Chapter 9
Licensing in the Theory of Cooperative R&D

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ABSTRACT

The literature on cooperative R&D did not pay much attention to knowledge sharing ex-post innovation through technology licensing, which is a common phenomenon in many industries. The author shows how licensing ex-post R&D affects the incentive for cooperative R&D and social welfare by affecting R&D investment and the probability of success in R&D. Licensing increases both the possibility of non-cooperative R&D and social welfare.

INTRODUCTION

Cooperation in R&D is a common phenomenon in this contemporary world.[1] A large body of literature has emerged to explain the rationale for cooperative research and development (R&D). Current literature has identified knowledge spillover, uncertainty in the R&D process, cost sharing in R&D and unsuccessful patent application as the main motives for cooperative R&D (see, e.g., d'Aspremont, and Jacquemin, 1988, Kamien et al. 1992, and Suzumura, K., 1992, Marjit, 1991, Combs, 1992, Mukherjee and Marjit, 2004, Mukherjee, 2005, Kabiraj, 2006 and 2007 and Mukherjee and Ray, 2009). However, the previous works have generally ignored knowledge sharing ex-post innovation through technology licensing, which is an important element of conduct in many industries.[2] In this chapter, we show how licensing ex-post R&D affects the incentive for cooperative R&D and social welfare by affecting R&D investment and the probability of success in R&D.[3]

Considering knowledge sharing as the benefit from cooperative R&D, we show that licensing ex-post R&D does not encourage the firms to do cooperative R&D, while the firms do cooperative R&D in the absence of licensing provided the cost reduction through R&D is small. It must be clear from our analysis that if cooperative R&D provides other benefits such as cost sharing and synergies,

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along with knowledge sharing, cooperative R&D may occur even in the presence of licensing, yet licensing reduces the incentive for cooperative R&D. Hence, one would expect less cooperative R&D in industries where knowledge sharing through licensing is easy.

If there is no licensing, we show that there can be a situation where the firms prefer cooperative R&D but welfare is higher under non-cooperative R&D, thus creating a conflict of interest between the firms and the society. However, even if licensing reduces the incentive for cooperative R&D, it increases welfare irrespective of its effect on R&D organization.

The remainder of the paper is organized as follows. Section 2 provides the model with non-cooperative and cooperative R&D without licensing. We extend this model in section 3 by incorporating licensing ex-post R&D. Section 4 shows welfare implications. Section 5 concludes.

THE CASE OF NO LICENSING

Consider an economy with two firms, called firm 1 and firm 2. Assume that these firms can produce a homogeneous product with a technology corresponding to the constant marginal cost of production $\bar{c}$. Both firms do R&D and each of them tries to reduce the cost of production to *c*, which is assumed to be zero for simplicity. However, success in R&D is uncertain. Assume that p and $(1-p)$ show respectively unconditional probability of success and failure in R&D. We assume that both firms face the same probability of success in R&D. Assume that each firm affects the probability of success in R&D through its own R&D investment, i.e., $p(x_i)$, $i = 1,2$, where x_i is firm i's R&D investment. We consider that $p'(x_i) > 0$, $p''(x_i) < 0$, $p'(0) = \infty$ and $p'(\infty) = 0$ for $i=1,2$. We further assume that there are no fixed costs related to production and R&D.

The assumption of no fixed cost of R&D implies that both firms always find it profitable to do R&D compared to no R&D. If there are fixed costs of R&D, firms might not find it profitable to do R&D if the probabilities of success in R&D were sufficiently low. Since our purpose is to examine the impact of licensing on R&D organization, i.e., non-cooperative and cooperative R&D, and social welfare, we abstract the possibility of no R&D by assuming no fixed cost of R&D.

Assume that the inverse market demand function is

$$P = 1 - q, \tag{1}$$

where, P is price of the product, q is the industry output and $1 > \bar{c}$. We further assume that $\bar{c} < .5$ which implies that if one firm has a technology corresponding to the marginal cost of production 0 and the other firm has a technology corresponding to the marginal cost of production $\bar{c}$, the outputs of both firms are positive.

We consider the following game in this section. At stage 1, both firms decide whether to do non-cooperative R&D or cooperative R&D. At stage 2, they compete like Cournot duopolists in the product market. We solve the game through backward induction.

The expected profit of the *i*th firm under non-cooperative R&D and under cooperative R&D are respectively

$$\begin{aligned} V_i(NC) &= p(x_i)p(x_j)\pi_i(0,0) \\ &+p(x_i)(1-p(x_j))\pi_i(0,\bar{c}) \\ &+(1-p(x_i))p(\boldsymbol{x}_j)\pi_i(\bar{c},0) \\ &+(1-p(x_i))(1-p(x_j))\pi_i(\bar{c},\bar{c}) - x_i \end{aligned} \tag{2}$$

and