts of some modifications of Japanese patent system on the level of price competition and the R&D activities of firms in the automobile industry, using econometric methods. In particular, this study investigates the impacts of the modifications in 1998, 1999, 2003 on the level of price competition in Japanese automobile market and on R&D activities in the Japanese automobile industry. The automobile industry is selected for three reasons. First, the automobile industry is one of the leading industries in Japan. Second, automobile firms tend to obtain more patents than firms in other industries. Third, the possibility that firms in the automobile industry conceal new technologies without applying for patents does not need to be considered in econometric analysis. Basically, firms with new technologies in automobile industry will apply for patents for that technology. An interview with a Japanese automobile manufacturer in 2013 suggested that in the automobile industry firms apply for in relation to the output of R&D activities except for know-how¹. This is because applying for patents for the new technologies has greater merit than concealing the new technologies. Rival firms can copy new technologies if they reverse engineer automobiles which are equipped with newly technologies. Thus firms need to protect new technologies by obtaining patent rights.

The structure of this report is as follows. Chapter II analyses R&D activities in the Japanese automobile industry in the period between 1991 and 2013. For comparison, Chapter II also analyses R&D activities in the German automobile industry in the period between 2000 and 2013. Chapter III examines whether price competition has been reduced in the Japanese automobile market. In the last Chapter, some conclusions and policy implications are given.

II The impact of some modifications of the patent systems in the last fifteen years on firms' R&D activities

In Chapter I, it is suggested that the Japanese patent system experienced three modifications which have possibly influenced R&D activities: (1) a strengthening of the penalties against the infringement of patent rights and a lowering of patent fees to maintain patent rights in 1998; (2) enforcing the relief against the infringement of patent rights in 1999; and (3) a

lowering of fees for patent applications, patent examinations, and patent maintenance in 2003. These modifications have the possibility of promoting R&D activities because they give patentees some additional advantages. Chapter II examines whether these modifications led to the promotion of R&D activities in the Japanese automobile industry, by comparing R&D activities in the Japanese automobile industry to those in the German automobile industry. The German automobile industry is selected for comparison because the German automobile industry is similar to the Japanese automobile industry in that German firms obtain many patents, and because there has been no drastic modification of the German patent system.

First, it is confirmed that R&D expenses in the Japanese automobile industry have increased more than in the German automobile industry after the Japanese patent system was modified three times around 2000. In the period between 2000 and 2007, when no large macro shock occurred, R&D expenses increased both in the Japanese automobile industry and the German automobile industry. However, the average rate of increase of R&D expenses in the Japanese automobile industry is twice that in the German automobile industry from 2000 to 2007. This suggests that the modifications of Japanese patent systems around 2000 have the possibility of promoting the increases of R&D expenses in Japanese automobile industry.

Next, it is verified that modifications of Japanese patent system in 1998, 1999, and 2003 have improved the efficiency of R&D in the Japanese automobile industry over the last fifteen years, using econometric methods. It is also verified that the efficiency of R&D in the German automobile industry has not changed since 2000 using econometric methods. A knowledge production function where no economies of scales are assumed because more researchers or more R&D expenses would not improve R&D efficiency, is employed for these verifications.² To control for differences in the R&D efficiencies across firms or over time, an inefficiency term is added to the knowledge function. This means that stochastic frontier analysis is applied to the knowledge functions. In this study, the output of the knowledge production function is defined as the number of forward citations or the amount of profits, and the input factors are defined as the number of researchers, the number of inventors, R&D expenses, and the cost of technologies imported from foreign firms. By the way, to apply

stochastic frontier analysis to the knowledge production function, the dependent variables need to be continuous. Thus, the amount of output (forward citations or profits) per patent application and the number of inputs per patent application are used as the measures of output and input factors, respectively.

