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by Arijit Mukherjee and Soma Mukherjee

Arijit Mukherjee is Lecturer, School of Economics, University of Nottingham and Soma Mukherjee is Research Planning Officer, Keele University

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Licensing and welfare reducing competition*

Arijit Mukherjee

University of Nottingham and The Leverhulme Centre for Research in Globalisation and Economic Policy, UK

and

Soma Mukherjee

Keele University, UK

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Abstract: This paper shows that technology licensing may be socially undesirable. Possibility of licensing increases the incentive for entry and thus, increases competition. If technology of the incumbent and entrant is sufficiently close, licensing-induced entry reduces social welfare. Otherwise, licensing always increases welfare.

Key Words: Entry, Licensing, Welfare

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Correspondence to: Arijit Mukherjee, School of Economics, University of Nottingham, University Park, Nottingham, NG7 2RD, UK

E-mail: arijit.mukherjee@nottingham.ac.uk

Fax: +44-115-951 4159

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Licensing and welfare reducing competition

1 Introduction

This paper shows that there are situations when technology licensing is socially undesirable. We show that possibility of licensing increases the incentive for entry and thus, increases competition. However, the effect on social welfare is ambiguous. If the technologies[1] of the incumbent and the entrant are sufficiently close then licensing-induced entry reduces social welfare. But, the possibility of licensing increases welfare if either the technologies of the incumbent and the entrant are sufficiently different or entry occurs irrespective of the possibility of licensing.

Technology licensing is an important strategic decision in many industries (see, e.g., Rostocker, 1984 Calvert, 1964 and Taylor and Silberston, 1973) and has attracted fair amount of attention in recent years. There is already a vast literature on technology licensing. However, to the best of our knowledge, all previous works on licensing, except the recent contributions by Erutku and Richelle (2000) and Fauli-Oller and Sandonis (2002), show that licensing increases social welfare. While Erutku and Richelle (2000) show this possibility in a market where licenser and licensee do not compete in the product market, Fauli-Oller and Sandonis (2002) show that licensing may reduce welfare when licenser and licensee compete in prices and licensing contract involves output royalty.

Present paper considers a situation where licenser and licensee compete in the product market like Cournot duopolists. We show licensing reduces welfare under Cournot competition and without royalty licensing.[2]

Reasons for our results are as follows. We consider that if licensing occurs, price for the licensed technology is determined through bargaining between the firms.[3] A positive bargaining power helps a licensee to extract surplus out of the licensing agreement and increase its payoff. Hence, possibility of licensing increases the incentive for entry.

[1] In this paper we define technology by the marginal cost of production. Lower marginal cost of production implies better technology.

[2] The existence of royalty payment in the licensing contract is also necessary for licensing to reduce welfare in Erutku and Richelle (2000).

[3] See Mukherjee (2002) and Mukherjee and Mukherjee (2002) for works on licensing where price of the technology is determined through bargaining.

Therefore, there are situations when entry occurs because of licensing. Though licensing increases competition in the product market, it imposes cost of entry on the society. If technology of the entrant (i.e., licensee) is sufficiently close to that of the incumbent (i.e., licenser) and entry takes place only if there is possibility of licensing, it implies that cost of entry is sufficiently high. So, even if licensing creates competition by inducing entry, it imposes sufficiently higher cost to the society and as a result, reduces welfare. But, if technology of the entrant is sufficiently different to that of the incumbent then a sufficiently low cost of entry can deter entry without licensing. So, while licensing creates the benefit of competition, the cost to the society is also sufficiently low. In this situation, licensing increases welfare even if licensing induces entry. However, if entry occurs irrespective of licensing, welfare always increases as it creates production efficiency in the industry and does not impose any cost to the society.

Remainder 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

We consider a duopoly market with homogeneous products. We assume that there is a monopolist incumbent, firm 1, in the market and a potential entrant, firm 2.

