Technology transfer in duopoly
The role of cost asymmetry

Sankar Mukhopadhyay, Tarun Kabiraj*, Arijit Mukherjee

Economic Research Unit, Indian Statistical Institute, 203 B.T. Road, Calcutta 700035, India
Received 28 January 1998; accepted 11 January 1999

Abstract

This article examines the possibility of a profitable technology transfer deal in a duopoly. We show that under a fixed fee contract, technology transfer will be always profitable if the products are sufficiently differentiated or the firms behave sufficiently cooperatively or both. Under a profit sharing contract, however, a profitable technology transfer deal always exists even in a market characterised by Cournot duopoly with homogeneous goods. © 1999 Elsevier Science Inc. All rights reserved.

JEL classification: D43, L13

Keywords: Technology transfer; Conjectural variation; Fixed fee contract; Profit sharing contract

1. Introduction

Literature on technology transfer has grown in volumes over the years, which takes care of issues such as strategic transfer of technology, obsolete technology transfer, optimal licensing contracts, and modes of payments. A brief outline of this literature is given below.

Rockett (1990a) focuses on licensing equilibrium in which weak firms are encouraged to enter for the sole purpose of crowding the market to deter entry of the strong rivals. Gallini (1984) portrays the case where an incumbent strategically licenses its superior technology to a potential entrant to reduce the latter's incentives for developing a possibly better technology. Gallini and Winter (1985) show that in a duopoly

_____

* Corresponding author. Present address: Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Shatin, NT, Hong Kong, PRC. Tel.: 852-2609-7763; fax: 852-2603-5104.

E-mail address: tarunkabiraj@hotmail.com (T. Kabiraj)

the availability of licensing encourages research when the firms' initial technologies are close in terms of cost, and discourages research when initial cost differences are sufficiently large. Katz and Shapiro (1985) consider a game of R&D rivalry and licensing and show that major innovations will not be licensed, but that equally efficient firms will tend to license minor innovations.

On the question of the quality of the transferred technology Rocket (1990b) shows that if imitation cost is either very high or very low the best technology is transferred; if the imitation cost is in an intermediate range the best technology will not be transferred. Kabiraj and Marjit (1992; 1993) examine the possibility of international technology transfer under threat of entry and show that the best technology is unlikely to be transferred. On the question of optimal licensing contracts, Kamien and Tauman (1986) find fixed fee licensing superior to royalty-based licensing, from both the inventor's and the consumers' perspective. Katz and Shapiro (1986) analyze the profit maximizing strategy for a monopolistic innovator selling licenses to a group of firms that compete in the downstream market. They show that a pure price strategy is not, in general, optimal; placing a quantity restriction typically raises profits. Rockett (1990b) depicts the situation where in the no-imitation case a royalty per unit is charged by the transferor to extract all surplus. When imitation is costless, a fixed fee contract is optimal. Between these two, a combination of royalty and fixed fee will be charged.

The above discussion shows that if a fixed fee contract exists, then there are situations where technology transfer may not take place at all depending on the initial cost asymmetry between the firms (see, e.g., Katz & Shapiro, 1985 and Marjit, 1990). We re-examine the question of profitable technology transfer and see how the presence of product differentiation and behavioral interactions other than Cournot conjectures influence the technology transfer decision. We see that, in general, the initial degree of competition and collusiveness plays the most important role. If the initial situation is one of near collusion, a profitable technology transfer deal between the two firms always exists, whatever their initial technological gap. We also examine the role of cost asymmetry in the context of technology transfer when a profit sharing contract replaces a fixed fee contract.

Two papers closely related to our problem are Marjit (1990) and Katz and Shapiro (1985). In particular, Marjit (1990) considers an initial Cournot duopoly with homogeneous goods and concludes that a profitable technology transfer can occur if and only if the firms are reasonably close in terms of their initial technologies; technology transfer is unlikely to occur if the technology gap is too long. Marjit, Kabiraj, and Mukherjee (1997), however, construct a model of multifirm industry of homogeneous goods with a number of advanced and backward firms and discuss the possibility of a technology transfer agreement between one advanced and one backward firm. The article shows that if there are at least two advanced firms initially, a bilateral technology transfer agreement between two asymmetric firms is always profitable. Results similar to Marjit (1990) arise only when there is exactly one advanced firm.

