MICROECONOMIC STUDIES OF INNOVATION, PATENT LICENSING, AND NETWORK EFFECTS

Yoshihito Yasaki

Abstract

The importance of designing appropriate competition and intellectual property policies to balance dynamic incentives and static efficiencies in areas of rapid technological change is now widely recognized. Much work has been done on investigating how these policies affect market performance and what should be taken into account in order to design policies that promote innovation and, at the same time, reap the most benefit out of innovation. Technological progress has, in turn, led to much increased information exchange through various modes of communication. Demand for communication technologies often display network effects under which the benefit accruing to a network user depends on the number of other users on the same network. Thus, a related policy concern is what policies are appropriate in markets characterised by network effects. Building on existing literature regarding these issues, this dissertation investigates several specific policy issues concerning

competition and intellectual policies in areas characterised by network effects or rapid technological advance.

Chapter 1, "Economics of Intellectual Property Rights and Network Effects: An Introductory Overview," reviews the existing literature on innovation, intellectual property rights, and network effect.

Chapter 2 through to chapter 4 are concerned with innovative activities and policies regarding them. The subject of chapter 2 is employee inventions. R&D activities by firms have been a chief proponent of technological progress in the recent era. How to allocate the rights and revenues arising from inventions developed by an employee researcher as part of his job between the employee himself and the employer has recently become a contentious issue in Japan. Chapter 2, "Contribution-Proportional Remuneration Rule for Employee Inventions and Its Effects on Effort and Investment Incentives," investigates the effects, on the incentives of the employer and employee, of the rule employed by the court in the case of a lawsuit regarding the level of remuneration the employer pays the employee for such employee inventions. It is shown that the possibility for the court to intervene in the level of remuneration for employee inventions and to impose a pre-set distribution rule creates inefficiencies relative to the case where private contracts between the employer and employee are honoured. Unless the employer's investment and employee's effort are substitutes, the contribution-proportional

remuneration rule leads to the share effect (excessive incentives on the part of each party to expend investment or effort in order to increase his/her share of the surplus) dominating the probability effect (insufficient incentives on the part of each party arising from the fact that it cannot capture all the increase in the expected surplus), and thus to excessive investment and effort relative to the joint payoff maximising levels. If the court captures the employer's investment less fully than the employee's effort, the employer's investment may be too low compared to the joint payoff maximising level.

Once a firm has patented a successful technology, it can monopolise the product market by producing goods exclusively using the patented technology without licensing it to other firms. However, manufacturing firms usually do licence their patented technologies to other firms, including to their competitors. Why do they do so, when licensing technologies will create competitors in the product market? Chapter 3, "Why Do Firms License Patented Technologies Even to Their Competitors?," theorises the explanation often provided by industry experts but hitherto not analysed in detail in the theoretical literature, namely that the technology-holder licenses its technology in order to expand the product market by allowing other firms, with different technological capabilities, to produce goods that are differentiated from its own, so that more potential customers are covered than when it tries to monopolise the market. Using a simple Hotelling-type duopoly model, it is shown that when the degree of product

differentiation is sufficiently large, the technology-holder earns higher profit by licensing its technology. Licensing always leads to higher consumer surplus and total surplus. Next, using data from the Survey of Intellectual Property-Related Activities carried out by Japan's Patent Office, the determinants of Japan's manufacturing firms' propensity to license their technologies are estimated at the industry level. It was found that both the ratio of advertisement expenditure to sales (industry-level) and the number of patents individual firms use (firm-level) have positive effects on firms' tendency to license patented technologies. The advertisement-sale ratio is a proxy for the degree of differentiation, and the number of patents individual firms use is a proxy for how many patented technologies are embodied in a product. The result is consistent both with our model of "pie-expansion" and with the claim that in industries where products embody many patented technologies, licensing is actively undertaken. The importance of patents as an appropriability mechanism was also shown to have a positive effect on the licensing propensity.

When production of goods requires a number of essential technologies, research laboratories that do not engage in production have incentives to set higher licensing royalty rates than vertically integrated firms that engage in both R&D and production. Using a simple three-firm, three-stage mode, chapter 4, 'Licensing of Essential Patents by Vertically-Integrated Firms and Research Laboratories: Patent Pools and Compulsory Licensing,' shows that requiring the

research laboratory to join the patent pool and license its technology at a reasonable rate reduces its incentives under a wide range of conditions but always raises the vertically integrated firms' incentives to invest in R&D, resulting in a higher joint probability of the essential technologies being successfully developed, higher expected consumer surplus, and higher expected total surplus. One interesting finding is that, when the probability of successful innovation increases only slowly with increasing R&D investment, the research laboratory's incentives to invest in R&D also increases when it is required to join the patent pool and set a lower royalty rate than otherwise, because the benefits from higher probability of successful innovation by the vertically integrated firms offset incentive losses from reduced expected gross profit.

Rapid technological progress has resulted in much increased communication between people and between firms. Communication networks are typically characterised by network effects. The next two chapters deal with industries characterised by network effects. Many network industries have observed the phenomenon that networks compete without being interconnected with each other in the early stages of the industry development but later become interconnected. Chapter 5 of this dissertation, "Compatibility Decisions in the Presence of Network Effects," provides a theoretical explanation for such a phenomenon and shows that an increase in the network-independent component of user demand facilitates compatibility (interconnection). It also shows that if firms choose to provide interconnection then it is also

socially desirable, whereas if firms choose to keep the networks unconnected it may or may not be socially desirable to require interconnection.

Previous literature, as well as the analysis in chapter 5, has shown that the presence of network effects warrants special attention on the part of the competition policy authority and may require it to intervene in firms' behaviour. As in the case of other industries, actual implementation of policies requires careful study of the demand and cost conditions of the market under concern. In particular, the existence and strength of network effects is a key parameter that should be studied. In chapter 6, "Network Effects in the Japanese Word-Processing Software Market," the size of network effects in the Japanese word-processing software markets in the period between 1998 and 2001 is estimated from scanner data from large retailers using both hedonic price models and discrete choice models. Network effects are shown to be present on the whole, but separate analyses of adjacent two years reveal that network effects, as measured by the positive effect of the installed base variables on the dependent variables in the estimation models, are not present in the beginning of the sample period but present towards the end. Possible reasons for such outcomes are also discussed. It is also demonstrated that firms with smaller installed bases may be able to overcome the disadvantage caused by the differential network effects if they can develop products that embody the latest technological progress continuously.