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March 2004

Domestic vs. foreign competition with licensing*

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Abstract: We show the effects of entry of a domestic firm and a foreign firm on welfare, in presence of licensing. In case of licensing with up-front fixed-fee, domestic entry increases welfare if the technological differences between the firms are not very large, whereas foreign entry increases welfare for moderate technological differences. If licensing occurs with output royalty, domestic entry always increases welfare but foreign entry increases welfare if the technological differences between the firms are not sufficiently small.

Key Words: Entry, Licensing, Welfare

JEL Classification: D43, L13, 034

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Domestic vs. foreign competition with licensing

1. Introduction

This paper shows the effect of entry on social welfare when the entrant is relatively cost inefficient then the incumbent. We consider a situation where technological difference between the firms creates a difference in the costs of production of the firms.[1] Technological difference, however, may create the avenue for technology licensing, which increases the profits of the firms as well as cost efficiency in the industry. We show that if the firms have the option for licensing, entry of a domestic firm and entry of a foreign firm has significantly different implications on domestic welfare.

In case of domestic entry, we find that licensing with up-front fixed-fee increases welfare if the technology[2] of the entrant is not very much inefficient compared to that of the incumbent, while licensing with output royalty always increases welfare. But, in case of foreign entry, fixed-fee licensing increases welfare of the importing country if the technological difference of these firms is moderate, whereas royalty licensing increases welfare if the entrant's technology is sufficiently inefficient than the incumbent's. Hence, our analysis is important for competition policies and shows that the policy makers need be concerned about the technological efficiency of the entrant, type of the licensing contract (i.e., fixed-fee or royalty licensing) available to the firms and also whether domestic or foreign firm enters the market.

[1] Knowledge spillover about the incumbent's technology, expiry of the incumbent's old patents or research and development (R&D) by the entrant may create the threat of entry. However, imperfect absorptive capacity of the entrant or its lower R&D productivity may make it technologically inefficient than the incumbent.

[2] Here technology is defined by the marginal cost of production. Lower marginal cost implies better technology.

This paper also contributes to the literature on entry in an imperfectly competitive market with quantity setting firms, which shows that entry of a new firm may reduce social welfare. Brander (1981), Markusen (1981), Cordella (1993) and Collie (1996) suggest that in an open economy, entry of a foreign firm reduces welfare of the importing country unless the marginal cost of the foreign firm is not sufficiently smaller than the domestic firm. Klemperer (1988) and Lahiri and Ono (1988) show that entry can reduce social welfare even in a closed economy. In case of closed economy, entry reduces welfare if the marginal cost of production of the entrant is sufficiently higher than the incumbent. We find that the possibility of licensing alters the results of these previous works significantly. For example, we show that while foreign entry does not increase welfare for small technological differences between the firms, domestic entry may not increase welfare for sufficiently large technological differences.

Remainder of the paper is organized as follows. Section 2 considers the problem of domestic entry and section 3 considers the problem of foreign entry. Section 4 concludes.

2. Domestic entry

In this section we will consider the case of a closed economy. To show the implications of entry, we will consider two situations: (i) a monopoly, and (ii) a duopoly with an incumbent and an entrant.

2.1 The case of monopoly

Consider an economy with a monopolist firm (henceforth, incumbent), who produces a product with a constant marginal cost of production c_1. For simplicity, assume that there is no other cost of production.

The inverse market demand function for the product is $P = a - q$, where the notations have usual meanings. The incumbent maximizes the following objective function to maximize its profit:

$$\underset{q}{\text{Max}}(a - q - c_1)q . \tag{1}$$

The optimal output of the incumbent is $q^* = \frac{(a - c_1)}{2}$ and its profit and consumer surplus are respectively $\frac{(a - c_1)^2}{4}$ and $\frac{(a - c_1)^2}{8}$. Therefore, welfare of the economy is

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

2.2 Entry of a new firm

Now, consider entry of a new firm (called entrant) with marginal cost of production c, where $c_1 \leq c$.[3] We assume that the incumbent is a technology leader, who has patented several of its technologies. However, patent of old technology may expire which, therefore, induces entry of a firm. Alternatively, we may assume that the entrant has developed a new technology through its own R&D but, due to its lower

[3] Since, our purpose is not to focus on entry deterrence, we abstract our analysis from other costs of production of the entrant.

