UNIVERSITY OF NOTTINGHAM

Discussion Papers in Economics

Discussion Paper
No. 03/05

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April 2003

DP 03/05
ISSN 1360-2438

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April 2003

Welfare effects of entry: the impact of licensing*

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Abstract: This paper shows that the possibility of licensing can significantly alter the effects of entry on social welfare. We find that while licensing with output royalty always raises welfare due to entry, licensing with up-front fixed-fee reduces the possibility of lower welfare compared to a situation without licensing. Hence, our results have important implications for competition policy.

Key Words: Entry, Licensing, Welfare
JEL Classification: D43, L13, 034

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* The authors are solely responsible for the views presented here but not the Universities. We thank Jong-Hee Hahn for his suggestions. The usual disclaimer applies.

Welfare effects of entry: the impact of licensing

1 Introduction

Common wisdom suggests that welfare of an economy increases in a more competitive environment. However, Klemperer (1988) and Lahiri and Ono (1988) have argued that entry in a quantity setting oligopolistic market increases welfare provided the marginal cost of production of the entrant is not sufficiently high compared to that of the incumbent. Asymmetric marginal cost of production (or, uneven technologies) becomes the important ingredient in the works of Klemperer (1988) and Lahiri and Ono (1988).[1] Therefore, their analysis implies that it is important to analyze the competition policy carefully.

It is already evident in the literature that when technological differences exist between the firms producing in the imperfectly competitive markets, often the technologically advanced firms raise their profits by licensing their technologies to the technologically inferior firms. As a representative sample, one may look at Rockett (1990), Marjit (1990), Kabiraj and Marjit (1993), Lin (1996), Wang (1998), Mukherjee (2001, 2002) and Mukherjee and Balasubramanian (2001). We show that if the firms are engaged in technology[2] licensing then it eliminates (in case of licensing against output royalty) or at least reduces (in case of fixed-fee licensing) the possibility of lower welfare caused by entry. Hence, our result suggests that the policy makers need not be concerned about the technological efficiency of the new entrants in those industries where technology licensing is not difficult.[3]

The logical explanations of our findings are as follows. If the entrant's marginal cost is higher than that of the incumbent's, entry has two opposing effects on social welfare. While entry creates a positive effect of competition, it also creates a negative effect through production inefficiency by shifting production from the cost efficient incumbent to the cost inefficient entrant. In absence of licensing, if the cost of the entrant is sufficiently higher than that of the incumbent's, the negative impact

[1] There is another literature showing the possibility lower welfare under entry due to the existence of fixed cost. For example, one may refer to Schmalensee (1976), von Weizsäcker (1980a, b), Stiglitz (1981), Spence (1984) and Tandon (1984) and Suzumura and Kiyono (1987).

[2] We define the technology by the marginal cost of production. Lower marginal cost implies better technology.

through production inefficiency dominates the positive impact of competition and hence, reduces social welfare. But, when the cost differences between the incumbent and the entrant are not very large, the benefit from competition dominates the negative impact of production inefficiency and raises social welfare.

Now, consider that the incumbent firm can license its technology to the entrant with an up-front fixed-fee. If licensing occurs then it allows both firms to use the efficient technology. Further, since the licensing is with up-front fixed fee only, it helps both firms to produce with the lowest marginal cost that eliminates production inefficiency. So, whenever licensing with fixed-fee occurs, entry increases welfare. Though it has been shown that fixed-fee licensing will not occur for all relevant cost differences, we find that there are cost parameters that are consistent with 'lower welfare under entry in absence of licensing' and 'profitable licensing and higher welfare under entry'.

If licensing occurs with per-unit output royalty then licensing is profitable for all relevant technology differences between the incumbent and the entrant. The optimal output royalty will be such that the effective marginal cost of production of the licensee (i.e., the entrant) will be the same under licensing and no-licensing. The optimal output of the incumbent and the entrant will be the same under licensing and no-licensing but the profit of the licenser (i.e., the incumbent) increases due to royalty income. We find that the gain through royalty income outweighs the negative impact of production inefficiency and hence, raise social welfare.

Rest of the paper is organized as follows. Section 2 considers the problem of entry without the possibility of licensing. Section 3 extends the analysis by incorporating the possibility of licensing. Section 4 concludes.

