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"Unilateral" technology licensing from an entrant to incumbent monopolist

Neelanjan Sen
University of Calcutta

Abstract

An incumbent monopolist, tries to deter entry and thus never licenses its technology to any potential entrant. This paper, however shows that the monopolist may license in the technology of the entrant that remains out of the market in the pre-licensing stage. Post-licensing, the entrant actually enters the market, but this reduction in the market share of the incumbent, (paradoxically) increases its post-entry profit. Moreover the entrant can actually subsidize the monopolist to license its technology. Licensing decreases welfare if the monopolist is either a foreign firm (whose profit is totally repatriated) or a domestic firm.

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Contact: Neelanjan Sen - neelu.sen@gmail.com.
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1. Introduction

In a market characterized by an incumbent monopolist, it is generally accepted that licensing of the technology used by the incumbent monopolist[1] to a potential entrant is not possible. This happens as the monopolist always tries to deter entry of any potential entrant (see Salop 1979 and Milgrom 1982 for example). The existing literature on licensing (see Marjit 1990, Wang 1998, Kamien and Tauman 1986, Sen and Tauman 2007, Fauli-Oller and Sandonis 2002, Mukherjee 2002 etc.) explains it in terms of "drastic innovation". In these models, the unit costs of production of all the competing firms are assumed to be constant. Innovation is termed as "drastic" if it leads to a large reduction in the unit cost of the patent-holding firm. This allows the patent-holding firm to be the monopolist as it becomes unprofitable for the other competing firms to enter the market. Evidently, the patent-holding firm (the monopolist) never licenses its technology to any of the possible entrants as it reduces the industry profit.[2] In real world strong maintenance of trade secret[3] by firms like Kentucky Fried Chicken (KFC)[4], Coca-Cola[5] etc; which gives the holder an advantage over competitors, who do not know or use the secret technology, validates why a monopolist never licenses its technology. The present model examines the possibility of licensing in a market, where there exists a monopolist and an entrant. Contrary to the present literature it is assumed that the technology of these firms is characterized by constant unit cost and positive fixed-cost. In this context too the monopolist never licenses its technology to the entrant. *However, the entrant may license its technology to the monopolist.* This idea is in contrast to the existing literature, because there licensing is never possible from an

[1]In the rest of the paper instead of writing "the incumbent monopolist" always, we simply use "monopolist" to refer the incumbent monopolist.

[2]As argued by Arora and Fosfuri (2003), when the innovator is also a monopolist in the product market, the licensing strategy would not expand firms market share, but it increases competition in the product market. Hence, a monopolist patent holder would never license its technology.

[3]For definition see- Restatement of Torts, Section 757. Liability for disclosure or use of another's Trade Secret.

[4]See the article- The KFC secret recipe is kept in a vault in Kentucky. http://www.moneycontrol.com

[5]See the article- Where is the secret formula for Coca-Cola kept? http://www.coca-cola.co.uk

entrant, who possesses an inferior technology than the incumbent monopolist. In the present model fixed-cost plays a pivotal role in explaining how the entrant, unable to compete with the monopolist in the pre-licensing stage, enters the market after licensing its technology to the monopolist.

The present paper is also related to Kabiraj and Marjit (2003). There in a duopoly market a foreign firm and a local firm compete in the home country and it is shown that a tariff may induce transfer of technology from foreign firm to the local firm. In the present model the monopolist can be viewed as a foreign firm whose profits are repatriated back to the foreign country while it competes in the home country with a domestic entrant. Then the licensing of technology from the domestic entrant to the monopolist will always lead to lower welfare for the home country. Moreover if the monopolist is a domestic firm, then also welfare of the home country reduces after transfer.

In a framework of strategic trade Mukherjee (2002) studies the role of a fixed amount of subsidy, if the technologies of the firm are characterized by constant marginal cost and fixed cost. The present paper closely builds on Mukherjee (2002) and discusses the issue of licensing when both firms possess technologies characterised by positive fixed-cost and a constant marginal cost. Even though the paper focuses on fixed-fee licensing, the main results of the paper holds good even in case of royalty licensing. The possibility of negative fixed-fee (subsidy in licensing) is also identified as in Ottoz and Cugno (2009), Liao and Sen (2005) and Anderson (2013).