R&D capability, it could generate a technology, which is inferior to that of the incumbent.[4]

Consider the following game under entry. In stage 1, the firms take decision on licensing.[5] In stage 2, the firms compete in the product market like Cournot duopolists with homogeneous products. We solve the game through backward induction.

We consider two important types of licensing contracts (see, Wang, 1998): (i) fixed-fee licensing, where the licenser charges up-front fixed-fee for its technology, and (ii) licensing with output royalty, where the licenser charges royalty per-unit of output.[6] Assume that the incumbent gives a take-it-or-leave-it offer to the entrant. The entrant accepts the offer if it is not worse-off compared to no licensing.

Further, in our analysis we put a restriction on c so that $c < \frac{(a+c_1)}{2}$, which ensures that the entrant always produces positive output. If $c > \frac{(a+c_1)}{2}$, the incumbent alone will produce positive output without licensing and therefore, entry will have no real impact in our analysis.

2.2.1 Fixed-fee licensing

Let us first consider the case of fixed-fee licensing. Here, the incumbent licenses its technology to the technologically inefficient entrant and charges an up-front fixed-fee for its technology.

[4] Mills and Smith (1996) provide strategic reason for using different technology by different firms.
[5] Under no-entry, the incumbent does not license its technology since the firms produce homogeneous products and the incumbent is a monopolist.
[6] Licensing with fixed-fee (output royalty) can be optimal licensing contract under costless imitation (no imitation) (Rockett, 1990).

First, we determine the profits of the firms under no licensing. Here, the incumbent and the entrant maximize the following expressions respectively:

$$\underset{q_1}{\text{Max}}(a - q_1 - q_2 - c_1)q_1 \tag{3}$$

and

$$\underset{q_2}{\text{Max}}(a - q_1 - q_2 - c)q_2, \tag{4}$$

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

The optimal outputs of the incumbent and the entrant are respectively $\frac{(a - 2c_1 + c)}{3}$ and $\frac{(a - 2c + c_1)}{3}$.

Now, consider the situation under licensing. If licensing occurs, both firms produce with c_1 since the incumbent charges an up-front fixed-fee for its technology. The profits of the incumbent and the entrant are respectively $\frac{(a - c_1)^2}{9} + F$ and $\frac{(a - c_1)^2}{9} - F$, where F is the optimal licensing fee charged by the incumbent.

The payoffs of the incumbent and the entrant under no licensing are respectively $\frac{(a - 2c_1 + c)^2}{9}$ and $\frac{(a - 2c + c_1)^2}{9}$. Here, the following two conditions must be satisfied for the incumbent and the entrant, respectively, for a profitable licensing agreement:

$$\frac{(a - c_1)^2}{9} + F \geq \frac{(a - 2c_1 + c)^2}{9} \tag{5}$$

and

$$\frac{(a - c_1)^2}{9} - F \geq \frac{(a - 2c + c_1)^2}{9}. \tag{6}$$

The incumbent gives a take-it-or-leave-it offer to the entrant. So, the fixed-fee charged by the incumbent will make the entrant indifferent between licensing and no licensing, i.e., $F = \frac{(a-c_1)^2}{9} - \frac{(a-2c+c_1)^2}{9}$. So, licensing occurs provided

$$\frac{2(a-c_1)^2}{9} > \frac{(a-2c+c_1)^2}{9} + \frac{(a-2c_1+c)^2}{9}, \tag{7}$$

which is satisfied for $c < \frac{(2a+3c_1)}{5}$, where $\frac{(2a+3c_1)}{5} < \frac{(a+c_1)}{2}$.

Fixed-fee licensing allows the incumbent to increase its profit. Also, since both firms use the efficient technology, the incumbent faces higher competition from the entrant. So, the incumbent licenses its technology if the initial technologies of these firms are sufficiently close (i.e., $c < \frac{(2a+3c_1)}{5}$). When the initial technologies of these firms are sufficiently close, licensing does not create much competition but helps to increase industry profit by creating production efficiency in entrant's firm. Therefore, in this situation, licensing is profitable to these firms. But the effect of competition dominates the effect of cost efficiency when $c > \frac{(2a+3c_1)}{5}$ and makes licensing unprofitable.