2 Entry without the possibility of licensing

2.1 The case of monopoly

Let us consider an economy with a monopolist firm. The monopolist (henceforth the incumbent) can produce its product with a constant marginal cost of production c_1.

[3] In another paper Mukherjee and Mukherjee (2003) examine the effect of entry on social welfare in a vertically separated industry when the upstream firm has market power.

For simplicity, we assume that there is no other cost of production. The inverse market demand function for the product is given by

$$P = a - q\,, \tag{1}$$

where the notations have usual meanings.

The incumbent firm maximizes the following objective function, being the monopoly producer of the product:

$$\underset{q}{\text{Max}}(a - q - c_1)q\,. \tag{2}$$

Maximization of (2) gives us the optimal production of the incumbent as $q^* = \frac{(a-c_1)}{2}$. Hence, profit of the incumbent and consumer surplus are respectively $\frac{(a-c_1)^2}{4}$ and $\frac{(a-c_1)^2}{8}$. So, in case of monopoly, welfare of the economy, is

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

2.2 Entry of a new firm

To focus on the effect of entry on social welfare we consider entry of a new firm (called entrant) with marginal cost of production c, where $c_1 \le c$. We also assume that the entrant does not need to bear any othere cost of production. We assume that the firms produce like Cournot duopolists with homogeneous products. In order to generate positive output by the entrant in absence of licensing, we assume that $c < \frac{(a+c_1)}{2}$. For $c > \frac{(a+c_1)}{2}$, the incumbent alone will produce positive amount in the market and therefore, entry has no real impact on our analysis.[4]

The incumbent and the entrant maximizes the following expressions respectively:

$$\underset{q_1}{\text{Max}}(a - q_1 - q_2 - c_1)q_1 \tag{4}$$

and

$$\underset{q_2}{\text{Max}}(a - q_1 - q_2 - c)q_2\,, \tag{5}$$

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

It is easy to derive that the optimal outputs of the incumbent and the entrant are respectively $\frac{(a-2c_1+c)}{3}$ and $\frac{(a-2c+c_1)}{3}$. Therefore, the profits of the incumbent and the entrant and consumer surplus are respectively $\frac{(a-2c_1+c)^2}{9}$, $\frac{(a-2c+c_1)^2}{9}$ and $\frac{(2a-c_1-c)^2}{18}$. So, welfare of the economy, in case of 'entry without licensing', is

$$W_{nl}^{e} = \frac{(a-2c_1+c)^2}{9} + \frac{(a-2c+c_1)^2}{9} + \frac{(2a-c_1-c)^2}{18}. \qquad (6)$$

Hence, we have the following proposition comparing welfare of the economy under 'entry without licensing' and no-entry.

Proposition 1: *Welfare under 'entry without licensing' is greater than the welfare under no-entry provided* c *is less than a critical value, say,* c^**, where* $c^* \in (c_1, \frac{(a+c_1)}{2})$.

Proof: From (6), we find that W_{nl}^{e} is continuous, quadratic and convex in c over $[c_1, \frac{(a+c_1)}{2}]$ with a minimum value at $c = \frac{(4a+7c_1)}{11}$, where $\frac{(4a+7c_1)}{11} \in [c_1, \frac{(a+c_1)}{2}]$. Comparing (3) and (6), we find that $W^m = W_{nl}^{e}$ at $c = \frac{(a+c_1)}{2}$, $W^m > W_{nl}^{e}$ at $c = \frac{(4a+7c_1)}{11}$ and $W^m < W_{nl}^{e}$ at $c = c_1$. So, we can say that there exists a value of $c \in [c_1, \frac{(a+c_1)}{2}]$, say, c^*, such that $W^m < W_{nl}^{e}$ for all $c \in (c_1, c^*)$ and $W^m > W_{nl}^{e}$ for all $c \in (c^*, \frac{(a+c_1)}{2})$. Q.E.D.