The plan of the article is the following. In section 2, we consider the possibility of technology transfer under the fixed fee licensing contract. This model is a general

one in the sense that we have introduced (horizontal) product differentiation as well as symmetric conjectural variation in the model so that we can address the different degrees of competition. We consider two special cases of this general model. The first is the case of Cournot competition with differentiated product, with the result that technology transfer is always profitable if the products are sufficiently differentiated, irrespective of initial technological gap. The second special case considers a symmetric conjectural variation model with homogeneous product. Here also it turns out that technology transfer is profitable irrespective of the initial technological gap if the value of coefficient of conjectural variation is above some critical level. In section 3 we have considered profit sharing arrangements. We show that under this arrangement a profitable technology transfer contract is always possible even in a market characterized by Cournot duopoly with homogeneous goods. Section 4 concludes the article.

2. Fixed fee licensing

Consider a symmetric conjectural variation model with two quantity setting firms, 1 and 2, competing in a market with differentiated products. Let the inverse demand function as faced by the ith firm be [Eq. (1)][1]

$$p_i = a - q_i - \theta q_j \qquad (1)$$

with $i, j = 1, 2; j \neq i$, and $\theta \in (0, 1]$. θ represents the degree of substitutability between the products. $\theta = 1$ means the goods are perfect substitutes (homogeneous) and $\theta = 0$ means goods are unrelated.[2] Let the technology of a firm be represented by its constant marginal cost of production. We assume that there is no fixed cost of production. Without any loss of generality let us assume that firm 1 has more efficient production technology. We denote the ith firm's marginal cost of production by c_i, with $0 \leq c_1 < c_2 < a$. Then profit of firm i is defined as

$$\pi_i = (p_i - c_i)q_i .$$

Let v be the coefficient of symmetric conjectural variation, that is, $v = [\partial_{qi}]/[\partial_{qj}]\ i \neq j$. Then under non-cooperative competition in equilibrium

$$q_i = \frac{(\theta v + 2 - \theta)(a - c_i) + \theta(c_j - c_i)}{(\theta v + 2)^2 - \theta^2}$$

and [Eq. (2)]

$$\pi_i = (\theta v + 1)\left[\frac{(\theta v + 2 - \theta)(a - c_i) + \theta(c_j - c_i)}{(\theta v + 2)^2 - \theta^2}\right]^2, i, j = 1, 2; i \neq j . \qquad (2)$$

The assumption of initial duopoly implies that $c_1 < c_2 < \bar{c}_2(\theta; v)$ where

$$\bar{c}_2(\theta; v) = \frac{(\theta v + 2 - \theta)a + \theta c_1}{\theta v + 2} .$$

This follows from the fact that as $c_1 < c_2 < a$, we must have $q_2 = 0$ if $c_2 \geq \bar{c}_2\ (\theta; v)$.

Let us define

$$\Omega(c_1, c_2; \theta; v) = \pi_1(c_1, c_2) + \pi_2(c_1, c_2) .$$

It is easy to check that Ω is convex in c_2 and decreasing at $c_2 = c_1$. Let $\tilde{c}_2(\theta; v)$ be the solution of $\Omega(c_1, c_1; \theta; v) = \Omega(c_1, c_2; \theta; v)$. Then $\Omega(c_1, c_1; \theta; v) > \Omega(c_1, c_2; \theta; v)$ if and only if $c_2 < \tilde{c}_2(\theta; v)$. In our case

$$\tilde{c}_2(\theta; v) = \frac{2[(\theta v + 2)^2 - 2\theta(\theta v + 2) + \theta^2]a - [(\theta v + 2)^2 - 4\theta(\theta v + 2) + \theta^2]c_1}{(\theta v + 2)^2 + \theta^2} .$$

Now under the fixed fee contract, technology transfer is defined profitable if and only if the post-transfer industry payoff exceeds the pre-transfer industry payoff, that is [Eqs. (3) and (4)]

$$\Omega(c_1, c_1; \theta; v) > \Omega(c_1, c_2; \theta; v) \tag{3}$$

$$\Leftrightarrow c_2 < \tilde{c}_2(\theta; v) . \tag{4}$$

It then follows from the above that technology will be transferred irrespective of the initial technology gap if $\bar{c}_2(\theta; v) \leq \tilde{c}_2(\theta; v)$. When $\tilde{c}_2(\theta; v) < \bar{c}_2(\theta; v)$, technology transfer will occur if and only if the two firms are closer in terms of their initial technology levels, that is, $c_2 < \tilde{c}_2$. Later (under case 2 below) we discuss the possibility of discontinuity of Ω function when $v > 0$.