Assume that firm 1 produces its product with a constant marginal cost of production c_1. To economize on the notations, we make a simplifying assumption that $c_1 = 0$. It is needless to say that our qualitative results hold even for $c_1 > 0$. We further assume that firm 2 produces its product with constant marginal cost of production c, where $0 < c$. We also assume that the entrant needs to incur an entry cost, E. This entry cost is associated with entering an industry, which may be acquiring a license, setting up an office, lawyer fees, etc. For simplicity, we also assume that there is no other cost of production.[4]

We consider the following game. In stage 1, the entrant decides on entry. If it enters, it needs to incur the cost of entry. In stage 2, the firms produce in the product market. If there is no entry in stage 1, the incumbent produces like monopolist. In

[4] Production may also require fixed costs. However, we assume away the possibility of fixed cost of production, as it is not essential for our main story.

case of entry in stage 1, the firms compete like Cournot duopolists with homogeneous products.[5] We solve the game through backward induction.

The inverse market demand function for the product is given by

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

where the notations have usual meanings.

Throughout our analysis we assume that $c < \frac{a}{2}$. If entry occurs, this assumption generates positive output by the entrant in absence of licensing. For $c > \frac{a}{2}$, firm 1 alone produces positive amount in the market even if entry occurs and therefore, entry has no real impact on our analysis.

Let us first consider the situation of entry in stage 1. Under entry, firm 1 and firm 2 maximize the following expressions respectively to maximize their profits in the product market:

$$\underset{q_1}{\text{Max}}(a - q_1 - q_2)q_1 \tag{2}$$

and

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

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

It is easy to derive that optimal outputs of firm 1 and firm 2 are respectively $q_1^* = \frac{(a+c)}{3}$ and $q_2^* = \frac{(a-2c)}{3}$. Second order conditions for maximization are satisfied. Therefore, net profits of firm 1 and firm 2 and consumer surplus are respectively $\frac{(a+c)^2}{9}$, $\frac{(a-2c)^2}{9} - E$ and $\frac{(2a-c)^2}{18}$.

We have done the above analysis under the assumption that entry takes place. However, firm 2 enters provided its net profit is positive. Hence, firm 2 enters the market provided $\frac{(a-2c)^2}{9} > E$.

So, if $\frac{(a-2c)^2}{9} > E$ welfare of the economy is

[5] This assumption of Cournot competition with homogeneous product not only helps us to show our main point in the simplest way, but also eliminates the factor responsible for the welfare reducing licensing in Fauli-Oller and Sandonis (2002).

$$W_{nl}^{e} = \frac{(a+c)^2}{9} + \frac{(a-2c)^2}{9} + \frac{(2a-c)^2}{18} - E . \quad (4)$$

If $\frac{(a-2c)^2}{9} < E$, firm 2 does not enter and firm 1 becomes a monopolist. In this situation, firm 1 maximizes the following objective function:

$$\underset{q_1}{\text{Max}}(a - q_1)q_1 . \quad (5)$$

Maximization of (5) gives us the optimal output of firm 1 as $q_1^* = \frac{a}{2}$. Second order condition for maximization is satisfied. Hence, profit of firm 1 and consumer surplus are respectively $\frac{a^2}{4}$ and $\frac{a^2}{8}$.

So, if $\frac{(a-2c)^2}{9} < E$, welfare of the economy is

$$W^{m} = \frac{3a^2}{8} . \quad (6)$$

3 Entry with the possibility of licensing

The technological difference between the firms, which gives rise to differences in marginal costs of production, creates the possibility of licensing. Now, we extend the model further by incorporating possibility of licensing between these firms.

We consider the following game with the possibility of licensing. In stage 1, the entrant decides on entry. If it enters, it incurs a cost of entry. If entry occurs in stage 1, these firms, in stage 2, decide on licensing. Licensing occurs if it does not make any of these firms worse off compared to no licensing. In stage 3, the firms produce in the product market. If there is no entry in stage 1, the incumbent produces like a monopolist. In case of entry, the firms compete like Cournot duopolists. We solve the game through backward induction.

We assume that firm 1 licenses its technology to the technologically inferior entrant and charges a price for its technology. First, we consider a fixed-fee licensing contract in order to show the result of this paper in the simplest possible way. As already mentioned in the literature, possibility of imitation by the licensee or lack of information needed for provision of royalty in the licensing contract could be the reason for licensing with up-front fixed-fee only (see, e.g., Katz and Shapiro, 1985 and Rockett, 1990). We will show in subsection 3.3 that our qualitative results hold even under licensing with per-unit output royalty, which is another important way of technology licensing (see, e.g., Wang, 1998).

