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

Cost-saving production technologies and partial ownership

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Abstract

This work analyzes the incentives to acquire cost-saving production technologies when cross-participation exists at ownership level. We show that cross-participation reduces the incentives to adopt the cost-saving production technology.

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1 Introduction

This work examines the incentives to acquire cost-saving production technologies when cross-participation exists at ownership level.[1] We find this analysis quite relevant since it is generally considered that each firm is owned by a different shareholder (see, for example, Bester and Petrakis, 1993).

The question we analyze in this work can be illustrated by taking the automobile industry as an example**.** We focus our analysis on technologies that can produce a single model of a product class (dedicated technologies). Elkins *et al.* (2004) argue that the automobile industry has traditionally purchased this type of technology to produce a given product with low costs per unit and high volume. On the other hand, in this industry there are examples of partial ownership of rivals. One illustrative example is given by the French firm Renault, which acquired a 36.8% equity stake in Nissan Motor in 1999 (Renault Presse, 10/20/99). We set our model in this context.

Assuming a duopoly market structure, Bester and Petrakis (1993) analyze firms' technology choices when each firm is owned by a different shareholder. They focus their analysis on the choice between two types of production technology: a low marginal cost technology and a high marginal cost technology. For the former to be adopted more investment is needed than for the latter. We extend this analysis by considering that one of the firms is jointly owned by the two shareholders and the other is owned by one of the shareholders.

Bester and Petrakis (1993) obtain that, for a determinate range of values of parameters, there are two asymmetric equilibria: in each of them one firm adopts the low marginal cost technology and the other the high marginal cost technology. However, unlike Bester and Petrakis (1993), we obtain that, in general, there is only one asymmetric equilibrium: the firm that is owned by only one shareholder chooses the high marginal cost technology while the firm that is jointly owned by the two shareholders adopts the low marginal cost technology. The reason for this result is the following. First, the latter firm has a higher output (i. e. is more aggressive) than the former firm since only the former firm internalizes the fact that the two firms compete in the product

[1] For an explanation of why partial ownership arrangements are formed see Alley (1997)

market. Second, a firm is more aggressive when adopting the low marginal cost technology than when adopting the high marginal cost technology. This implies that from the point of view of the shareholder who has a stake in both firms the incentive to adopt the high marginal cost technology is reinforced. By contrast, the other shareholder will attempt to take advantage of this situation, which reinforces the incentive to adopt the low marginal cost technology. We also obtain that cross-participation at ownership level increases the range of values of parameters for which only one firm adopts the low marginal cost technology. This means that, in comparison with the case in which each firm is owned by only one shareholder, under partial ownership there is a greater range of values of parameters for which we obtain the asymmetric equilibrium in which only one firm adopts the low marginal cost technology.

2 The model and results

We consider a single industry consisting of two firms, 1 and 2, that produce a homogeneous good. Each firm can choose between two different production technologies: a low marginal cost technology (Technology-l), which has constant marginal cost $c_l = 0$ and fixed cost $F_l = F$ and a high marginal cost technology (Technology-h), which has constant marginal cost c_h and fixed cost $F_h = 0$.

There are two shareholders, A and B. Firm 1 is completely owned by shareholder A while firm 2 is jointly owned by the two shareholders, with shareholder B having the majority of shares in firm 2. We denote by α (α<1/2) the fraction of shares that owner A has in firm 2. As a result, firm 1 is controlled by shareholder A and firm 2 by shareholder B. We assume linear inverse demand function:$p = a - b(q_1 + q_2), a > \frac{2c}{1-\alpha}$, where p is the market price and q_i is the output level of firm i. Shareholders are assumed to maximize their total profit, which means that the objective function of shareholder A is $\pi_A = \pi_1 + \alpha\pi_2$, while the objective function of shareholder B is $\pi_B = (1-\alpha)\pi_2$, where the profit of firm i is given by $\pi_i = (p - c_i)q_i - F_i$, i=1, 2.

We consider a two stage game. In the first stage, the two shareholders simultaneously choose the production technology. In the second stage, the two shareholders take output decisions. We solve the game by backward induction

from the last stage of the game to obtain a subgame-perfect Nash equilibrium. Given that there are two different technologies, there are four cases: (i) both firms adopt Technology-l, (ii) both firms adopt Technology-h, (iii) firm 1 adopts Technology-h and firm 2 adopts Technology-l and, finally, (iv) firm 1 adopts Technology-l and firm 2 adopts Technology-h.