Now directly comparing the expressions for $\tilde{c}_2$ and $\bar{c}_2$ we can find that [Eq. (5)]

$$\tilde{c}_2 \gtreqless \bar{c}_2 \Leftrightarrow f(\theta; v) \gtreqless 0 \tag{5}$$

where

$$\begin{aligned} f(\theta; v) &= (\theta v + 2)^3 - 3\theta(\theta v + 2)^2 + \theta^2(\theta v + 2) + \theta^3 \\ &= (\theta v + 2 - \theta)(\theta v + 2 - \theta(1 + \sqrt{2}))(\theta v + 2 - \theta(1 - \sqrt{2})) . \end{aligned}$$

So far we have considered different values of conjectural variation and product differentiation together. Now to get the further insight into the problem we consider following two cases to highlight the role of product differentiation and conjectural variations separately.

2.1. Case 1: Horizontal product differentiation with Cournot conjectures

This situation corresponds to $v = 0$ and $\theta \in (0, 1)$. With these values we have Eq. (6)

$$f(\theta; 0) = (2 - \theta)(2 - \theta(1 + \sqrt{2}))(2 - \theta(1 - \sqrt{2})) . \tag{6}$$

Then $f(\theta; 0) = 0$ produces three roots of θ. However, only one of them lies in the interval $(0, 1)$. The permissible root of θ is $\theta_0 = 2(\sqrt{2} - 1) = 0.8$ (approximately). We further note that $f_\theta(\theta; 0) < 0$ at $\theta = \theta_0$. Hence, we have the following proposition immediately.

Proposition 1. (a) For $\theta < \theta_0$, $\Omega(c_1, c_1; \theta; 0) > \Omega(c_1, c_2; \theta; 0) \ \forall c_2 \in (c_1, \bar{c}_2(\theta; 0))$.

   (b) For $\theta \geqslant \theta_0$, $\exists \tilde{c}_2$, $c_1 < \tilde{c}_2 < \bar{c}_2(\theta; 0)$ such that $\Omega(c_1, c_1; \theta; 0) > \Omega(c_1, c_2; \theta; 0)$ if and only if $c_2 < \tilde{c}_2$.

The above results imply that if the products are sufficiently differentiated (i.e., $\theta < \theta_0$), technology transfer is always profitable; if the products are not sufficiently differentiated, then technology transfer is profitable if and only if the initial technological differences are not too large (i.e., $c_2 < \tilde{c}_2$). The intuition of the above result is simple. If technology transfer takes place, the payoff of the licensor falls, whereas the payoff of the licensee increases. The overall effect on industry profits is ambiguous. The competitive effect dissipates industry profits, whereas the efficiency effect increases industry profits. If the licensee's payoff increases at the expense of the licensor's payoff, then the industry profit falls compared to the pre-transfer situation. Hence, it is not possible for the licensor to charge a price for its technology so that both firms can guarantee at least their pre-transfer levels of payoffs. If the initial cost differences of the firms are sufficiently large, then it creates near monopoly of the technologically superior firm. In that case, it may not be beneficial for the technologically superior firm to license its technology to its technologically inferior competitor, as technology transfer will create competition, which reduces industry profits. However, if the products of the firms are differentiated, this may help to reduce the loss of market share by the licensor, whereas it makes the licensee more cost efficient. Therefore, product differentiation makes less profit loss of the licensor and creates more profit rise of the licensee. This increases the likelihood of technology transfer. For sufficient product differentiation, the profit loss of the licensor, after technology transfer, is negligable but this technology transfer increases the profit of the licensee in such a way that it is always profitable to license the technology in this situation. Otherwise, technology will be transferred provided that the technologies of firms are sufficiently close so that technology transfer does not increase much competition between the firms.[3]

2.2. Case 2: Symmetric conjectural variation with homogeneous products

Having seen the effect of product differentiation on technology transfer let us now concentrate on the effect of conjectural variation.[4] $\theta = 1$ along with $v \neq 0$ characterizes this situation. However, in this case we shall have to be a bit more careful because Ω function becomes discontinuous at $c_2 = (a + c_1)/2$ for $v > 0$. To understand why this is the case, let us take a look at how the output of firm 1 changes as c_2 increases.

From the reaction function of firm 1, we get

$$q_1(\bar{c}_2(v)) = \frac{a - c_1}{2 + v}$$

which is, however, less than its unrestricted monopoly output for $v > 0$. So it is obvious that firm 1 will start producing monopoly output even at some lower c_2 (say, c_2^*), and $\forall c_2 > c_2^*$ it will continue to produce its unrestricted monopoly output $[(a - c_1)/2]$. Figure 1 illustrates this case.