We assume that the price for the technology under licensing is determined through a generalized Nash bargaining process. We assume that α and $(1-\alpha)$ are the bargaining powers of firm 1 and firm 2 respectively.

Let us now examine the situation when licensing is optimal, conditional on entry, in stage 1.

3.1 Profitability of licensing

Assume that firm 2 enters in stage 1. Since licensing occurs after entry, it is easy to understand that the cost of entry does not affect the decision at the licensing stage. If the firms do not engage in licensing, the payoffs of these firms at the stage of licensing are $\frac{(a+c)^2}{9}$ and $\frac{(a-2c)^2}{9}$.

Since we consider fixed-fee licensing, both firms produce with constant marginal cost of production ‘ 0 ’, if licensing occurs.[6] So, profits of firm 1 and firm 2 in the product market are respectively given by $\frac{a^2}{9}+F$ and $\frac{a^2}{9}-F$.

The fixed-fee is determined by maximizing the following expression:

$$\underset{F}{Max}\left(\frac{a^2}{9}+F-\frac{(a+c)^2}{9}\right)^{\alpha}\left(\frac{a^2}{9}-F-\frac{(a-2c)^2}{9}\right)^{(1-\alpha)}. \tag{7}$$

Maximizing (7) and after rearranging, we find the optimal licensing fee as

.

$$F^* = \alpha\left(\frac{2a^2}{9}-\frac{(a+c)^2}{9}-\frac{(a-2c)^2}{9}\right)+\left(\frac{(a+c)^2}{9}-\frac{a^2}{9}\right). \tag{8}$$

Second order condition for maximization is satisfied.

Therefore, the net gain from licensing to the incumbent and the entrant are respectively

$$\frac{a^2}{9}-\frac{(a+c)^2}{9}+F^* = \alpha\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right) \tag{9}$$

[6] We assume that licensing helps firm 2 to take the full benefit of firm 1’s technology.

and

$$\frac{a^2}{9}-\frac{(a-2c)^2}{9}-F^* = (1-\alpha)\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right). \tag{10}$$

So, licensing occurs provided $\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right)>0$ or $c<\frac{2a}{5}$.

Therefore, if $c>\frac{2a}{5}$, the possibility of entry does not affect our analysis of the previous section since here licensing has no impact on our analysis.

Now, consider the situation for $c<\frac{2a}{5}$. Here, firm 1 knows that licensing will occur ex-post entry. So, net profits of firm 1 and firm 2 under licensing are respectively

$$\frac{a^2}{9}+F^* = \alpha\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right)+\frac{(a+c)^2}{9} \tag{11}$$

and

$$\frac{a^2}{9}-F^* = (1-\alpha)\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right)+\frac{(a-2c)^2}{9}-E. \tag{12}$$

Note that for any positive bargaining power of firm 2, i.e., for $\alpha<1$, its net profit as shown by (12) is greater than its profit under no licensing, which is $\frac{(a-2c)^2}{9}-E$. Profit of firm 2 under licensing increases with its bargaining power.

The proposition below follows immediately from the above discussion.

Proposition 1: *Suppose* $c<\frac{2a}{5}$. *Possibility of licensing increases the incentive for entry and higher bargaining power of firm 2 increases its incentive for entry.*

Reason for the above result is the following. Positive bargaining power of firm 2 helps it to extract surplus from licensing and increase its profit. Given that $c<\frac{2a}{5}$, firm 2 knows that if it enters the market, it will get license from firm 1. Since, firm 2 can keep some surplus created through this licensing agreement, this extra gain from licensing may now make its entry profitable and will induce it to enter in stage 1. As a result of entry, licensing occurs in stage 2 and makes entry profitable.

Though we have seen that licensing increases incentive for entry, entry will occur provided expression (12) is positive, i.e.,

$$(1-\alpha)\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right)+\frac{(a-2c)^2}{9}>E. \quad (13)$$

We have already seen that if $c>\frac{2a}{5}$, licensing does not affect our analysis of the previous section. The above discussion also suggests that if $c<\frac{2a}{5}$ but condition (13) does not hold, licensing does not affect our analysis of the previous section.