Data on 25 firms between 1991 and 2012 are used to estimate a knowledge production function in the Japanese automobile industry. Data on patents is generated from IIP Patent Database (Institute of Intellectual Property), using access 2013 and Stata 12. Data on R&D is drawn from micro data in the Survey of Research and Development (*Kagakugijutsukenkyuu chousa*) conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications, Japan. The firms which have answered the questionnaires continuously over the 21 year period of 1991 to 2012 are chosen as the firms to be included in the sample analyzed. Observations which include output or input factors with a value of zero or a negative value are eliminated because the production function assumes that all output and input factors are positive. As a result, 25 firms and 331 samples are used for estimation when dependent variable is defined as the number of forward citation per patent. 25 firms and 408 samples are used for estimation when dependent variable is defined as the amount of profit per patent. Data on 28 firms between 2000 and 2008 are used to estimate a similar knowledge production function for the German automobile industry. Data on patents including the average number of inventors per patent is generated from PATSTAT (European Patent Office) using MySQL 5.6. Data on R&D expenses is drawn from the “R&D Ranking of EU Top 1000 companies” (European Commission), and from the annual reports published by individual firms, and financial reports of individual firms (Bundesanzeiger.de). As a result, 28 firms and 118 samples are used for estimation.

The estimation results show that the modification of the Japanese patent system in 2003 led to a decrease in the number of forward citations per patent application in the Japanese automobile industry, while the modifications in 1998 and 1999 had no impact on these citations. It is considered that the modification in 2003 provided firms with more incentives to apply for more patents because the modification in 2003 reduced the average fees for patent applications, patent examinations and patent maintenance by 90,000 yen per patent application. In fact, the

number of patent applications has increased since 2003. The estimation results also show that profits per patent application have increased since 2003. One possible reason for this is that the constant modifications to strengthen the protection rights started to influence profits in 2003 rather than the direct impact of the modification in 2003. Furthermore, the estimation results confirm that R&D efficiencies have not changed in the German automobile industry since 2000.

III Did the strengthening of the protection of patent rights lead to a reduction in price competition?

As Chapter I indicates, a necessary condition for patentees to be able to obtain profits by selling patented products without price competitions is that the patent rights provide sufficient protection. The estimation results in Chapter II show the possibility that the constant modifications to strengthen protection rights have increased profits since 2003. Thus, Chapter III examines whether price competition has been reduced in the Japanese automobile market since 2003. This hypothesis is examined by looking at movements in the price elasticity of demand, which provides an indication of how many additional automobiles can be sold when the price is lowered. A smaller absolute value of the price elasticity of demand means reduced price competition.

To obtain estimates of the price elasticity of the demand for automobiles, a demand function for new passenger cars in the Japanese automobile market is estimated. The estimated demand function follows the discrete choice model of product differentiation in Irwin and Pavcnik (2004), whose framework was originally proposed by Berry (1994). In this model, it is assumed that a consumer has a two-step decision making process when he/she purchases a new passenger car: First, the consumer decides the type of the passenger car from among standard, small, and mini cars; and then, the consumer decides the model of the passenger car. Following Berry (1994) who estimates demand functions for automobiles, the demand for cars depends on the market shares of the selected models in the market of the selected types, car prices, and car performances in the model.

Data on the models of Japanese passenger cars between 2003 and 2010 are used to estimate the demand function year by year. Data on car sales are drawn from the *Automotive Yearbook*

(*Jidousha nenkan*) (*Nikkan Jidousha Shinbun-sha*, and Automobile Business Association of Japan) and *Auto Aftermarket Data Book* (AM Network). Though the displacement volume indicates a car's performance, passenger cars are categorized into three types according to their displacement volume. Though its horsepower also indicates a car's performance, the horsepower is sometimes correlated with the car's displacement volume. Thus, the displacement volume and the horsepower are not used as independent variables in this study. As a substitute, the number of patents owned by the automaker producing the car is used because the major patented automobile technologies are expected to improve the overall performance of a car by increasing fuel efficiency and reducing emissions. The number of effective patents for each automobile manufacture is provided by the Japan Patent Office. Since data are not necessarily available for all models, the unbalanced panel dataset used in the analysis contains 257 models and a total of 1,319 observations.