As c_2 increases from initial duopoly equilibrium E_1, q_1 increases along $R_1(v)$. However as soon as $R_2(v, c_2^*)$ *is reached, there will be a discontinuous jump of q_1*, to
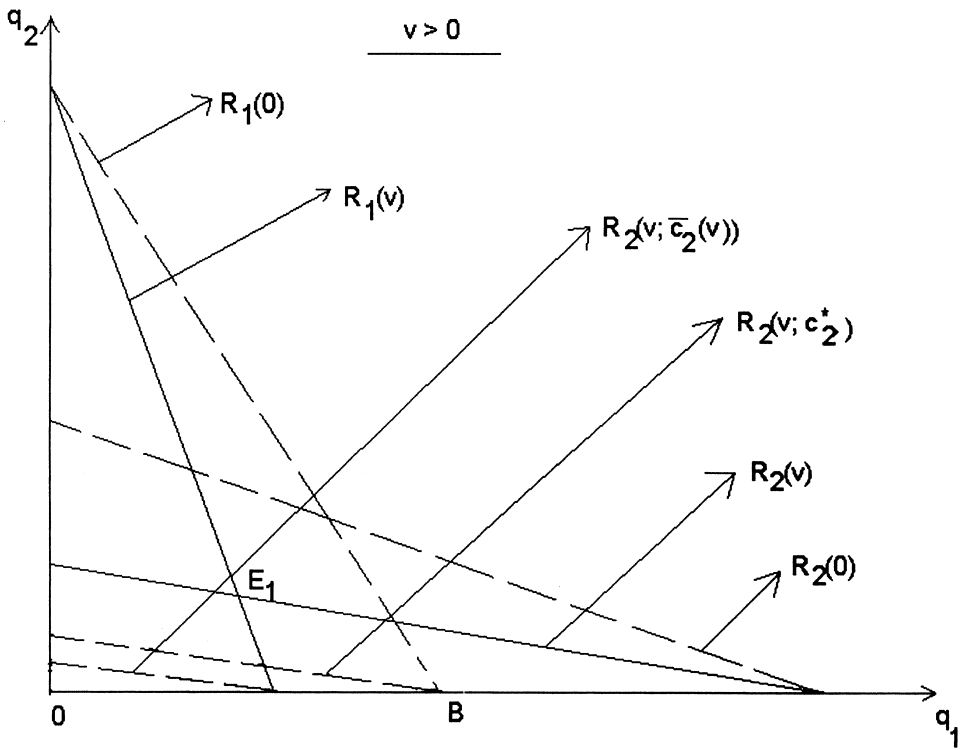
Fig. 1. Behavior of q_1 when $v > 0$.

$(a - c_1)/2$ (= OB in the figure). Thereafter for all $c_2 \geq c_2^*[=(a + c_1)/2]$, q_1 remains constant at $(a - c_1)/2$.

Let us now explain what happens when $v < 0$. Figure 2 illustrates this case. As c_2 increases from initial duopoly equilibrium E_2, q_1 increases along $R_1(v)$. At $c_2 = \bar{c}_2(v)$, $q_1(\bar{c}_2(v)) = [(a - c_1)/(2 + v)]$ ($> (a - c_1)/2$, $v < 0$). After that as c_2 further increases, q_1 decreases till it reaches $(a - c_1)/2$ (= OB). Thus there is a kink at $\bar{c}_2(v) = c_2'$ (say).

The case, $v = 0$, is, however, fairly simple. From initial equilibrium, as c_2 increases to $\bar{c}_2 (v)$, q_1 increases monotonically to $(a - c_1)/2$. Figure 3 shows how q_1 changes against c_2 for different values of v.

