Licensing in a foreign competition with differentiated goods

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Abstract: We study the effects of entry of a foreign firm on domestic welfare in the presence of licensing, when the firm produce differentiated goods. We also consider that the entrant is technologically superior to the incumbent. We show that foreign entry increases domestic welfare for sufficiently large technological differences between the firms under both fixed-fee licensing and royalty licensing. Since differentiation of the goods reduce competition between firms, it increases the possibility of licensing.

Keywords: Game Theory, optimization problems, Cournot model, differentiation, entry, licensing

1. INTRODUCTION

The study of the effect of entry on social welfare has been addressed in Collie (1996), Cordella (1993) and Klemperer (1988). In a closed economy, Klemperer (1988) shows that entry reduces social welfare if cost of the entrant is sufficiently higher than that of the incumbent (see also Lahiri and Ono (1988)). Collie (1996) examines this issue in an open economy and shows that entry of a foreign firm reduces domestic welfare unless the cost of the foreign firm is sufficiently lower than that of the incumbent. Cordella (1993) also considers this issue in an open economy, showing the effects of the number of firms. Technological difference is an important reason for cost differences between firms, which may encourage them to share their technological information through licensing. Faul-Oller and Sandonis (2003) show that higher welfare under entry is more likely in the presence of licensing by the technologically efficient incumbent compared with no licensing. Their results suggest that entry always increases welfare if there is licensing with output royalty but licensing with fixed fee only increases the likelihood of higher welfare under entry rather than eliminating the possibility of lower welfare under entry. While they have considered the situation of a closed economy, Mukherjee and Mukherjee (2005) show the welfare implications of entry in the presence of technology licensing in an open economy. If either the entrant or the incumbent has a relatively superior technology [1], it creates the possibility of technology licensing. Mukherjee and Mukherjee (2005) show that if there is licensing with upfront fixed fee, entry of a foreign firm not only increases domestic welfare when the foreign firm is sufficiently technologically superior to the domestic firm, it also increases domestic welfare if the foreign firm's technological inferiority is neither very small nor very large. However, if there is licensing with output royalty, foreign entry increases domestic welfare when the foreign firm is either sufficiently technologically superior or sufficiently technologically inferior to the domestic firm. So, the presence of technology licensing significantly affects the result of Collie Collie (1996), which considers the welfare effect of foreign entry without licensing. In this paper, we follow Mukherjee and Mukherjee (2005), by doing a similar study for differentiated goods, in the case of a technologically superior entrant. Since differentiation of the goods reduce competition between firms, it increases the possibility of licensing. These results have important implications for competition policies and show that the policymakers need to be concerned about the technological efficiency of the foreign firm and the type of licensing contract (i.e. fixed-fee or royalty licensing) available to the firms.

We should mention that issues related to those of this paper have been studied by Ferreira (2009), Ferreira (2008), Ferreira and Ferreira (2008) and Ferreira et al. (2008).

2. THE MODEL AND THE RESULTS

Consider a country, called the domestic country, in which there is a monopolist, called incumbent. To study the implications of entry, we will consider the following two situations in our analysis: (i) where the incumbent is a monopolist in the domestic country; and (ii) where a foreign firm, called entrant, enters the market and competes with the incumbent. We suppose that the entrant is technologically superior to the incumbent. This situation may be consistent for trade between the developed countries with technological leapfrogging by the technologically lagging country.

2.1 The case of a monopoly

Let us first consider the situation where the incumbent is a monopolist in the domestic country, where the inverse market demand function is given by $p = a - q$, where p is the price, q the quantity in the market and $a > 0$

[1] In our analysis, technology is defined by the marginal cost of production. Lower marginal cost implies better technology.

the demand intercept. We assume that the incumbent can produce a good with the constant marginal production cost c_1. For simplicity, we assume that there is no other production cost. The incumbent maximizes the following objective function to maximize its profit: $\max_q(a-q-c_1)q$. Optimal output of the incumbent is $q^* = (a-c_1)/2$ and its profit and consumer surplus are, respectively, $\pi^* = (a-c_1)^2/4$ and $CS = (a-c_1)^2/8$. Therefore, in the monopoly case, welfare W^m of the domestic country, which is the summation of consumer surplus and profit of the incumbent, is given by

$$W^m = \frac{3(a-c_1)^2}{8}.$$

2.2 Entry without licensing

To show the implications of licensing, let us first consider entry of a foreign firm without licensing. Assume that there is a foreign firm, called entrant, who can produce the good at the constant marginal production cost c_2 less than the marginal cost c_1 of the domestic firm. So, we consider the following assumption:

Assumption 1. $c_2 < c_1$.

