Essays on Innovations, collaborations and patenting

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Executive summary

This doctoral dissertation consists of 6 chapters. Chapter 1 is introduction. It summarizes each chapter.

Chapter 2 analyzes whether and how international research collaboration in terms of co-inventions and co-ownership may affect invention performance. We distinguish its potential effects on the number of inventors involved in the invention, the scope and the speed of using the prior knowledge as measured by the US patent references and the other effects. We focus on the OECD triadic patents which have been applied to the patent offices of the US and Japan and the European Patent Office.

International research collaborations have become important, as more countries in the world have significantly strengthened research capability and as firms globalize their research operations. They may also become more important as R&D tasks become more complex and requires more knowledge input and experiences (Jones (2009)). There are many literature on research collaboration, both on the incidence of co-ownership (see, for an example, Cassiman and Reinhilde (2002), Hagedoorn, Link and Vonortas (2002) and Hagedoorn (2002)) and on the effects of such research cooperation on the economic performance (see, for an example, Cockburn and Henderson (1998), Sakakibara (1997), Branstetter and Sakakibara (1998), Lerner and Merges (1998) and see a survey by Siegel (2002)). However, most studies are at firm

level (One exception is Mowery, Oxley and Silverman (1996)). This makes it very difficult to assess how research collaboration actually affects the process of knowledge production, such as the scope of the knowledge used for research.

This chapter makes an attempt to assess the effects of international research collaborations on invention performance at patent family level, focusing on internationally co-invented or co-owned patents. International collaborations might expand the size of research team, therefore the human capita available for research. It might also expand the scope of the knowledge used for invention by enhancing the absorptive capability of the research team and increase the speed of research. Finally, it might also have productivity effect, that is, it might enhance the productive use of the knowledge absorbed. The patent level study allows us to examine the effects of research collaborations through these various channels, so that it would help us understand how international research collaboration might work or might not work.

Our major findings are the following. First, internationally co-applied patents are associated with significantly larger inventor size, except for Japan. Second, international research collaborations in terms of co-inventions are strongly associated with more backward and science literature citation but not with backward patent citation (number and the lag). Third, once we control for the number of inventors and the number of literature cited, international research collaborations are not associated with higher patent quality, in term of forward citation, the number of claims or the duration of patent term (renewal). Fourth, co-applications tend to be associated with lower patent quality, once we control for the number of inventors.

Chapter 3 examines the structure and the evolution of the patents judged as

essential for three recent major technical standards (MPEG2, DVD formats and W-CDMA). We have found that these standards have many essential patents, which are owned by many firms with different interest. The number of essential patents has increased significantly over time since the standard was set. We identify three reasons for why the essential patents are many and increase over time: they cover number of different technology fields; there exists R&D competition even in a narrowly defined technology field, and a firm can expand its patent portfolio by using continuation and the other practices based on the priority dates of its earlier filed patent applications in the USA (Continuation, Continuation-in-Part, Division). Around 40% of the essential US patents for MPEG2 and DVD standards have been obtained by using these application procedures. However, our analysis does not support the view that a firm with a pioneering patent can obtain more essential patents, using these practices.

The fact that there are numerous patentees suggests that the benefit from cooperation through the patent pool in avoiding the tragedy of anti-commons is large, while at the same time there can be a big coordination problem, since an individual firm (especially a firm specialized in research) may prefer higher royalty rates at the expense of others (Aoki and Nagaoka 2004, 2005). Next, it makes good economic sense that the disclosure policy as well as the licensing commitment required by a standard body covers not only granted patents, but also pending patents as well as patents to be applied for in the future with respect to the standard. And, our results indicate that the application practices such as continuations are not used more by a firm with pioneering inventions, suggesting that the success of obtaining patents based on continuations and related practices may depend more on the patenting strategy of a firm than on the quality of its inventions.

