

Empirical Studies on the R&D Boundaries of the Firm: Licensing, Alliances, and University-Industry Collaborations

Kenta Nakamura

Abstract

In this dissertation, we intend to explore the R&D boundaries of the firm focusing on licensing, alliances, and university-industry collaborations.

Traditionally, the issue of the boundary of the firm has been discussed in relation to make-or-buy decisions in a vertical chain of production. How much supply of materials and parts is (and should be) integrated has been at the center of both theoretical and empirical studies on the boundary of the firm. This issue has become a critical decision in the firm's R&D strategy as well. With technologies becoming more science-based and complex, and with competition becoming more intensive on a global scale, it is now difficult for any firm to develop all technologies by themselves. Moreover, firms depend on scientific knowledge

generated in universities, technologies acquired from other firms, and alliances with other firms, universities, and research institutes. This tendency is particularly strong with such high-tech industries as pharmaceuticals, chemicals, electronics, and automobiles.

In Chapter 2, we investigate the firm's decision on in-house R&D and procurement of R&D from outside. Various modes of R&D procurement are available and we classify them between commissioned R&D, joint R&D, and technology acquisitions (*i.e.*, licensing-in). Making use of a large-scale database including about 14,000 manufacturing firms in Japan, we empirically analyze the determinants of these three modes of procured R&D to test the hypotheses built around the two major theories – the transaction cost theory and the capability theory. In view of the presence of a large number of firms who failed to perform any R&D activity at all, we formulate the R&D decision process as a double-hurdle model.

Generally, the estimation results support the two theories. Most importantly, we find positive impacts of firm size, in-house R&D intensity, diversification, and vertical integration, which supports the hypothesis that the presence of a large and broad absorptive capacity is a

contributing factor for procured R&D by making it easier for the firms to seek potential partners, evaluate them, monitor R&D alliances, and utilize the outcome for commercialization. We have also found a positive effect of appropriability by patents, which supports the hypothesis that appropriability reduces transaction costs. Many of these results apply to R&D commissioned to non-group organizations, joint R&D, and licensing but not necessarily to R&D commissioned to in-group firms, suggesting that groups are quasi-internal organizations and therefore monitoring and appropriability issues do not arise.

In Chapter 3, we analyze the determinants of partner choice between domestic firms and foreign firms. Supposing that the domestic firm and the foreign firm exist as potential partners of technology licensing (patent licensing-out), we examine the effect of three factors, that is, (1) relative technological gap between overseas and Japan, (2) absorptive capacity, and (3) transaction costs. In addition, as a benchmark, we also examine the determinants of domestic and foreign licensing.

Our results generally support the two theories (the transaction cost theory and the

capability theory) again: (1) in an industry with strong patent protection, firms can engage in international technology transfer with low transaction costs though the impact on domestic licensing is not significant. Then we confirm that firms which benefit from high appropriability are likely to choose more foreign firms as a licensee. (2) High absorptive capacity of the foreign licensee, which is measured by the extent of the relative technological levels of overseas to Japanese industries, encourage international licensing and the likelihood of choosing foreign partners because the licensor is able to obtain large licensing income due to good performance of the licensee. However, when patent is more effective, the impact of absorptive capacity decreases. (3) The net impact of the relative technological levels is negative. This suggests technological advantages of Japanese firms increase international licensing. (4) Small firms do not own sufficient complementary assets, especially for expanding their business overseas; hence they are likely to choose more foreign firms as a licensee.

Knowledge flow between universities and industries is essential. Thus, the Japanese government has actively promoted pro-patent policies to promote research collaboration among

industries, universities, and governments, and to facilitate the commercialization of their research outcomes. To test the effectiveness of the policy initiatives, Chapter 4 is focused on the following two questions: (1) how the Japanese pro-patent policies encouraged the public sector to file valuable patents, and (2) how the presence of co-assignees in the public sector affects the values of corporate patents. We examine the value of Japanese biomedical patents that were filed for the years 1991–2002 by various types of (co-)assignees, in particular, public sector researchers, both before and after the introduction of pro-patent legislative measures such as the TLO Act in 1998 and the Japanese Bayh-Dole Act in 1999. We use citation counts by subsequent patents (*forward* citations) to measure the value of the patents. By adjusting the heterogeneity of propensity to cite by subsequent patents in 19 major biomedical fields per year, we employ panel regressions that control for a fixed effect of the first assignee of a patent.

Our main findings are as follows: (1) patents filed by a corporation as well as jointly filed patents by no less than two corporations are highly valued on average; (2) if a corporation is the first assignee, a patent with a government co-assignee is highly valued on average; (3)

although the value of government patents is not very impressive, it has risen since the introduction of the pro-patent policy; and (4) there is no significant change in the value of university patents before and after the Japanese Bayh-Dole Act. These findings may reflect the fact that the pro-patent policy is only now beginning to have some impact on the patenting activity of government research institutes. On the other hand, it does not appear to dictate the patenting behavior of university researchers. We are of the opinion that the institutional and organizational features of government research institutes and universities are the keys to elucidate the salient responses between these institutes.

The recent proliferation of the patents for upstream inventions in life-science has raised the concern that they might harm downstream innovations, especially given that a genetic invention is often unique in its nature. In Chapter 5, we empirically analyze the structural characteristics of research licensing in life-science, focusing on exclusivity and royalty, in order to evaluate how important such risk might be.

Our major findings are the following. A university, especially the one without much

licensing experience, provides an exclusive license more often than others, despite the guidelines promoting non-exclusive licensing by a funding agency. On the other hand, we do not find the evidence for a firm with extensive downstream assets (pharmaceutical firm) to require more exclusivity. However, pharmaceutical firms often accept higher royalty for exclusive rights. In addition, we find that a research license is more likely to be exclusive and more expensive (1) if the research stage covered by a license is more downstream, (2) the technology covered is not limited to a pure research tool, and (3) the contract is ex-ante, consistent with our theoretical expectation.