Assumption 1 can be interpreted as the foreign firm being technologically superior to the domestic firm. We also assume that there is no other production cost of the entrant, namely we assume that there is no transportation costs and/or tariff. In our stylized framework, we assume that the entrant exports its product to the domestic country and the firms (the incumbent and the entrant) compete like Cournot duopolists with differentiated products. The inverse demands are given by

$$p_i = a - q_i - \gamma q_j,$$

with $\alpha > 0$ and $0 < \gamma \leq 1$, where p_i is the price and q_i the amount produced of good i, for $i, j \in \{1, 2\}$. We note that the two products are substitutes, and, since $\gamma \leq 1$, "cross effects" are dominated by "own effect". The value of γ expresses the degree of product differentiation. When γ is equal to one, the goods are homogeneous, and when γ tends to zero, we are close to independent goods. In what follows, we restrict the parameters of the model to satisfy the following assumption:

Assumption 2.

$$\max\left\{0, \frac{2c_1-(2-\gamma)a}{\gamma}\right\} < c_2 < \frac{(2-\gamma)a+\gamma c_1}{2}.$$

This assumption requires that, in case of entry, both firms always produce positive outputs.

The incumbent and the entrant choose their outputs to maximize, respectively, their profits, i.e.,

$$\max_{q_1}(a-q_1-\gamma q_2-c_1)q_1 \quad \text{and} \quad \max_{q_2}(a-\gamma q_1-q_2-c_2)q_2,$$

where q_1 and q_2 are the outputs of the incumbent and the entrant, respectively. Optimal outputs of the incumbent and the entrant are, respectively,

$$q_1^* = \frac{(2-\gamma)a-2c_1+\gamma c_2}{4-\gamma^2}$$

and

$$q_2^* = \frac{(2-\gamma)a-2c_2+\gamma c_1}{4-\gamma^2}.$$

Profits of the incumbent, the entrant and consumer surplus are, respectively,

$$\pi_1^* = \frac{((2-\gamma)a-2c_1+\gamma c_2)^2}{(4-\gamma^2)^2},$$

$$\pi_2^* = \frac{((2-\gamma)a-2c_2+\gamma c_1)^2}{(4-\gamma^2)^2}$$

and

$$CS = \frac{2(2-\gamma)(2+\gamma-\gamma^2)a^2-2(4-3\gamma^2+\gamma^3)(c_1+c_2)a}{2(4-\gamma^2)^2} + \\ + \frac{(4-3\gamma^2)c_1^2+(2\gamma^3c_1+(4-3\gamma^2)c_2)c_2}{2(4-\gamma^2)^2}.$$

So, in the case of entry without licensing, domestic welfare W_{nl}^e is given by

$$W_{nl}^e = \frac{2(2-\gamma)a^2-2((3-\gamma)c_1+(1-\gamma)c_2)a}{2(4-\gamma^2)} + \\ + \frac{3c_1^2-(2\gamma c_1-c_2)c_2}{2(4-\gamma^2)}.$$

Proposition 1. Assume that there is no possibility of technology licensing between the firms. If

$$c_1 > \frac{(3\gamma-2)a}{3\gamma} \quad \text{and} \quad c_2 < \frac{3\gamma c_1-(3\gamma-2)\mathrm{a}}{2},$$

entry increases domestic welfare. It reduces welfare otherwise.

2.3 Entry with licensing

Now, we are going to analyse the case of the entry under licensing. We consider two important types of licensing contracts (see, for example, Wang Wang (1988)): (i) fixed-fee licensing, where the licenser charges an upfront fixed fee for its technology; and (ii) licensing with output royalty, where the licenser charges royalty per unit of output.

We consider the following game under entry. At stage 1, the technologically efficient entrant decides whether to license its technology to the incumbent, and the incumbent accepts the licensing contract, if it is not worse off under licensing compared with no licensing. At stage 2, the firms compete *à la* Cournot.

Fixed-fee licensing We have seen above that profits of the incumbent and the entrant under no licensing are, respectively,

$$\pi_{1,nl}^* = \frac{((2-\gamma)a-2c_1+\gamma c_2)^2}{(4-\gamma^2)^2}$$

and

$$\pi_{2,nl}^* = \frac{((2-\gamma)a-2c_2+\gamma c_1)^2}{(4-\gamma^2)^2}.$$

Now, consider the situation under licensing. If licensing occurs, both firms produce with c_2, since the entrant charges an upfront fixed fee for its technology. Profits of the incumbent and the entrant are, respectively,

$$(a-c_2)^2/(2-\gamma)^2 - F \quad \text{and} \quad (a-c_2)^2/(2-\gamma)^2 + F,$$

where F is the optimal licensing fee charged by the entrant. So, licensing is profitable, if the following two conditions are satisfied for the incumbent and the entrant, respectively (with at least one strict inequality):

$$\frac{(a-c_2)^2}{(2+\gamma)^2} - F \geq \frac{((2-\gamma)a - 2c_1 + \gamma c_2)^2}{(4-\gamma^2)^2}$$

and

$$\frac{(a-c_2)^2}{(2+\gamma)^2} + F \geq \frac{((2-\gamma)a - 2c_2 + \gamma c_1)^2}{(4-\gamma^2)^2}.$$

Therefore, we can prove the following result.