However, licensing has an impact on our analysis both when $c<\frac{2a}{5}$ and condition (13) holds. In this situation, firm 2 enters only with the possibility of licensing. So, when $c<\frac{2a}{5}$ and (13) holds, welfare of the economy is

$$W_{l,f}^{e}=\frac{4a^2}{9}-E. \quad (14)$$

3.2 Effect of licensing on welfare

The previous subsection has discussed the effect of licensing on market entry. Now, let us examine how the possibility of licensing affects social welfare.

Proposition 2: *Assume* $c<\frac{2a}{5}$.

(a) If $\frac{(a-2c)^2}{9}>E$*, the possibility of licensing increases welfare.*

(b) If $E\in\left(\frac{(a-2c)^2}{9},(1-\alpha)\left(\frac{2a^2}{9}-\frac{(a-2c)^2}{9}-\frac{(a+c)^2}{9}\right)+\frac{(a-2c)^2}{9}\right)$*, the possibility of licensing reduces (increases) welfare when* c *is less (greater) than a critical value, where this critical value is between* 0 *and* $\frac{2a}{5}$*, and depends on* E.

Proof: Given that firm 2 has entered the market, licensing occurs if and only if $c < \frac{2a}{5}$. So, we restrict our attention to these values of c.

(a) If $\frac{(a-2c)^2}{9} > E$, firm 2 enters irrespective of the possibility of licensing. Expressions (4) and (14) describe welfare of the economy without and with the possibility of licensing respectively. We find that (14) is always greater than (4), which implies that the possibility of licensing always increases welfare.

(b) Assume that $E \in (\frac{(a-2c)^2}{9}, (1-\alpha)\left(\frac{2a^2}{9} - \frac{(a-2c)^2}{9} - \frac{(a+c)^2}{9}\right) + \frac{(a-2c)^2}{9})$.

Here, entry occurs provided there is possibility of licensing. But, entry does not occur without the possibility of licensing.

Welfare of the economy without the possibility of licensing and with the possibility of licensing are given by (6) and (14) respectively. Comparing (6) and (14) we find that the possibility of licensing reduces welfare provided

$$E - \frac{5a^2}{72} > 0. \qquad (15)$$

Left hand side (LHS) of (15) increases with E and we have the restriction that $E \in (\frac{(a-2c)^2}{9}, (1-\alpha)\left(\frac{2a^2}{9} - \frac{(a-2c)^2}{9} - \frac{(a+c)^2}{9}\right) + \frac{(a-2c)^2}{9})$. If $E = \frac{(a-2c)^2}{9}$, then (15) holds provided

$$3a^2 + 32c^2 - 32ac > 0. \qquad (16)$$

LHS of (16) is continuous and decreasing in c over $[0, \frac{2a}{5}]$. Further, LHS of (16) is positive at $c = 0$ but negative at $c = \frac{2a}{5}$. This shows that if c is less than a critical value, where this critical value is between 0 and $\frac{2a}{5}$, (15) holds.

Note that the upper bound of E increases with lower α. So, this upper bound reaches maximum at $\alpha = 0$. Assuming $\alpha = 0$, we find that if E takes the upper bound of $(1-\alpha)\left(\frac{2a^2}{9} - \frac{(a-2c)^2}{9} - \frac{(a+c)^2}{9}\right) + \frac{(a-2c)^2}{9}$, condition (15) holds provided

$$3a^2 - 8c^2 - 16ac > 0 . \tag{17}$$

LHS of (17) is continuous and decreasing in c over $[0, \frac{2a}{5}]$ and it is positive at $c = 0$ but negative at $c = \frac{2a}{5}$. This shows that if c is less than a critical value, where this critical value is between 0 and $\frac{2a}{5}$, (15) holds.

Conditions (16) and (18) are different for different values of E. This implies that the critical value of c depends on the value of E. This proves the result.

Q.E.D.