Therefore, with fixed-fee licensing, the industry profit and consumer surplus are respectively $\frac{2(a-c_1)^2}{9}$ and $\frac{2(a-c_1)^2}{9}$, if $c < \frac{(2a+3c_1)}{5}$. But the industry profit and consumer surplus are respectively $\frac{(a-2c_1+c)^2 + (a-2c+c_1)^2}{9}$ and $\frac{(2a-c_1-c)^2}{18}$ for $\frac{(2a+3c_1)}{5} < c < \frac{(a+c_1)}{2}$.

So, welfare under 'entry with fixed-fee licensing' is

$$W_{l,f}^{e} = \frac{4(a-c_1)^2}{9}, \qquad \text{for} \quad c < \frac{(2a+3c_1)}{5} \tag{8}$$

and

$$W_{nl}^{e} = \frac{(a-2c_1+c)^2 + (a-2c+c_1)^2}{9} + \frac{(2a-c_1-c)^2}{18}, \text{ for } c \in (\frac{(2a+3c_1)}{5}, \frac{(a+c_1)}{2}). \tag{9}$$

Proposition 1: *With the possibility of fixed-fee licensing, entry increases welfare for* $c < \frac{(2a+3c_1)}{5}$.

Proof: Under entry, fixed-fee licensing occurs for $c < \frac{(2a+3c_1)}{5}$ and welfare is given by (8), which is greater than welfare under no-entry, which is (2).

But, under entry, fixed-fee licensing does not occur for $c > \frac{(2a+3c_1)}{5}$ and welfare is given by (9). We find that (9) is positively sloped with respect to c for $c \in [\frac{(2a+3c_1)}{5}, \frac{(a+c_1)}{2})$, and (9) is less than and equal to (2) at $c = \frac{(2a+3c_1)}{5}$ and $c = \frac{(a+c_1)}{2}$ respectively. This proves the result. Q.E.D.

Entry has two opposing effects on welfare. While entry creates a positive effect of competition, it also creates a negative effect of production inefficiency by shifting production from the cost efficient incumbent to the cost inefficient entrant. Fixed-fee licensing allows both firms to use the efficient technology and therefore, entry increases welfare when fixed-fee licensing occurs. However, fixed-fee licensing does not occur if the technology of the entrant is sufficiently inferior to that of the incumbent. Sufficiently large technological inferiority of the entrant also creates significant production inefficiency in this situation. So, when the technology of the entrant is sufficiently inferior to that of the incumbent, the negative effect of production inefficiency dominates the positive effect of competition, which, in turn, reduces social welfare.

2.2.2 Licensing with output royalty

Now, consider licensing with per-unit output royalty. Here, under licensing, the incumbent charges a per-unit output royalty for its technology.

If licensing does not occur, the analysis is similar to subsection 2.2.1 under no licensing. But in case of licensing, the effective marginal cost of the entrant is $(c_1 + r)$, where r is the optimal per-unit output royalty. The optimal outputs of the incumbent and the entrant are respectively $\frac{(a - c_1 + r)}{3}$ and $\frac{(a - c_1 - 2r)}{3}$. So, their profits are respectively $\frac{(a - c_1 + r)^2}{9} + \frac{r(a - c_1 - 2r)}{3}$ and $\frac{(a - c_1 - 2r)^2}{9}$.

The incumbent maximizes the following expression to determine the optimal royalty rate:

$$\underset{r}{Max} \frac{(a - c_1 + r)^2}{9} + \frac{r(a - c_1 - 2r)}{3} \tag{10}$$

subject to the constraint $r \leq (c - c_1)$.[7] Maximizing (10) and ignoring the constraint $r \leq (c - c_1)$, the optimal rate of royalty is $\frac{(a - c_1)}{2}$. Since, $\frac{(a - c_1)}{2}$ is greater than $(c - c_1)$ for all $c < \frac{(a + c_1)}{2}$, the optimal per-unit output royalty becomes $(c - c_1)$.