3 Entry with the possibility of licensing

Now, we extend the model further by incorporating the possibility of licensing between the firms, in case of entry.[5] Under licensing, the incumbent licenses its technology to the technologically inferior entrant and charges a price for its technology. We have considered two important types of licensing contracts (see, e.g., Wang, 1998)[6]: (i) fixed-fee licensing, where the licenser charges an up-front fixed-fee

[4] It is easy to understand that there is no incentive for licensing for $c > \frac{(a+c_1)}{2}$, since these firms produce homogeneous products and hence, entry has no real impact on these costs of production of the entrant even in presence of licensing.

[5] It is easy to understand that in case of no-entry, the incumbent does not have the incentive for licensing its technology, since the products of these firms are homogeneous and the incumbent becomes the monopolist without licensing.

[6] One may refer to Rockett (1990) for optimal licensing contract in a duopoly when the licenser faces the threat of imitation from the licensee.

for its technology, and (ii) licensing with output royalty, where the licenser charges a linear royalty per-unit of output for its technology. Further, we assume that the incumbent will give a take-it-or-leave-it offer to the entrant and the entrant will accept the offer if it does not make the entrant worse-off compared to a no-licensing situation.

It is evident that if there is no-entry then the incumbent becomes a monopolist. But, in case of entry, we consider the following game. In the first stage, the firms decide whether to make a licensing agreement between them. Then, conditional to the decision on licensing, in stage 2, the firms compete like Cournot duopolists.

3.1 Fixed-fee licensing

In this subsection, we focus on the fixed-fee licensing contract. If the firms do not decide to make licensing contracts then the payoffs of the incumbent and entrant are $\frac{(a-2c_1+c)^2}{9}$ and $\frac{(a-2c+c_1)^2}{9}$ (see subsection 2.2).

If the firms decide to make licensing contract then both firms will produce with a technology corresponding to the constant marginal cost of production c_1, because the incumbent charges only an up-front fixed-fee for its technology. Therefore, if licensing takes place, 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. However, both incumbent and entrant would make the licensing agreement if neither of them is worse-off under licensing compared to no-licensing. That is, to make a licensing agreement, we need to satisfy the following two conditions for the incumbent and the entrant respectively:

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

and

$$\frac{(a-c_1)^2}{9}-F \geq \frac{(a-2c+c_1)^2}{9}. \tag{8}$$

Since, the incumbent gives a take-it-or-leave-it offer to the entrant, the incumbent will charge the fixed-fee in a way that makes 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, the incumbent has the incentive to offer a licensing contract with this amount of fixed-fee provided

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

We find that condition (9) is satisfied provided $c < \frac{(2a+3c_1)}{5}$, where $\frac{(4a+7c_1)}{11} < \frac{(2a+3c_1)}{5} < \frac{(a+c_1)}{2}$.

Hence, licensing with fixed-fee will occur for $c < \frac{(2a+3c_1)}{5}$. In this situation, both firms will produce with a constant marginal cost of production c_1 and the industry profit (i.e., the summation of the profits of the incumbent and the entrant) and consumer surplus are $\frac{2(a-c_1)^2}{9}$ and $\frac{2(a-c_1)^2}{9}$ respectively. So, in case of entry, if licensing with up-front fixed-fee takes place, welfare of the economy is given by

$$W^e_{l,f} = \frac{4(a-c_1)^2}{9}. \tag{10}$$

However, for $c > \frac{(2a+3c_1)}{5}$, licensing with up-front fixed-fee will not take place even if there is entry. Hence, in this situation, welfare under entry is given by the expression (6).

Proposition 2: *If the firms have the option for licensing with up-front fixed-fee, welfare under entry will be lower (higher) compared to the welfare under no-entry provided* $c > (<) \frac{(2a+3c_1)}{5}$. *So, relative to the situation without licensing, licensing with up-front fixed-fee reduces the possibility of lower welfare due to entry.*

Proof: If $c > \frac{(2a+3c_1)}{5}$ then licensing with up-front fixed-fee does not take place even if there is entry. It is evident from Proposition 1 that, in this situation, welfare under entry is lower than the welfare under no-entry, since $\frac{(4a+7c_1)}{11} < \frac{(2a+3c_1)}{5}$.

But, if $c < \frac{(2a+3c_1)}{5}$ then, in case of entry, licensing with up-front fixed-fee takes place and welfare under entry is given by the expression (10). Comparing (3) and (10) we find that for $c < \frac{(2a+3c_1)}{5}$, entry always increases welfare.

