E C O N O M I C S   B U L L E T I N

Optimal licensing contract in an open economy

Arijit Mukherjee
University of Nottingham

Abstract

Empirical evidences show that technology licensing contracts differ significantly and may consist of only up-front fixed-fee, only output royalty or the combinations of fixed-fee and output royalty. We explain these possibilities under international technology transfer. The trade-off between the incentive for saving the transportation cost of exporting and the incentive for reducing competition after licensing is responsible for the results. Our explanation differs from the existing studies where imitation and product differentiation are responsible for different licensing contracts.

I would like to thank Alessandra Guariglia and Kullapat Suetrong for very useful discussions. The usual disclaimer applies.
Citation: Mukherjee, Arijit, (2007) "Optimal licensing contract in an open economy." *Economics Bulletin,* Vol. 12, No. 3 pp. 1-6
Submitted: January 13, 2007. **Accepted:** February 25, 2007.
URL: http://economicsbulletin.vanderbilt.edu/2007/volume12/EB-07L10001A.pdf

1. Introduction

Technology licensing is an important phenomenon in many industries and has generated a fair amount of theoretical and empirical research.[1] However, the evidences show that licensing contracts differ significantly. According to Rostoker (1984), royalty alone was used for 39% of the time, fixed-fee alone for 13% of time, and royalty and fixed-fee for 46% of time, among the firms surveyed.

In an international Cournot duopoly, where the foreign firm is technologically efficient than the host-country firm, we show that the optimal licensing contract may consist of only up-front fixed-fee, only output royalty or the combinations of fixed-fee and output royalty. The trade-off between the incentive for saving the transportation cost of exporting and the incentive for reducing competition after licensing is responsible for the results. Our explanation differs from the existing studies where imitation (Rockett, 1990) and product differentiation (Mukherjee and Balasubramanian, 2001 and Faulí-Oller and Sandonis, 2002) are responsible for different licensing contracts if the licenser and the licensee compete in the product market.[2] Huge amount of evidences on international technology licensing (see, e.g., Root and Contractor, 1981 and Saggi, 2002) provide empirical relevance to our analysis.[3]

In a closed economy, Poddar and Sinha (2005) show that different types of licensing contracts can be the equilibrium outcomes *if the licenser is cost inefficient than the licensee*. They show that only fixed-fee (only royalty) is optimal for high (low) cost differences between the firms, and the combination of royalty and fixed-fee is optimal for intermediate cost differences. *In contrast, we consider licensing in an open economy and show our results under the usual assumption of a low cost licenser and a high cost licensee*. Our results also differ from theirs. We show that, if the own cost of the licensee is sufficiently high, licensing with only fixed-fee (only royalty) is optimal if the transportation cost is sufficiently high (low), which implies lower (higher) effective cost differences between the firms, while the combination of fixed-fee and output royalty is optimal for intermediate transportation costs. If the own cost of the licensee is not very high, the optimal licensing contracts consist of either royalty only or the combinations of fixed-fee and royalty.

The remainder of the paper is organized as follows. Section 2 describes the model and derives the results. Section 3 concludes.

2. The model and the results

Let us consider a firm, firm F, who wants to export its product in a country, called host-country. We assume that the constant marginal cost of firm F is c, which is normalized to 0, for simplicity. Firm F also needs to incur a per-unit transportation

---

[1] See Rostoker (1984), Kamien (1992) and Saggi (2002) for surveys on technology licensing.

[2] There is another literature which compares profitability of the fixed-fee licensing contract and the royalty licensing contract (see, e.g. Wang, 1998, Filippini, 2005 and the references therein). However, unlike the present paper, this literature does not consider optimal combination of fixed-fee and royalty.

If the licenser and the licensee do not compete in the product market, asymmetric information about the quality of the technology may be the reason for different types of licensing contracts (Gallini and Wright, 1990).

[3] Kabiraj and Marjit (2003) show the effects of strategic trade policy on the incentive for fixed-fee licensing and consumers. Mukherjee and Pennings (2006a and 2006b) consider licensing by a monopolist in presence of strategic trade policy. In contrast, we consider optimal licensing contracts in a duopoly without strategic government policy.

cost, t, for exporting its product to the host-country.[4] There is a firm in the host-country, firm H, who can produce a homogeneous product at the constant marginal cost of production $c_h > 0$.

We assume that $c_h < \frac{a}{2}$, which will ensure that the equilibrium output of firm H will always be positive. We also assume that $t < c_h$, which implies that the licenser (firm F) has lower cost than the licensee (firm H).

We assume that the inverse market demand function is

$$P = a - q \qquad (1)$$

where the notations have usual meanings.