In stage two, each shareholder chooses the output level that maximize its objective function. Solving these problems in each of the cases we obtain equilibrium output levels, firms' profits and shareholders' profits:

$$q_2^{hh} = \frac{(a-c)}{b(3-\alpha)}, q_1^{hh} = \frac{(a-c)(1-\alpha)}{b(3-\alpha)}, q_2^{ll} = \frac{a}{b(3-\alpha)}, q_1^{ll} = \frac{a(1-\alpha)}{b(3-\alpha)}, q_2^{lh} = \frac{a+c}{b(3-\alpha)},$$

$$q_1^{hl} = \frac{a(1-\alpha)-2c}{b(3-\alpha)}, q_2^{hl} = \frac{a-2c}{b(3-\alpha)}, q_1^{lh} = \frac{a(1-\alpha)+c(1+\alpha)}{b(3-\alpha)}, \pi_2^{hh} = \frac{(a-c)^2}{b(3-\alpha)^2},$$

$$\pi_1^{hh} = \frac{(a-c)^2(1-\alpha)}{b(3-\alpha)^2}, \pi_2^{ll} = \frac{a^2}{b(3-\alpha)^2} - F, \pi_1^{ll} = \frac{a^2(1-\alpha)}{b(3-\alpha)^2} - F, \pi_2^{lh} = \frac{(a+c)^2}{b(3-\alpha)^2} - F,$$

$$\pi_1^{hl} = \frac{(a-(2-\alpha)c)(a(1-\alpha)-2c)}{b(3-\alpha)^2}, \pi_2^{lh} = \frac{(a-2c)^2}{b(3-\alpha)^2},$$

$$\pi_1^{lh} = \frac{(a-\alpha a+c+c\alpha)(a+c-\alpha c)}{b(3-\alpha)^2} - F, \pi_B^{hh} = \frac{(1-\alpha)(a-c)^2}{b(3-\alpha)^2}, \pi_A^{hh} = \frac{(a-c)^2}{b(3-\alpha)^2},$$

$$\pi_B^{ll} = \frac{a^2(1-\alpha)}{b(3-\alpha)^2} - F(1-\alpha), \pi_A^{ll} = \frac{a^2}{b(3-\alpha)^2} - F(1+\alpha),$$

$$\pi_B^{lh} = \frac{(a+c)^2(1-\alpha)}{b(3-\alpha)^2} - F(1-\alpha), \pi_A^{hl} = \frac{(a-2c)^2 + \alpha c(5a-\alpha a-c)}{b(3-\alpha)^2} - \alpha F,$$

$$\pi_B^{lh} = \frac{(a-2c)^2(1-\alpha)}{b(3-\alpha)^2}, \pi_A^{hl} = \frac{(a+c)^2 - \alpha c(5a-\alpha a-4c+\alpha c)}{b(3-\alpha)^2} - F.$$

Given that the output level of a firm decreases with its own marginal cost of production and increases with that of the rival firm and since Technology-l has a lower marginal production cost than Technology-h, we have that $q_i^{lh} > q_i^{ll} > q_i^{hh} > q_i^{hl}$ and $p_i^{lh*} > p_i^{ll*} > p_i^{hh*} > p_i^{hl*}, i = 1, 2$, where q_i^{lh} and p_i^{lh*} denote the output level of firm i and its net price of the marginal cost of production, respectively, when this firm adopts Technology-l and the other Technology-h; the other expressions are interpreted similarly. Then, firm i's marginal cost reduction is strategically advantageous for firm i since it increases the output level of this firm and the net price, and the higher net price and output level are, the greater the profit of the firms is. This means that quantity competition creates a positive strategic incentive to adopt the cost-saving technology. Therefore, if we do not consider that there is cross-participation at ownership level, the gains from a marginal cost reduction depend on three factors: (I) the price net of the marginal cost of production (denoted as p^*), (II) the output level and (III) the investment needed to acquire the cost saving-technology. We have seen that $p_i^{lh*} > p_i^{ll*} > p_i^{hh*} > p_i^{hl*}$ and $q_i^{lh} > q_i^{ll} > q_i^{hh} > q_i^{hl}, i = 1, 2$. Consequently, (I) and (II) lead to a positive incentive to adopt Technology-l in both firms. On the other hand, (III) leads to a negative incentive to adopt Technology-l.