Chapter 4 is a complementary analysis of Chapter 3. In Chapter 3, we have shown that a firm with a pioneering patent does not obtain more essential patent using continuation procedures. This chapter examines whether a pioneering invention of patent pool administrated by MPEGLA LLC yields more number of essential patents applied using continuing procedures by using patent level sample, not by firm level sample. This analysis supported that a pioneering invention does not tend to yield patents applied by continuing procedures. Also, we obtained the result that a vertically integrated firms with research and production departments use more continuing applications.

Chapter 5 examines how continuing applications (Continuation application, Division, and Continuation-in-Part) are used and how they strengthen patent protections of the inventions in the U.S. patent system with patent family as a unit of analysis. Hedge, Mowery and Graham (2007) have analyzed the effects of these procedures on quality of patents using patent level sample. They have made it appear that CIPs are used by R&D intensive small firms and cover relatively valuable inventions, but continuations cover less valuable patents of capital intensive firms. We also obtained the similar results using patent as a unit of analysis. However, when an invention is applied with using continuing applications, the parent applications and the child applications by these procedures disclose the same invention and constitute a patent family, which protects the invention as a whole. We consider that patent family is more suitable as a unit of analysis to examine how an applicant uses continuing applications and how these applications procedures affect protection of inventions, by

using large sample covering the US domestic patent families.

First, we analyze whether inventors with pioneering inventions use more continuing applications. I treat the existence of provisional applications and the number of citations to non-patent literature of non-provisional applications as an indicator of pioneering status of these inventions. We have found that the pioneering inventions in these terms make significantly frequent use of continuing applications. Next, I analyze how continuing applications enhance the patent protection of the inventions proxied by forward citations to patent family. We have found that all types of continuing applications have significantly positive effects on forward citations to family.

There are many studies examining value of patents using patent references as an index of quality of invention with patent-level sample. In the results of patent level studies, it was considered that continuation in-part applications bring about high quality of patents, but continuation and divisional applications does not. However, the patent family analysis in this study showed that any types of continuing applications contribute enhancement of the value of portfolio of patents protecting a inventions. Patent level studies can observe the marginal effects on the value of portfolio of patents. But is does not evaluate the value of portfolio as a whole. In this meaning, patent level studies could mislead the conclusions regarding many discussions about how continuing applications should be used.

In chapter 6, we again turn to the issue of technical standards. This chapter analyzes how extensively the information embodied in standard and related documents are used in R&D and how significantly they affect the value of R&D, based both on the RIETI inventor survey and on bibliographic information of triadic patents families and

the PATSTAT database for constructing the database for our analysis.

Major findings are as follow. First, the information embodied in standard and related documents are the important knowledge sources for the conception of R&D projects in the information and telecommunication area (ICT). Citations to standard documents are less frequently made but are useful measure of knowledge flow from standard. Around a half of the inventors citing standard documents recognize standard as important or very important for the conception of the R&D project. Once the standards are cited, it is a significant indicator of knowledge flow.

Second, standards enhance R&D performance, although the effect varies across standards. The R&D projects using standard information more intensively tends to generate significantly more valuable patents and more number of patents in ICT, controlling for research labor input and the use of scientific literature and that of patent literature. They are also more licensed, although not more internally used. Consistent with these results based on the RIETI inventor survey, an invention citing standard documents is more highly cited, controlling for the inventive inputs. Private international forum standards tend to generate more highly cited patents than national or international public standards. They enjoy large geographical network externality as well as use more recent scientific knowledge. A part of the residuals in favor of private international forum standards would be its swiftness in adopting new technology. Surprisingly, international public standards do not compare well with private international forum standards, although promoting downstream innovation is not the only objective of a standard organization.

Our study combining the RIETI survey information and bibliographic information convincingly shows that the citation information in the US patent documents can be

usefully used to measure the knowledge flows from standard to inventions, although it covers a relatively small part of the knowledge flow, even if the latter is very important. We have also shown that such information can also be used to assess how various standard organizations work as knowledge generating institutions. This finding will open up a number of interesting research questions.