Now, given the nature of adjustment of q_1, it is clear that

$$\Omega(c_1, c_2; 1; v) = \frac{(a - c_1)^2}{4} \qquad \text{for} \qquad c_2 \geq \frac{a + c_1}{2},$$

but for $c_2 < (a + c_1)/2$, the expression of $\Omega(c_1, c_2; 1; v)$ is given by

$$\Omega(c_1, c_2; 1; v) = \frac{1}{(1 + v)(3 + v)^2}[(a(1 + v) - c_1(2 + v)$$

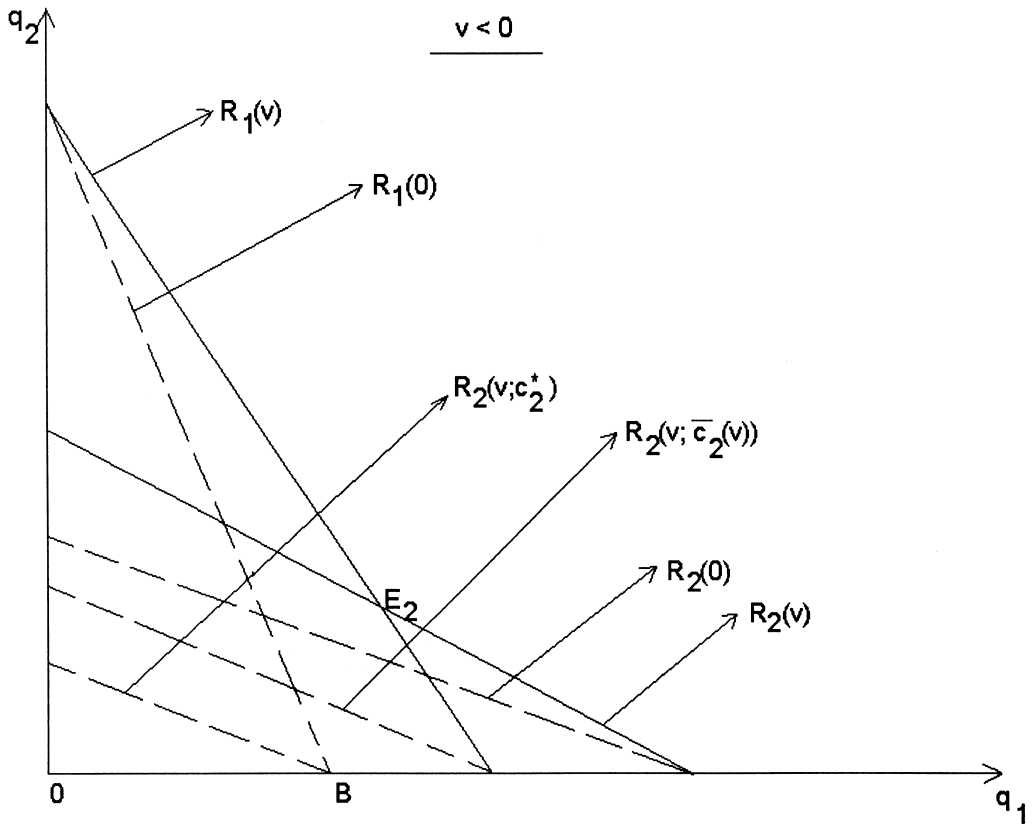$$+ c_2)^2 + (a(1 + v) - c_2(2 + v) + c_1)^2].$$

Fig. 2. Behavior of q_1 when $v < 0$.

This proves that there is a discontinuous jump in $\Omega(c_1, c_2; 1; v)$ curve at $c_2^* = (a + c_1)/2$ for all $v > 0$.

If the Ω function were continuous at $c_2^* (= (a + c_1)/2)$, its value would have been [Eq. (7)]

$$\Omega^p(c_1, c_2^*; 1; v) = \left[\frac{(3 + 2v)(a - c_1)}{2(3 + v)(1 + v)}\right]^2 (1 + v) \tag{7}$$

Because the Ω function is continuous in $c_2 < c_2^*$, and it is increasing in the neighborhood of c_2^*, the sufficient condition that ensures that there will always be a profitable transfer is Eq. (8):

$$\Omega(c_1, c_1; 1; v) > \Omega^p(c_1, c_2^*; 1; v)$$

$$\Leftrightarrow v > \frac{(\sqrt{2} - 1)}{2} \equiv v_0 \text{ (say)}, \tag{8}$$