In order to obtain an estimate of the price elasticity of demand for each year, the demand function is estimated using pooled data for each year. The estimation results show that the absolute value of the price elasticity of demand has tended to fall in the Japanese automobile market since 2003. This means that price competition has become less severe in the Japanese automobile market. The results also show that the automobile manufacturers which have more patents tend to have larger market shares.

IV Conclusion

Using econometric method, this study shows that in the Japanese automobile industry the modifications of the Japanese patent system between 1998 and 2013 led to reduced price competition and the promotion of R&D activities. First, this study summarizes three modifications of the patent system which have the possibility of influencing R&D activities over the last fifteen years: These are: (1) the strengthening of the penalties against the infringement of patent rights and the lowering of patent fees to maintain patent rights in 1998; (2) the enforcement of relief against the infringement of patent rights in 1999; and (3) the lowering of fees for patent applications, patent examinations, and patent maintenance in 2003. Since these modifications give some advantages to patentees, there is a possibility that

they led to the promotion of R&D activities in Japan. Next, this study analyses R&D activities in the Japanese automobile industry in the period between 1991 and 2013. The automobile industry is selected because the automobile industry is one of the major industries in Japan, automobile firms tend to obtain more patents than firms in other industries, and patent applications are made in relation to most of the output of R&D activities in the automobile industry. As a result of an econometric analysis, it is found that the lowering of fees for patent applications, patent examinations, and patent maintenance in 2003 led to a decrease in the number of forward citations per patent application. One possible reason for this outcome is that the reduction of the fees for patent applications and patent maintenance in 2003 led to an increase in the number of patent applications. The fees for patent applications, patent examinations, and patent maintenance were reduced by 90,000 yen on average in 2003. Another possible reason is that new eco-friendly technologies changed the trend of R&D and led to a decrease in forward citations. It is also found that profits per patent application have increased since 2003. One possible reason for this is that the constant modifications to strengthen the protection of patent rights could be effective after 2003. Thus, patentees could obtain more profits by selling patented products in the market. Another possible reason is that consumers have come to prefer high quality cars which can save on running costs compared to low-priced cars after 2003. Finally, this study examines whether price competition has been reduced in the Japanese automobile market since 2003. The results of the econometric analysis confirm that price competition has tended to become less severe after 2003.

In conclusion, it can be said that the modifications of the Japanese patent systems around 2000 seem to have promoted R&D activities in the Japanese automobile industry. Though a reduction in price competition in the Japanese automobile market can be observed, it is not clear whether the constant modifications to strengthen the protection of patent rights led to this reduction in price competition. This study also found that the drastic change of patent fees in 2003 has influenced the quality of patents. Future modifications of the Japanese patent system which change patent fees have the possibility of changing both the quality of patents as well as the quantity of patents. When the fees for patent applications, patent examinations, and patent

maintenance are changed, it is necessary to predict the impact of modification of the patent system on both the quantity and the quality of patents.

References

Berry, S. T. (1994). "Estimating discrete-choice models of product differentiation," *The RAND Journal of Economics* 25(2), 242-262.

Irwin, D.A., Pavcnik, N. (2004). "Airbus versus Boeing revised: international competition in the aircraft market." *Journal of International Economics* 64, 223-245.

Taniguchi, M. (2014) "A Quantitative Analysis of the Economic Effects of Patents on Industry: The Case of Japanese Automobile Industry." Institute of Intellectual Property, Report of the 2012FY Industrial Property Research Promotion Project (2012FY-2014FY) entrusted by the Japan Patent Office.

¹ This interview was intended to help understand the behavior of automobile firms (see Taniguchi (2014)). The results of this interview have not been published.

² For reference, the results of estimating a translog knowledge production function where economies of scale are assumed are presented in the Appendix. These results support the findings related to the impact of the modifications of the Japanese patent system in 1998, 1999, and 2003, which is examined using a knowledge production function with no economies of scale in Chapter II.