We consider the following game. At stage 1, the firms decide on licensing. Under licensing, firm F offers a take-it-or-leave-it licensing contract with up-front fixed-fee (L) and per-unit output royalty (r), and firm H accepts the contract if it is not worse off under licensing than no licensing.[5] At stage 2, the firms produce like Cournot duopolists, and the profits are realized. We solve the game through backward induction.[6]

Standard calculation shows that under no licensing, which will give us the reservation payoffs of the firms under licensing, the payoffs of firms F and H are respectively $\frac{(a-2t+c_h)^2}{9}$ and $\frac{(a-2c_h+t)^2}{9}$.

Let us now consider the game under licensing. If firm F licenses its technology to firm H, firm F maximize the following expression to determine the optimal licensing contract:

$$\underset{r,L}{Max} \frac{(a-2t+r)^2+3r(a-2r+t)}{9} + L, \qquad (2)$$

subject to

$$\frac{(a-2r+t)^2}{9} - L \geq \frac{(a-2c_h+t)^2}{9} \qquad (3)$$

$$\frac{(a-2t+r)^2+3r(a-2r+t)}{9} + L \geq \frac{(a-2t+c_h)^2}{9} \qquad (4)$$

$$r, L \geq 0 \quad \text{and} \quad q_f, q_h \geq 0, \qquad (5)$$

where q_f and q_h are the equilibrium outputs of firms F and H respectively, and (3) and (4) show the participation constraints of firms H and F respectively. Since, ex-

---

[4] Though tariff barriers have reduced in recent years, international transportation costs are still significant (Hummels, 1991 and Milner, 2005).

[5] We will consider non-negative fixed-fees and output royalties. Like the existing literature on licensing, this may be motivated by the anti-trust laws.

[6] It must be clear that it is optimal for firm F to license its technology to firm H, and not to enter the host-country market, thus creating monopoly in the host-country. However, the commitment by firm F for not entering the host-country may not be credible either due to lack of enforcement in the world economy or it may be easy for firm F to enter the market with almost similar technologies, thus preventing monopoly in the host-country (see, e.g., Marjit, 1990, Wang, 1998, Kabiraj and Marjit, 2003 and Mukherjee and Pennings, 2005, to name a few, for similar assumptions). The assumption of no-commitment by the licenser for not entering the product market after licensing can also be found in Gallini and Winter (1985) and Katz and Shapiro(1985) for licensing in closed economies. We follow this strand of the literature and assume away credible commitment by firm F for not entering the host-country market after licensing, thus creating competition after licensing.

post licensing, firm H has no incentive to use the licensed technology if $r > c_h$, the optimal value of r does not exceed c_h. Therefore, the optimal royalty rate satisfies $0 \le r \le c_h$.

Since, firm F offers a take-it-or-leave-it licensing contract to firm H, the optimal L equals to $\frac{(a-2r+t)^2}{9} - \frac{(a-2c_h+t)^2}{9}$, and therefore, (2) reduces to

$$\underset{r}{Max} \frac{(a-2t+r)^2 + (a-2r+t)^2 + 3r(a-2r+t) - (a-2c_h+t)^2}{9}. \quad (6)$$

Ignoring the constraint $0 \le r \le c_h$, we find that the optimal royalty rate is $r^* = \frac{(a-5t)}{2}$. Note that, if $t \ge \frac{a}{5}$, the optimal royalty rate is 0. Hence, the optimal royalty rate satisfying the constraint $0 \le r \le c_h$ is $r^* = Min\{Max\{0, \frac{(a-5t)}{2}\}, c_h\}$, and the corresponding up-front fixed-fee is $L^* = Max\{\frac{(a-2r^*+t)^2 - (a-2c_h+t)^2}{9}, 0\}$.

Given the assumption $t < c_h$, the optimal royalty rate can be zero (i.e., $t \ge \frac{a}{5}$) provided $c_h > \frac{a}{5}$. However, t cannot be greater than $\frac{a}{5}$ if $c_h < \frac{a}{5}$, and therefore, the optimal royalty rate cannot be zero in this situation.[7] It should also be clear that firm F would always license its technology to firm H.[8]

The following proposition is immediate from the above discussion.

Proposition 1: *Assume $t < c_h$. We find that firm F always licenses its technology to firm H, and (i) if $c_h \in (\frac{a}{5}, \frac{a}{2})$, the optimal licensing contract consists of the royalty rate $r^* = Min\{Max\{0, \frac{(a-5t)}{2}\}, c_h\}$ and the up-front fixed-fee $L^* = Max\{\frac{(a-2r^*+t)^2 - (a-2c_h+t)^2}{9}, 0\}$, but (ii) if $c_h \in (0, \frac{a}{5})$, the optimal licensing contract consists of the royalty rate $r^* = Min\{\frac{(a-5t)}{2}, c_h\}$ and the up-front fixed-fee $L^* = Max\{\frac{(a-2r^*+t)^2 - (a-2c_h+t)^2}{9}, 0\}$.*

Licensing has certain effects. First, it helps to increase cost efficiency in the industry by allowing both firms to produce with the relatively superior technology,

---

[7] If we relax the assumption that $t < c_h$, the optimal royalty rate can be zero even if $c_h < \frac{a}{5}$.