[7] If $r > (c - c_1)$, licensing contract will make the entrant worse off compared to no licensing and will be rejected.

Optimal outputs and therefore, the profit of the entrant and consumer surplus are the same under licensing and no licensing, but the profit of the incumbent increases by the royalty income to $\frac{(c-c_1)(a-2c+c_1)}{3}$. This immediately implies that licensing with per-unit output royalty occurs for all values of $c \in (c_1, \frac{(a+c_1)}{2})$.

Welfare under 'entry with royalty licensing' is

$$W_{l,r}^{e} = \frac{(a-2c_1+c)^2}{9} + \frac{(c-c_1)(a-2c+c_1)}{3} + \frac{(a-2c+c_1)^2}{9} + \frac{(2a-c_1-c)^2}{18}. \quad (11)$$

Proposition 2: *If the firms have the option for licensing with per-unit output royalty, entry increases welfare for* $c \in [c_1, \frac{(a+c_1)}{2})$.

Proof: Expression (11) is a negatively sloped function with respect to c for $c \in [c_1, \frac{(a+c_1)}{2})$. Further, expression (11) is equal to expression (2) at $c = \frac{(a+c_1)}{2}$. This proves the result. Q.E.D.

The effective marginal cost of the entrant is the same under no licensing and licensing with output royalty. So, given the optimal royalty rate, licensing does not eliminate production inefficiency but increases the profit of the incumbent. Higher profit of the incumbent along with the competitive effect of entry outweighs the negative effect of production inefficiency and increases welfare. Since, licensing with per-unit output royalty occurs for all relevant cost differences, it always increases welfare due to entry.[8]

[8] If entry in our paper can be viewed as the opposite situation of horizontal merger of Faulí-Oller and Sandonis (2003), then our results of this section have flavor similar to them.

Propositions 1 and 2 can be found in Figure 1, which portrays welfare under no entry and domestic entry with licensing.[9]

Figure 1

3. Foreign entry

Now, we consider the case of an open economy. We assume that the incumbent is in a country, called domestic country, whereas the entrant is from a different country, called foreign country. We are interested to see the implications of entry on welfare of the domestic country. Again, like the previous section, we consider two situations: (i) incumbent as a monopolist, and (ii) duopoly with the incumbent and the entrant.

3.1 The case of monopoly

Since, without entry the incumbent is a monopolist in the domestic country, our analysis without entry is similar to subsection 2.1.

3.2 Entry of a new firm

Like subsection 2.2, we consider entry of a firm with marginal cost of production c, where $c_1 \leq c$, with the exception that now the entrant is a foreign firm.[10]

In our stylized framework, we assume that the entrant exports its product to the domestic country and the firms (the incumbent and the entrant) produce like Cournot duopolists with homogeneous products. To focus on the role played by

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[9] It is easy to find that (8) is greater than (11) for $c \in (c_1, \frac{(2a+3c_1)}{5})$.

[10] Following our justification in subsection 2.2 for the difference in technology, this situation fits well if we consider the domestic country as a developed country and the entrant is coming from a developing country.

technology licensing, we assume away transportation costs and/or tariff, and consider that the difference in marginal costs occurs due to technological difference only.

Under entry, we consider a game similar to subsection 2.2 and consider two types of licensing, viz., fixed-fee and royalty licensing.

Our analysis under foreign entry will be similar to that of under domestic entry of subsection 2.2, with a difference in welfare calculation. Since, the entrant is a foreign firm, its profit does not enter into the welfare function of the domestic country.

3.2.1 Fixed-fee licensing

Under foreign entry, the only difference that is noticed is in the welfare calculation of the domestic country. The decision on licensing, profit of the incumbent and consumer surplus remains the same, as in subsection 2.2. The profit of the entrant is not included in the welfare of the domestic country, and so, welfare of the domestic economy with fixed-fee licensing is

$$W_{l,f}^{e} = \frac{4(a-c_1)^2}{9} - \frac{(a-2c+c_1)^2}{9}, \quad \text{for} \quad c < \frac{(2a+3c_1)}{5}. \qquad (12)$$

$$W_{nl}^{e} = \frac{(a-2c_1+c)^2}{9} + \frac{(2a-c_1-c)^2}{18}, \text{ for} \quad c \in (\frac{(2a+3c_1)}{5}, \frac{(a+c_1)}{2}). \qquad (13)$$

Proposition 3: *With fixed-fee licensing, entry increases welfare for* $c \in (c', \frac{2a+3c_1}{5})$, *where* $c' \in [c_1, \frac{2a+3c_1}{5}]$.