Therefore, $c^* < \frac{(4a+7c_1)}{11} < \frac{(2a+3c_1)}{5}$ implies that licensing with up-front fixed-fee reduces the possibility of lower welfare due to entry. Q.E.D.

In a paper with fixed-fee licensing contract and focusing on the situation where the licenser and the licensee compete in the product market irrespective of the decision on licensing, Katz and Shapiro (1985) have shown that welfare of the economy increases under licensing compared to no-licensing. Hence, our result extends their result by showing that whenever fixed-fee licensing is profitable to the firms, entry raises welfare compared to the situation with a monopolist producer.

3.2 Licensing with output royalty

In this subsection we consider that the incumbent is licensing its technology with a per-unit output royalty instead of up-front fixed-fee. Again, it is easy to understand that licensing will occur only if there is entry. Without entry the incumbent becomes a monopolist and has no incentive for licensing.

Here the effective marginal cost of the entrant is $(c_1 + r)$, where r is the optimal per-unit output royalty. If the incumbent offers the licensing contract and the entrant accepts the offer then, given the per-unit output royalty, the optimal outputs of the incumbent and entrant are $\frac{(a-c_1+r)}{3}$ and $\frac{(a-c_1-2r)}{3}$ respectively. Given r, the profits of the incumbent and entrant are $\frac{(a-c_1+r)^2}{9} + \frac{r(a-c_1-2r)}{3}$ and $\frac{(a-c_1-2r)^2}{9}$ respectively. So, while choosing the optimal amount of output royalty, the incumbent maximizes the following expression:

$$\underset{r}{Max} \frac{(a-c_1+r)^2}{9} + \frac{r(a-c_1-2r)}{3} \tag{11}$$

subject to the constraint $r \leq (c-c_1)$.[7] Maximizing (11) while ignoring the constraint $r \leq (c-c_1)$, we find that the optimal value of the output royalty is $\frac{(a-c_1)}{2}$. However, $\frac{(a-c_1)}{2}$ is greater than $(c-c_1)$ for all $c < \frac{(a+c_1)}{2}$. This implies that the incumbent will charge the optimal per-unit output royalty equal to $(c-c_1)$.

With the optimal output royalty, the effective constant marginal cost of the entrant becomes c. Therefore, optimal outputs of the incumbent and entrant are same

[7] The entrant will be better off under no-licensing compared to licensing if $r > (c-c_1)$ and hence, will not accept the licensing contract with $r > (c-c_1)$.

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

Therefore, if the firms are engaged in licensing with per-unit output royalty, welfare is given by

$$W_{l,r}^{e} = \frac{(a-2c_1+c)^2}{9} + \frac{(c-c_1)(a-2c+c_1)}{3} + \frac{(a-2c+c_1)^2}{9} + \frac{(2a-c_1-c)^2}{18} \quad (12)$$

Proposition 3: *If the firms have the option for licensing with per-unit output royalty, entry always increases welfare.*

Proof: We have seen that if the firms have the option for licensing with per-unit output royalty then, in case of entry, licensing will take place for all values of $c \in (c_1, \frac{(a+c_1)}{2})$ and the corresponding welfare is given by the expression (12). The expression (12) is a negatively sloped function with respect to c for all values of $c \in (c_1, \frac{(a+c_1)}{2})$. Further, expression (12) is equal to expression (3) at $c = \frac{(a+c_1)}{2}$. It implies that welfare under entry is always greater than that of under no-entry when the firms have the option for licensing with per-unit output royalty. Q.E.D.

4 Conclusion

Common wisdom suggests that welfare increases with higher competition. However, previous research suggests that entry can reduce welfare when the entrant's marginal cost of production is sufficiently higher than that of the incumbent's.

We have re-examined this issue in an environment where the firms have the option for knowledge sharing through technology licensing. We find that while licensing with fixed-fee helps to reduce the possibility of lower welfare due to entry, licensing with output royalty always increases welfare due to entry.

Our analysis suggests that, while encouraging entry in an industry, the policy makers do not need to be concerned about the technological differences between the

incumbent and entrant in the industries where licensing is not difficult. Hence, our study has important implications for competition policy.

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