Reasons for the above results are as follows. Licensing has following effects. First, whenever licensing occurs, it makes the industry more technologically efficient since both firms are producing with efficient technology. Secondly, possibility of licensing may induce firm 2 to enter if entry is unprofitable to firm 2 without licensing. By attracting firm 2, possibility of licensing creates higher competition. Thirdly, if entry is induced by the possibility of licensing, entry of firm 2 creates a cost to the society due to the cost of entry.

If the cost of entry is such that entry occurs irrespective of the possibility of licensing, licensing creates only the above-mentioned first effect and therefore, licensing always increases social welfare.

But, if entry occurs only if there is possibility of licensing, all the above-mentioned three effects are relevant. Further, note that even if under entry and no entry, firms produce with the efficient technology of firm 1, welfare comparison will be influenced by firm 2's initial marginal cost of production, since it determines the cost of entry that makes entry profitable with licensing but unprofitable without licensing.

If the marginal cost of firm 2 is sufficiently low yet entry is unprofitable, it implies that the cost of entry is sufficiently high. So, when licensing induces entry, it creates a sufficiently higher negative effect on social welfare due to the third effect mentioned above. Therefore, even if licensing-induced entry creates higher competition and also higher cost efficiency, the negative effect of higher cost of entry outweighs this positive effect of licensing and reduces social welfare. In contrast, if the marginal cost of firm 2 is sufficiently high and entry occurs only with the possibility of licensing, it implies that the cost of entry is sufficiently low. In this situation, positive effects of licensing-induced entry (first two effects) outweigh the negative effect of cost of entry (third effect) and the possibility of licensing increases social welfare.

3.3 Licensing with output royalty

In this subsection we consider licensing with per-unit output royalty. Our purpose is to show that the qualitative results as obtained under fixed-fee licensing hold even under licensing with per-unit output royalty. As a simplification, let us only consider the situation where both incumbent and entrant have equal bargaining power in the licensing stage. So, instead of a generalized Nash bargaining process, here we focus on Nash bargaining process with equal bargaining power.

Since licensing occurs after entry, entry does not affect the decision at the licensing stage even if it occurs with per-unit output royalty. If the firms do not engage in licensing, the payoffs of these firms at the stage of licensing are $\frac{(a+c)^2}{9}$ and $\frac{(a-2c)^2}{9}$.

We consider that the entrant produces with constant marginal cost of production r, if licensing occurs, where r is the per-unit output royalty. So, profits of firm 1 and firm 2 in the product market are respectively given by $\frac{(a+r)^2}{9}+F$ and $\frac{(a-2r)^2}{9}-F$. Note that $r \le c$. Firm 2 will be worse off under licensing compared to no licensing without any fixed fee from firm 1. We assume away this type of negative fixed-fee, which might be prevented by the antitrust law (see, e.g., Rockett, 1990).

The royalty rate is determined by maximizing the following expression:

$$\underset{r}{Max}\left(\frac{(a+r)^2}{9}+F-\frac{(a+c)^2}{9}\right)\left(\frac{(a-2r)^2}{9}-F-\frac{(a-2c)^2}{9}\right). \quad (18)$$

Maximizing (18) and after rearranging, we find the optimal royalty rate as

$$r^* = \frac{a}{2}-\frac{\sqrt{5(a-2c)(5a-4c)}}{10}. \quad (19)$$

Second order condition for maximization is satisfied.

It is easy to check that r^* in (19) is always less than c for all values of $c \in (0, \frac{a}{2})$. Therefore, it implies that firm 2 always has the incentive to take licensing, if entry takes place. It also implies that firm 2 can always keep some surplus generated from licensing and therefore, licensing helps to increase its net profit.

Let us now consider profitability of firm 1 under licensing, given that entry has occurred. Firm 1's gain from licensing compared to no licensing is

$$X = \frac{(a+r^*)^2 + 3r^*(a-2r^*)}{9} - \frac{(a+c)^2}{9} \ . \tag{20}$$

We obtain X is equal to 0 at $c = 0$ and $c = \frac{a}{2}$. Further, X is concave in c over $c \in [0, \frac{a}{2}]$ and is maximal at $c = \frac{a}{4}$. This implies that, if entry occurs, firm 1 is always better off under licensing compared to no licensing for all $c \in (0, \frac{a}{2})$.