[8] The following reason makes licensing always profitable. Given the option for a two-part tariff licensing contract, firm F has always the option to charge a royalty rate c_h, which makes firm H indifferent under licensing and no licensing, and makes firm F better off under licensing than under no licensing, thus making licensing always profitable.

[9] We will consider non-negative fixed fees and output royalties.

though positive royalty rate helps to reduce the cost efficiency. Second, licensing helps to save the transportation cost by reducing the cost of firm H, and therefore, by shifting production from firm F to firm H. Third, licensing exposes firm F to more intense competition in the product market by reducing the cost of firm H, and the positive royalty rate helps to reduce the intensity of competition faced by firm F after licensing compared to no licensing. In the absence of transportation cost, i.e., for $t = 0$, it is always optimal for firm F to charge zero up-front fixed-fee and positive royalty rate $c_h < \frac{a}{2}$, since it helps firm F to raise its profit through royalty income and also to minimize its loss of profit due to the intense competition after licensing. This is in line with Rockett (1990), Mukherjee and Balasubramanian (2001) and Faulí-Oller and Sandonis (2003). Similar argument follows even for low transportation costs.

If the transportation cost is not very small, i.e., $t > \frac{a - 2c_h}{5}$, the incentive for saving the transportation cost is also very important, and induces firm F to charge a lower royalty rate and to extract the benefit of higher cost efficiency in firm H with a suitable up-front fixed-fee. Hence, in this situation, the optimal licensing contract is a combination of up-front fixed-fee and output royalty. If the transportation cost is very high, i.e., $t > \frac{a}{5}$, the incentive for saving the transportation cost dominates the incentive for reducing competition after licensing, and induces firm F to license the technology against a positive up-front fixed-fee only.

3. Conclusion

We provide a new reason for the existence of different types of licensing contracts. We show that, in case of international technology licensing, the trade-off between the incentive for saving the transportation cost of exporting and the incentive for reducing competition after licensing generate licensing contracts with only output royalty, only up-front fixed-fee or the combinations of fixed-fee and output royalty.

References

Faulí-Oller, R. and J. Sandonis, 2002, ‘Welfare reducing licensing’, *Games and Economic Behavior*, **41**: 192 – 205.

Filippini, L., 2005, ‘Licensing contract in a Stackelberg model’, *The Manchester School*, **73**: 582 – 98.

Gallini, N. T. and B. D. Wright, 1990, ‘Technology transfer under asymmetric information’, *RAND Journal of Economics*, **21**: 147 – 60.

Gallini, N. T. and R. A. Winter, 1985, ‘Licensing in the theory of innovation’, *RAND Journal of Economics*, **16**: 237 – 52.

Hummels, D., 1991, ‘Have international transaction costs declined?’ *Mimeo*, University of Chicago.

Kabiraj, T. and S. Marjit, 2003, ‘Protecting consumers through protection: the role of tariff induced technology transfer’, *European Economic Review*, **47**: 113 – 24.

Kamien, M., 1992, ‘Patent licensing’, in R. J. Aumann and S. Hart (Eds.), *Handbook of game theory*, Ch. 11.

---

[10] Note that t must be less than a to generate positive output of firm X under export.

Katz, M. and C, Shapiro, 1985, 'On the licensing of innovation', *RAND Journal of Economics*, **16**: 504 – 20.
Marjit, S., 1990, 'On a non-cooperative theory of technology transfer', *Economics Letters*, **33**: 293 – 98.
Milner, C., 2005, 'Protection by tariff barriers and international transaction costs', *Scottish Journal of Political Economy*, **52**: 105 – 21.
Mukherjee, A. and N. Balasubramanian, 2001, 'Technology transfer in horizontally differentiated product-market', *Research in Economics*, **55**: 257 – 74.
Mukherjee, A. and E. Pennings, 2006a, 'Tariffs, licensing and market structure', *European Economic Review*, **50**: 1690 – 1707.
Mukherjee, A. and E. Pennings, 2006b, 'Corrigendum to tariffs, licensing and market structure', *European Economic Review* (Forthcoming).
Poddar, S. and U. B. Sinha, 2005, 'Patent licensing from high-cost to low-cost firm', *Working paper 05/03*, National University of Singapore.
Rockett, K., 1990, 'The quality of licensed technology,' *International Journal of Industrial Organization*, **8**: 559 – 574.
Rostoker, M., 1984, 'A survey of corporate licensing', *IDEA*, **24**: 59 – 92.
Root, F. R. and F. J. Contractor, 1981, 'Negotiating compensation in international licensing agreements', *Sloan Management Review*, **22**: 23 – 32.
Saggi, K., 2002, 'Trade, Foreign Direct Investment, and International Technology Transfer: A Survey', *World Bank Research Observer*, **17**: 191 – 235.
Wang, X. H., 1998, 'Fee versus royalty licensing in a Cournot duopoly model', *Economics Letters*, **60**: 55 – 62.