Proof: Fixed-fee licensing occurs for $c < \frac{(2a+3c_1)}{5}$ and welfare is given by (12). We find that (12) is continuous and increasing in c for $c \in [c_1, \frac{2a+3c_1}{5}]$. Further, (12) is less than and greater than (2) at $c = c_1$ and $c = \frac{2a+3c_1}{5}$ respectively. This implies that there is a value of c, say $c' \in [c_1, \frac{2a+3c_1}{5}]$, such that entry increases welfare for $c \in (c', \frac{2a+3c_1}{5})$.

Fixed-fee licensing does not occur if $c > \frac{(2a+3c_1)}{5}$ and welfare is given by (13). We find that (13) is increasing in c for $c \in [\frac{(2a+3c_1)}{5}, \frac{(a+c_1)}{2})$ and is less than and equal to (2) at $c = \frac{(2a+3c_1)}{5}$ and $c = \frac{(a+c_1)}{2}$ respectively. This proves the result. Q.E.D.

Licensing allows the incumbent to increase its profit. If the initial technologies are very much similar (i.e., $c < c'$) then licensing does not increase the profit of the incumbent significantly. In this situation, the profit loss of the incumbent due to entry is greater than the benefit of competition and the gain from licensing. So, when $c \in (c_1, c')$, entry reduces welfare of the domestic country even if there is fixed-fee licensing. But licensing increases profit of the incumbent significantly if the technology of the entrant is sufficiently inferior (but not so inferior to eliminate the incentive for licensing), i.e., when $c \in (c', \frac{2a+3c_1}{5})$. Here the benefit from competition along with the gain from licensing outweighs the loss due to the incumbent's lower profit under entry. So, in this situation, entry with fixed-fee licensing increases welfare of the domestic country.

If $c > \frac{(2a+3c_1)}{5}$, fixed-fee licensing does not occur, and therefore, like the domestic entry of subsection 2.2.1, the effect of production inefficiency dominates the effect of competition. Since profit of the entrant is not included in domestic welfare, it creates a further negative impact on domestic welfare. On the balance, entry reduces domestic welfare for $c > \frac{(2a+3c_1)}{5}$.

3.2.2 Licensing with output royalty

Now, consider licensing with per-unit output royalty. Again, as in the above analysis, the existence of the foreign firm only affects the welfare calculation of the domestic country. So, here domestic welfare becomes

$$W_{l,r}^{e} = \frac{(a-2c_1+c)^2}{9} + \frac{(c-c_1)(a-2c+c_1)}{3} + \frac{(2a-c_1-c)^2}{18}. \tag{14}$$

Proposition 4: *If the firms have the option for licensing with per-unit output royalty, entry increases domestic welfare for* $c \in (\hat{c}, \frac{a+c_1}{2})$*, where* $\hat{c} \in [c_1, \frac{a+c_1}{2}]$.

Proof: Licensing with output royalty occurs for all $c \in (c_1, \frac{a+c_1}{2})$. We find that (14) is continuous and concave in c for $c \in [c_1, \frac{(a+c_1)}{2}]$ and it is less than and equal to (2) at $c = c_1$ and $c = \frac{(a+c_1)}{2}$ respectively. This implies that there is a value of c, say $\hat{c} \in [c_1, \frac{a+c_1}{2}]$, such that entry increases welfare for $c \in (\hat{c}, \frac{a+c_1}{2})$. Q.E.D.

Royalty licensing occurs for all $c \in [c_1, \frac{(a+c_1)}{2}]$. If the initial technologies are very much similar (i.e., $c < \hat{c}$) then royalty income under licensing is not very high. In this situation, the profit loss of the incumbent due to entry is greater than the benefit of competition and the gain from licensing. So, when $c \in (c_1, \hat{c})$, entry reduces welfare of the domestic country even with royalty licensing. But royalty income increases the incumbent's profit significantly if $c \in (\hat{c}, \frac{a+c_1}{2})$. This gain from licensing and the effect of higher competition outweighs the loss due to the incumbent's lower profit under entry. Therefore, in this situation, entry increases domestic welfare.