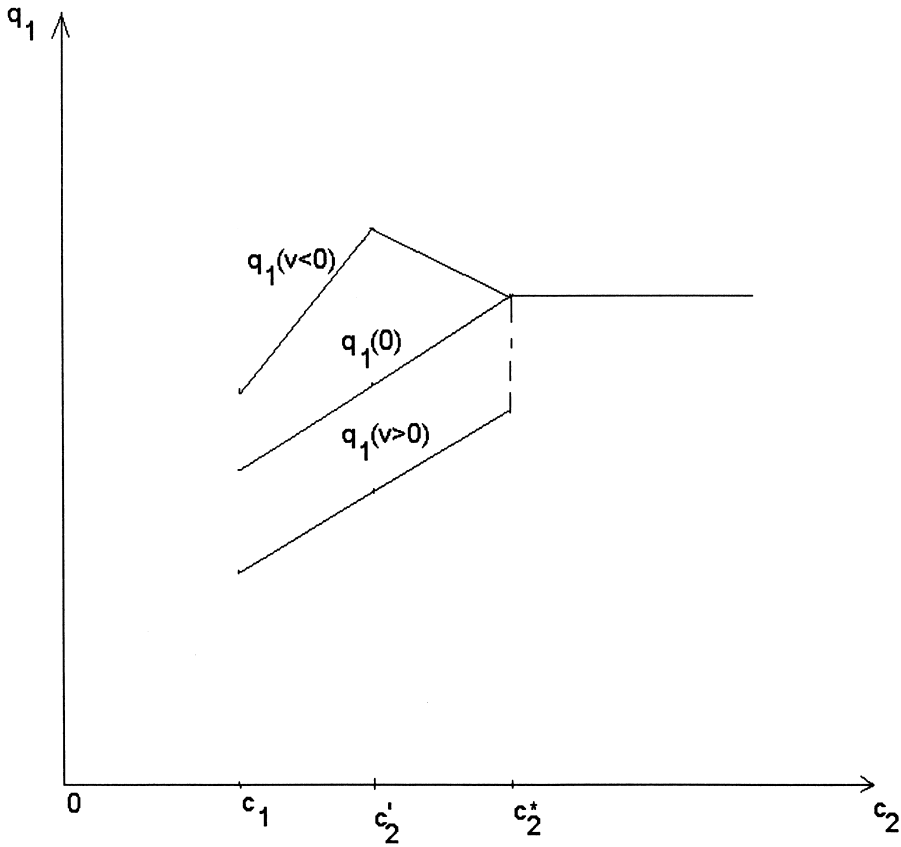that is, $v_0 = 0.2$ (approximately). Hence, we get the following proposition.

Fig. 3. q_1 as a function of c_2.

Proposition 2 (a) For $v > v_0$, $\Omega(c_1, c_1; 1; v) > \Omega(c_1, c_2; 1; v) \ \forall c_2 < (a + c_1)/2$.
(b) For $v \leq v_0$, $\exists \hat{c}_2$, $c_1 < \hat{c}_2 < (a + c_1)/2$ such that $\Omega(c_1, c_1; 1; v) > \Omega(c_1, c_2; 1; v)$ if and only if $c_2 < \hat{c}_2$.

Proposition 2 indicates that if the coefficient of conjectural variation is above some critical level, then technology transfer will always take place. On the other hand, if it is below that level, technology transfer will still take place provided that the initial technologies are reasonably close. The intuition of the result is simple. As the value of conjectural variation increases, firms begin to behave more and more cooperatively. Therefore, the loss of market share of the licensor decreases as conjectural variation increases. This increases the possibility of mutually profitable technology transfer.

So far we have looked at the profitability condition for technology transfer. In other words, we have examined the situation when technology transfer creates a gain from trade. Until now we have not said anything about how the gains will be divided between the firms. This leads to the question of the pricing of the technology. To find an answer we can think of a generalized Nash bargaining solution. Therefore, the surplus created will be divided according to the bargaining power of the respective

firms. For example, with an equal bargaining power, the price of the technology will be determined by maximizing the expression $(\pi_2(c_1, c_1) - F - \pi_2(c_1, c_2))$ $(F + \pi_1(c_1, c_1) - \pi_1(c_1, c_2))$ with respect to F provided that the post-transfer industry profit is larger than the pre-transfer industry profit, where F is the price of the technology. This will lead to the price of the technology as $F = [\pi_1(c_1, c_2) - \pi_2(c_1, c_2)]/2$.

3. Profit sharing

In the previous section, we have focused on the fixed fee contract and have shown that technology transfer will take place irrespective of initial technological gap if either the products are sufficiently differentiated or the coefficient of conjectural variation is sufficiently high or both.

Sometimes, however, the technologically superior firm takes financial interest in the technologically inferior firm and remains satisfied with only the dividend income. One question that may naturally arise is how this type of arrangements affects the technology transfer decision. In this section, we examine the role of cost asymmetry in the context of technology transfer when we have a profit sharing arrangement in place of a fixed fee contract.