Proposition 3: *Licensing increases the incentive for entry for all* $c \in (0, \frac{a}{2})$.

Proof: We have seen that $r^* < c$ for all $c \in (0, \frac{a}{2})$. This implies that firm 2's gross profit under licensing, i.e., $\frac{(a-2r^*)^2}{9}$, is greater than its gross profit without licensing, i.e., $\frac{(a-2c)^2}{9}$. Further, if entry occurs, firm 1 always licenses its technology for all $c \in (0, \frac{a}{2})$. This proves the result. Q.E.D.

So, if entry occurs, licensing always takes place and net profit of firm 2 is

$$\frac{(a-2r^*)^2}{9} - E = \frac{(a-2c)(5a-4c)}{45} - E \ . \tag{21}$$

So, when there is possibility of licensing and both firms have equal bargaining power, entry occurs if and only if

$$\frac{(a-2c)(5a-4c)}{45} > E \ . \tag{22}$$

Therefore, if $\frac{(a-2c)(5a-4c)}{45} > E$, and there is possibility of licensing, welfare of the economy is

$$W_{l,r}^{e} = \frac{2(a+r^*)^2 + 2(a-2r^*)^2 + 6r^*(a-2r^*) + (2a-r^*)^2}{18} - E. \qquad (23)$$

Proposition 4: *(a) If* $\frac{(a-2c)^2}{9} > E$*, the possibility of licensing increases welfare.*

(b) If $E \in (\frac{(a-2c)^2}{9}, \frac{(a-2r^*)^2}{9})$*, the possibility of licensing reduces (increases) welfare when* c *is less (greater) than a critical value, where this critical value is between* 0 *and* $\frac{2a}{5}$*, and depends on* E*.*

Proof: (a) If $\frac{(a-2c)^2}{9} > E$, welfare of the economy without and with licensing are given by (4) and (23). We obtain that (23) is always greater than (4).

(b) If $E \in (\frac{(a-2c)^2}{9}, \frac{(a-2r^*)^2}{9})$, welfare of the economy without and with licensing are given by (6) and (23). Comparing (6) and (23), we find that the possibility of licensing reduces welfare provided

$$E > \frac{(4a+r^*)(2a-r^*)}{18} - \frac{3a^2}{8}. \qquad (24)$$

We find that condition (24) holds at $E = \frac{(a-2r^*)^2}{9}$ provided $(a-2r^*)(a-6r^*) > 0$. Since, $a > 2r^*$, condition (24) holds provided $a > 6r^*$. It is easy to check that $a > 6r^*$ if and only if c is less than a critical value, say $\hat{c}$, where $\hat{c} \in (0, \frac{a}{2})$.

If $E = \frac{(a-2c)^2}{9}$, we obtain condition (24) holds if and only if

$$3a^2 - 32ac + 32c^2 + 8ar^* + 4r^{*2} > 0. \qquad (25)$$

Condition (25) holds at $c = 0$ but it does not hold at $c = \frac{a}{2}$. Further, LHS of (25) is quadratic and continuous in c over $[0, \frac{a}{2}]$. This implies that (24) holds if and only if c is less than a critical value, where the critical value lies between 0 and $\frac{a}{2}$. This proves the result. Q.E.D.

4 Conclusion

This paper examines the effect of licensing on entry and social welfare. We show that while licensing increases the possibility of entry, its effect on welfare is ambiguous.

If technology of the entrant is sufficiently close to that of the incumbent, we show that the possibility of licensing reduces social welfare. Otherwise, licensing increases social welfare. Thus, our result is in sharp contrast to the previous literature, which mainly shows that licensing always increases social welfare. Recent contributions showing the possibility of welfare reducing licensing have focused on price competition and the provision of output royalty in the licensing contract for their results. In contrast, our analysis demonstrates the importance of bargaining power of the licensee and the cost of entry under quantity competition and our result holds even for licensing without output royalty.

Thus, our result suggests that while encouraging licensing, it is important to consider its effects on entry as well as the cost of entry. Hence, our results have important implications for competition policy.

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