Propositions 3 and 4 can be found in Figure 2, which portrays welfare under no entry and foreign entry with licensing.[11]

Figure 2

Figure 2 also shows that there are technological differences for which entry increases welfare with fixed-fee licensing but not with royalty licensing (consider $c \in (c', \hat{c})$), which is in sharp contrast to Figure 1. So, whether royalty licensing, compared to fixed-fee licensing, increases the possibility of higher welfare under entry depends on the type of entry (i.e., domestic or foreign) and also on technological differences.

[11] We find that (12) is greater than (14) for $c \in (c_1, \frac{(2a+3c_1)}{5})$.

4. Conclusion

Differences in technologies create the possibility for technology licensing. We show the effect of entry on social welfare, in presence of licensing, when the entrant comes up with an inferior technology than the incumbent. We show that the results are significantly different for domestic entry and foreign entry. Further, the effects on welfare depend on the type of licensing contract (fixed-fee or royalty) and on the extent of technological difference between the firms.

Domestic entry with fixed-fee licensing increases welfare if the technological difference between the firms is not very large, while entry always increases welfare under royalty licensing. Foreign entry with fixed-fee licensing increases domestic welfare for moderate technological difference, but entry with royalty licensing increases domestic welfare if the technological difference is not very small.

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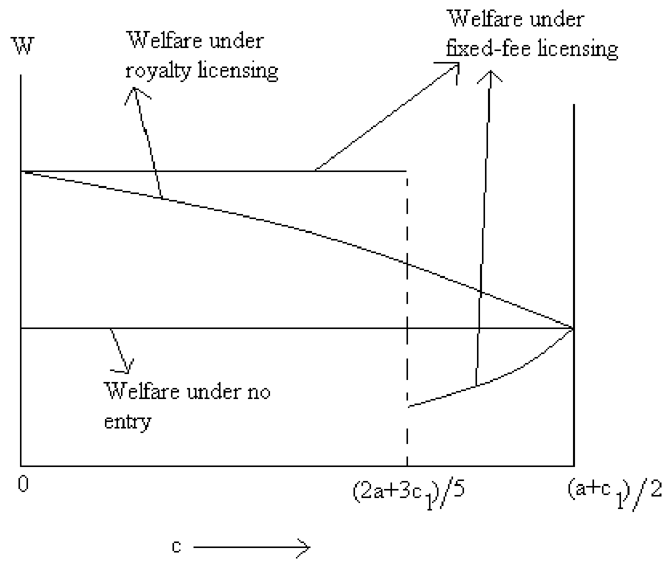

Figure 1: Welfare under no entry and domestic entry with licensing

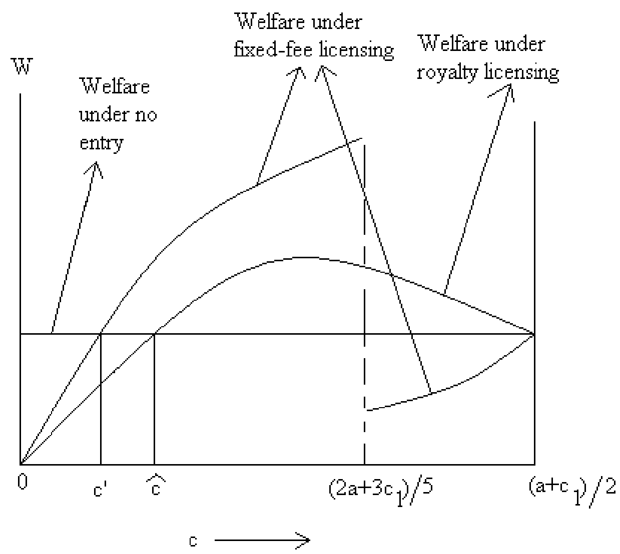

Figure 2: Welfare under no entry and foreign entry with licensing