Consider two firms, 1 and 2, competing in the market like Cournot duopolists with homogeneous products, and marginal cost of production of firm i is c_i, $(i = 1, 2)$, with $c_1 < c_2$. Again, transfer of technology means transfer of knowledge embodied in marginal cost function. Let us now suppose that the mode of contract on technology transfer is such that firm 1 gets a share α $(0 < \alpha < 1)$ of firm 2's post-transfer profit. Hence, in the post-transfer regime, profits of two agents are given by Eqs. (9) and (10):

$$\Pi_1 = \Pi^1(c_1, c_1) + \alpha\Pi^2(c_1, c_1) \tag{9}$$

$$\Pi_2 = (1 - \alpha)\Pi^2(c_1, c_1) \tag{10}$$

where Π^i is the ith firm's post-transfer profit from market operation. Let Π^{i0} be the ith firm's pre-transfer profit.

We assume linear industry demand function of the firm [Eq. (11)]

$$P = a - (q_1 + q_2). \tag{11}$$

Then,

$$\Pi^{10}(c_1, c_2) = \frac{(a - 2c_1 + c_2)^2}{9}; \qquad \Pi^{20}(c_1, c_2) = \frac{(a - 2c_2 + c_1)^2}{9}$$

$$\Pi^1(c_1, c_1) = \frac{(1 - \alpha)(a - c_1)^2}{(3 - \alpha)^2}; \qquad \Pi^2(c_1, c_1) = \frac{(a - c_1)^2}{(3 - \alpha)^2}.$$

The Individual Rationality constraint of firm 2 is now

$$(1 - \alpha)\Pi^2(c_1, c_1) \geqslant \Pi^{20}(c_1, c_2). \tag{12}$$

We also need the post-transfer industry profit to be higher than the pre-transfer industry profit, that is,

$$\Pi^1 + \Pi^2 > \Pi^{10} + \Pi^{20} . \tag{13}$$

Given the principal agent structure of the problem, Eq. (12) will be satisfied with equality. Hence Eq. (13) reduces to

$$\Pi_1 > \Pi^{10} . \tag{14}$$

For Eq. (14) to be satisfied we need

$$\alpha > \frac{3(c_2 - c_1)}{(a - 2c_1 + c_2)} \equiv \underline{\alpha} .$$

Now, if $c_2 < (a + c_1)/2$, that is, if initially there was a duopoly in the market, then we must have $\underline{\alpha} < 1$.

Considering Eq. (12) with equality we get

$$\frac{A^2}{9} \alpha^2 + [B^2 - \frac{2}{3} A^2]\alpha + (A^2 - B^2) = 0 \tag{15}$$

where

$$A = (a - 2c_2 + c_1) \quad \text{and} \quad B = (a - c_1) .$$

Let $f(\alpha)$ denote the LHS of Eq. (15). Then

$$f'(\alpha) = 0 \Rightarrow \alpha = \frac{(2/3) A^2 - B^2}{(2/9) A^2} = \alpha^* \text{ (say)} < 0 \quad \text{and} \quad f''(\alpha) = \frac{2}{9}A^2 > 0 .$$

Therefore, $f(\alpha)$ is strictly convex in α. It implies $f'(\alpha) > 0$ for $\alpha \in [0, 1]$ and $f(0) < 0$ and $f(1) > 0$. Hence, $\exists \alpha = \bar{\alpha}$ such that $f(\bar{\alpha}) = 0$ and

$$f(\alpha) \lesseqqgtr 0 \quad \text{according as} \quad \alpha \lesseqqgtr \bar{\alpha}, \alpha \in [0, 1] .$$

Also, it can be shown that

$$f(\underline{\alpha}) < 0 \Rightarrow \bar{\alpha} > \underline{\alpha}.$$

Define

$$\Omega(c_1, c_1; \alpha) = \Pi^1(c_1, c_1) + \Pi^2(c_1, c_1) .$$

Then we get the following proposition.

> Proposition 3. $\exists \bar{\alpha}, 0 < \bar{\alpha} < 1$ such that $\Omega(c_1, c_1; \alpha) > \Omega(c_1, c_2) \Leftrightarrow \alpha > \bar{\alpha}, \forall c_2 < (a + c_1)/2$.

The above proposition states that given an initial duopoly, a profitable technology transfer deal under profit sharing arrangements always exists. The intuition of the above result is as follows. As firm 1 transfers the better technology to firm 2, firm 1's own profit decreases while the profit of firm 2 increases relative to the pre-transfer level. Because firm 1 holds some share in firm 2, this partial ownership interest leads firm 1 to internalize its competitive behavior with the other firm and helps to increase industry profit. In other words, firm 1 behaves less competitively. If the reduction in

competitiveness because of firm 1's financial interest in firm 2 is sufficiently high, then profit sharing contract ensures a profitable technology transfer deal always.