However, when we consider partial ownership of rivals, an additional effect arises. When deciding the output level of firm 1, shareholder A internalizes the fact that firms 1 and 2 compete in the product market. By contrast, shareholder B does not internalize this effect. As a result, for a given pair of technologies (one for each firm), the output level of firm 2 is greater than that of firm 1: $q_2^{rs} > q_1^{rs}; r, s = h, l$ (i.e. firm 2 is more aggressive than firm 1). Moreover, it is easy to see that $\frac{\partial q_1^{rs}}{\partial \alpha} < 0$, which means that the output level of firm 1 decreases with the percentage of the shares that shareholder A has in firm 2. Therefore, the greater the value of parameter α the lower the output level of firm 1.

In the first stage of the game, shareholders A and B simultaneously choose the production technology of firms 1 and 2, respectively. Let:

$$F_{\alpha 1} = \frac{c\,(4-\alpha)(a\,(1-\alpha)+\alpha c)}{b\,(3-\alpha)^2}, F_{\alpha 2} = \frac{c\,(4-\alpha)(a\,(1-\alpha)-c)}{b\,(3-\alpha)^2},$$

$$F_1 = \frac{4ac}{b\,(3-\alpha)^2}, F_2 = \frac{4c_h(a-c)}{b\,(3-\alpha)^2},$$

where $F_{\alpha 1}$, $F_{\alpha 2,}$ F_1 and $F_{2,}$are the investments needed to adopt the cost-saving technology such that $\pi_A^{hh} = \pi_A^{lh}$, $\pi_A^{hl} = \pi_A^{ll}$, $\pi_B^{hh} = \pi_B^{lh}$ and $\pi_B^{hl} = \pi_B^{ll}$, respectively. It is straightforward to see that $F_1 > max\{F_{\alpha 1}, F_2\} > F_{\alpha 2}$, where $F_{\alpha 1} > F_2$ if and only if $a < a_1 = \frac{c(4+\alpha(4-\alpha))}{\alpha(5-\alpha)}$. Solving this stage we obtain the following result.

Proposition 1: Under partial ownership of rivals, if $F \leq F_{\alpha 2}$ both firms choose Technology-l. If $F > F_1$ both firms choose Technology-h. And, if $F_{\alpha 2} < F \leq F_1$ only one firm chooses Technology-l. In this last case, if $\alpha \geq 0.3649$ Technology-h is adopted by firm 1 and Technology-l is adopted by firm 2; if $\alpha < 0.3649$ and $F_{\alpha 1} < F < F_2$ either firm may adopt Technology-l while Technology-h is adopted by firm 1 and Technology-l is adopted by firm 2 otherwise.

The result obtained in Proposition 1 for the case α<0.3649 is illustrated in Figure 1. If the adoption of Technology-l does not require any investment F, then $\pi_B^{lj} > \pi_B^{hj}$ and $\pi_A^{lj} > \pi_A^{hj}$ $(j = h, l)$ which reflects the positive incentive that both shareholders have to adopt Technology-l caused by both (I) and (II). But, since in our model the adoption of Technology-l requires an investment, different investment levels will produce different results in equilibrium. In fact, if F is sufficiently low, $F \leq F_{\alpha 2}$, (I) and (II) together dominate (III) and both firms find the adoption of Technology-l profitable. By contrast, if F is sufficiently high, $F > F_1$, (III) dominates (I) and (II) together and both firms adopt Technology-h. For intermediate values of F, $F_{\alpha 2} < F \leq F_1$, the adoption of the cost-saving technology by a single firm induces a higher net price and a larger market share for the firm that adopts this technology, at the expense of the other firm's net price and market share, which is large enough for (I) and (II) to offset (III) in the firm that adopts Technology-l. As a result, only one firm adopts the cost-saving technology. On the other hand, we have seen that firm 2 is more aggressive in the product market than firm 1, which means that in general firm 1

has less incentives to adopt the cost-saving technology than firm 2. The reason for this result is the following. If firm 1 adopts Technology-l it will be more aggressive than if it adopts Technology-h. Given that shareholder A owns α per cent of the shares of firm 2, he internalizes the fact that the two firms compete in the product market and thus he prefers to choose the technology with the greater marginal production cost for firm 1. It must be noted that if $\alpha < 0.3649$, either firm may adopt Technology-l when $F_{\alpha 1} < F < F_2$. The reason is that although shareholder A owns α per cent of the shares of firm 2, this percentage is low enough. And, thus, there are two equilibria for intermediate values of parameter F: one firm adopts Technology-h and the other Technology-l.