Lemma 2. Licensing occurs if, and only if,

$$c_2 > \frac{2(2-\gamma)^2 a - (4+\gamma^2)c_1}{\gamma^2 - 8\gamma + 4} \quad \text{with} \quad \gamma \neq 4 - 2\sqrt{3}.$$

Under fixed-fee licensing, the profit of the incumbent and consumer surplus are, respectively,

$$\pi^*_{1,lf} = \frac{((2-\gamma)a - 2c_1 + \gamma c_2)^2}{(4-\gamma^2)^2}$$

and

$$CS_{lf} = \frac{(1+\gamma)(a-c_2)^2}{(2+\gamma)^2},$$

if $c_2 > \frac{2(2-\gamma)^2 a - (4+\gamma^2)c_1}{\gamma^2 - 8\gamma + 4}$. So, domestic welfare W^e_{lf} under fixed-fee licensing is given by

$$W^e_{lf} = \frac{((2-\gamma)a - 2c_1 + \gamma c_2)^2}{(4-\gamma^2)^2} + \frac{(1+\gamma)(a-c_2)^2}{(2+\gamma)^2}.$$

Proposition 3. Consider the possibility of fixed-fee licensing. Entry increases domestic welfare in the following situations:

(i) For $0 < \gamma < 2/3$, if

$$c_2 < \frac{\left(8\gamma + (2-\gamma)\sqrt{\Theta}\right)c_1}{4(\gamma^3 - 2\gamma^2 + 4)} - \frac{(2-\gamma)\left(\sqrt{\Theta} - 4(2-\gamma^2)\right)a}{4(\gamma^3 - 2\gamma^2 + 4)};$$

(ii) For $2/3 \leq \gamma \leq 1$, if

$$c_1 > \frac{(2-\gamma)\left(\sqrt{\Theta} - 4(2-\gamma^2)\right)a}{8\gamma + (2-\gamma)\sqrt{\Theta}}$$

and

$$c_2 < \frac{\left(8\gamma + (2-\gamma)\sqrt{\Theta}\right)c_1}{4(\gamma^3 - 2\gamma^2 + 4)} - \frac{(2-\gamma)\left(\sqrt{\Theta} - 4(2-\gamma^2)\right)a}{4(\gamma^3 - 2\gamma^2 + 4)},$$

where $\Theta = 6\gamma^5 + 12\gamma^4 - 24\gamma^3 - 24\gamma^2 + 32\gamma + 32$. It reduces welfare otherwise.

Licensing with output royalty Now, consider licensing with per-unit output royalty, where the entrant charges a per-unit output royalty for its technology. In that case of licensing, the effective marginal cost of the incumbent is $c_2 + r$, where r is the optimal per-unit output royalty. The optimal outputs of the incumbent and the entrant are, respectively,

$$q^*_{1,lr} = \frac{(2-\gamma)a - (2-\gamma)c_2 - 2r}{4-\gamma^2}$$

and

$$q^*_{2,lr} = \frac{(2-\gamma)a - (2-\gamma)c_2 + \gamma r}{4-\gamma^2}.$$

So, their profits are, respectively,

$$\pi^*_{1,lr} = \frac{((2-\gamma)a - (2-\gamma)c_2 - 2r)^2}{(4-\gamma^2)^2}$$

and

$$\pi^*_{2,lr} = \frac{(2-\gamma)^2(a-c_2)^2}{(4-\gamma^2)^2} + \\ + \frac{(2-\gamma)(4+2\gamma-\gamma^2)(a-c_2)r - (8-3\gamma^2)r^2}{(4-\gamma^2)^2}.$$

The entrant solves the problem

$$\max_r \pi^*_{2,lr}$$

subject to the constraint $r \leq c_1 - c_2$, to determine the optimal royalty rate.

Lemma 4. The optimal output royalty r^* is as follows:

(i) If

$$c_2 \geq \frac{2(8-3\gamma^2)c_1 - (2-\gamma)(4+2\gamma-\gamma^2)a}{8-2\gamma^2-\gamma^3},$$

then

$$r^* = c_1 - c_2;$$

(ii) If

$$c_2 < \frac{2(8-3\gamma^2)c_1 - (2-\gamma)(4+2\gamma-\gamma^2)a}{8-2\gamma^2-\gamma^3},$$

then

$$r^* = \frac{(2-\gamma)(4+2\gamma-\gamma^2)(a-c_2)}{2(8-3\gamma^2)}.$$

Proposition 5. Suppose that there is royalty licensing.

(i) If

$$c_2 \geq \frac{2(8-3\gamma^2)c_1 - (2-\gamma)(4+2\gamma-\gamma^2)a}{8-2\gamma^2-\gamma^3},$$

welfare implications of entry remain the same under licensing and no licensing.

(ii) If

$$c_2 < \frac{2(8-3\gamma^2)c_1 - (2-\gamma)(4+2\gamma-\gamma^2)a}{8-2\gamma^2-\gamma^3},$$

then entry always increases welfare.

3. CONCLUSIONS

We showed the effects of foreign entry on social welfare in the presence of licensing, when the firms produce differentiated goods. We considered both fixed-fee licensing and royalty licensing, in the case where the foreign firm (the entrant) is technologically superior to the domestic firm (the incumbent). We found that the welfare implications of entry depend upon the type of licensing contract, and since differentiation of the goods reduce competition between firms, it increases the possibility of licensing.

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