In the above discussion, we have assumed that the licensor has all the bargaining power and thus extracts all the surplus created by the technology transfer. If both parties have some bargaining power, however, then an argument similar to the previous section can show that α will be somewhere between $\underline{\alpha}$ and $\bar{\alpha}$ depending on the bargaining powers of the firms.

4. Conclusion

This article addresses the issue of profitable technology transfer in a duopoly and identifies the role of each of product differentiation, conjectural variation, and profit sharing arrangement in this context. We show that, with a fixed fee contract, a technology transfer deal is always profitable provided that the products are sufficiently differentiated or that the firms behave sufficiently cooperatively or both. Otherwise, the technology transfer decision depends on the initial cost asymmetry of the firms.

If we consider a profit sharing agreement instead of the fixed fee contract, a technology transfer deal can always be profitable irrespective of the initial technological gap even in a market characterized by Cournot duopoly with homogeneous goods. Thus the article shows that we should expect technology transfer to take place in a duopoly market more often than not.

Acknowledgments

Notes

1. This type of demand function can be derived if a typical consumer maximizes a quadratic utility function.
2. When $\theta < 0$, the goods are (gross) complements, but we shall not deal with this case in this paper.
3. If we consider price competition with differentiated products, this means in our structure $v = -\theta$ and $0 < \theta < 1$. In this situation we get similar results. The only difference is that the degree of differentiation needed to ensure that the technology will always be transferred is higher because the competition is more fierce under price competition.
4. The use of conjectural variations to represent a complex multiperiod interaction in a static model is subject to well known criticisms. Conjectures therefore are best interpreted as an efficient expository device to describe the market behavior that results from the underlying game. On conjectural variations see Perry

(1982), Bresnahan (1981), and Boyer and Moreaux (1983). The applications of conjectural variations may be found in Kwoka (1992) and Reitman (1994), to mention only two.

References

Boyer, M., & Moreaux, M. (1983). Consistent versus non-consistent conjectures in duopoly theory: some examples. *Journal of Industrial Economics XXXII*, 97–110.

Bresnahan, T. (1981). Duopoly models with consistent conjectures. *American Economic Review 71*, 934–945.

Gallini, N. (1984). Deterrence by market sharing: a strategic incentive for licensing. *American Economic Review 74*, 931–941.

Gallini, N., & Winter, R. (1985). Licensing in the theory of innovation. *RAND Journal of Economics 16*, 237–252.

Kabiraj, T., & Marjit, S. (1992). To transfer or not to transfer the best technology under threat of entry — the case of price competition. In B. Dutta et al. (Eds.), *Game Theory and Economic Applications* (pp. 356–368). New York: Springer-Verlag.

Kabiraj, T., & Marjit, S. (1993). International technology transfer under potential threat of entry — a Cournot-Nash framework. *Journal of Development Economics 42*, 75–88.

Kamien, M., & Tauman, Y. (1986). Fees vs. royalties and the private value of a patent. *Quarterly Journal of Economics 101*, 471–491.

Katz, M., & Shapiro, C. (1985). On the licensing of innovations. *RAND Journal of Economics 16*, 504–519.

Katz, M., & Shapiro, C. (1986). How to license intangible property. *Quarterly Journal of Economics 101*, 567–589.

Kwoka, J. (1992). The output and profit effects of horizontal joint ventures. *Journal of Industrial Economics XL*, 325–338.

Marjit, S. (1990). On a non-cooperative theory of technology transfer. *Economics Letters 33*, 293–298.

Marjit, S., Kabiraj, T., & Mukherjee, A. (1997). Bilateral agreements in a multifirm industry — technology transfer and horizontal merger. *Pacific Economic Review* (forthcoming).

Perry, M. (1982). Oligopoly and consistent conjectural variations. *Bell Journal of Economics 13*, 197–205.

Reitman, D. (1994). Partial ownership arrangements and the potential for collusion. *Journal of Industrial Economics XLII*, 313–322.

Rockett, K. (1990a). Choosing the competition and patent licensing. *RAND Journal of Economics 21*, 161–171.

Rockett, K. (1990b). The quality of licensed technology. *International Journal of Industrial Organisation 8*, 559–574.