Proposition 2: Under partial ownership of rivals: $\frac{\partial F_{\alpha 2}}{\partial \alpha} < 0, \frac{\partial F_1}{\partial \alpha} > 0$, and $\frac{\partial (F_1 - F_{\alpha 2})}{\partial \alpha} > 0$.

Under partial ownership of rivals we obtain that the range of values of parameters F and a for which both firms adopt either Technology-l or Technology-h decreases with the percentage of the shares, α, that the owner of firm 1 has in firm 2 ($\frac{\partial F_{\alpha 2}}{\partial \alpha} < 0$, $\frac{\partial F_1}{\partial \alpha} > 0$). As a result, the range of values of parameters F and a for which only one firm adopts Technology-l increases with parameter α ($\frac{\partial (F_1 - F_{\alpha 2})}{\partial \alpha} > 0$). This means that, compared to the case in which each firm is owned by only one shareholder, under partial ownership there is a greater range of values for which we obtain the asymmetric equilibria in which only one firms adopts Technology-l . However, under partial ownership the range of values of parameters F and a for which both firms adopt either Technology-l or Technology-h is lower. The intuition explaining this result is the following. On the one hand, as shareholder A internalizes the fact that firms 1 and 2 compete in the product market, firm 1 is less aggressive than firm 2. On the other hand, a firm is more aggressive in the product market when adopting Technology-l than when adopting Technology-h. This implies that from the point of view of shareholder A the incentive to adopt Technology-h is reinforced. By contrast, shareholder B will attempt to take advantage of this situation, which reinforces his incentive to adopt Technology-l. Finally, the greater the value of parameter α is the greater these incentives are.

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References

Alley, W. (1997) "Partial ownership arrangements and collusion in the automobile industry" *Journal of Industrial Economic*s **45**, 191-205.

Bester, H., and E. Petrakis (1993) "The incentives for cost reduction in a differentiated industry" *International Journal of Industrial Organization* **11**, 519-534.

Elkins, D., Huang, N., and J., Alden (2004) "Agile manufacturing systems in the automotive industry" I*nternational Journal of Production Economics* **91**, 201-298.

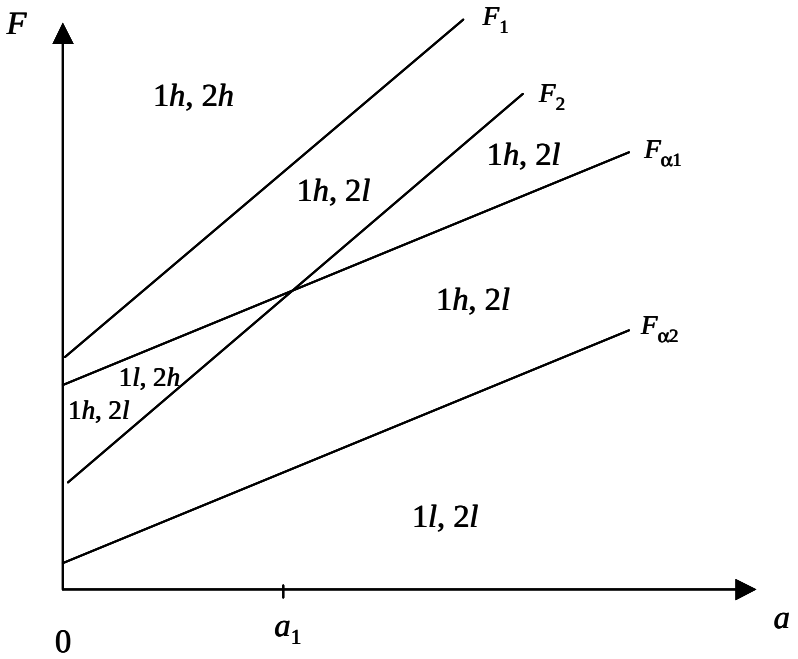

Fig. 1. Technology chosen by owners for $\alpha<0.3349$