The paper begins with a basic set-up which discusses the sequence of the game and what happens if licensing fails. Then it discusses the fixed-fee licensing between the firms, where the entrant offers an upfront fixed-fee. We discuss there the possibility of how a monopolist can become a licensee. The next section then deals with the welfare implications and the final section concludes the model.

2. Basic set-up

Consider a market where two firms designated as firm 1 and firm 2; produce a homogeneous product and engage in Cournot competition. Inverse market demand is $P = a - q$, where P is the price, $q = q_1 + q_2$ is the total output supplied in the market and $q_i,\ i = 1, 2$, is the output produced by the firm i. Cost function of firm i is $C(q_i) = c_i q_i + F_i$, where $i = 1, 2$ and c_i and F_i are the constant marginal and fixed cost respectively. Without any loss of generality let us further assume that $F_2 > F_1$ and $c_1 > c_2$. This implies that if c_1 is very high then firm 2 will become the monopolist.

The sequence of the game is discussed as follows. At stage 1, the firm 1 decides whether to license its technology to the other firm (firm 2) depending on the profitability of the endeavour. In case licensing is chosen, firm 1 gives a take-it-or-leave-it licensing contract with a up-front fixed-fee (T). At stage 2, firm 2 accepts the licensing contract if it is not worse off than rejecting it. At stage 3, conditional on licensing decision, the firms compete like Cournot duopolists and the profits are then realised. Lastly at stage 4, after the profits are realised the payments (fixed-fee) that are agreed in the stage 2 are made, only if the licensee has used the licensed technology for production of output. The game is solved through backward induction.

3. Pre-licensing stage

For simplicity we assume $c_2 = 0 < c_1$, $F_1 = 0 < F_2$ and also $c_1 > \frac{a}{2}$ such that firm 2 is the monopolist (incumbent). Higher marginal cost of firm 1 (the entrant) has forced it to stay out of the market. Firm 2 produces $q_2 = \frac{a}{2}$ units of output. Therefore pre-licensing (monopoly) profit of firm 2 is $\Pi_2^m = \frac{a^2}{4} - F_2$ and it is assumed to be positive or $F_2 < \frac{a^2}{4} = \bar{F}_2$, and $\Pi_1^m = 0$ is the profit of firm 1 when firm 2 is the monopolist (firm 1 stays out of the market).

4. Licensing by fixed-fee

Suppose firm 1 (the entrant) decides to offer (charges) T_1 (fixed-fee) to license its technology to firm 2.[6] Let $\Pi_i(T_1)$, $i = 1, 2$ be the net profit of firm i after transfer. Observing T_1, firm 2 will accept the offer if $\Pi_2(T_1)$ is at least more than Π_2^m, where $\Pi_2(T_1) = \frac{(a-c_1)^2}{9} - T_1$ and $\Pi_1(T_1) = \frac{(a-c_1)^2}{9} + T_1$ are the net profits of firm 2 and firm 1 respectively after transfer. We also

[6]Firm 2 (the monopolist) never transfers its technology to any potential entrant as it results in fall in the industry profit. It is due to this reason that the present model focuses on the other alternative, where firm 1 license its technology to firm 2.

assume $c_1 < a$ such that the both firms earn positive profits after transfer. Therefore licensing is possible if

$$\Pi_2(T_1) = \frac{(a-c_1)^2}{9} - T_1 \geq \Pi_2^m \tag{1}$$

and

$$\Pi_1(T_1) = \frac{(a-c_1)^2}{9} + T_1 \geq \Pi_1^m \tag{2}$$

as both these firms compete in the output market after transfer. As firm 1 licenses its technology it offers a very high fixed-fee, $\bar{T}_1$, such that

$\Pi_2(\bar{T}_1) = \Pi_2^m$

or $\bar{T}_1 = \frac{(a-c_1)^2}{9} + F_2 - \frac{a^2}{4}$. Finally, after transfer firm 1 will get

$\Pi_1(\bar{T}_1) = \frac{2(a-c_1)^2}{9} + F_2 - \frac{a^2}{4}$.

Therefore licensing is possible if the industry profit after transfer increases as in Marjit (1990), Wang (1998) etc. This happens if $\Pi_1(\bar{T}_1) > \Pi_1^m$ or

$$F_2 > \frac{a^2}{4} - \frac{2(a-c_1)^2}{9}. \tag{3}$$

It is to be noted that $\bar{T}_1$ can either be positive or negative. The following lemmas therefore discuss this issue.

Lemma 1. *If $F_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, technology is transferred and $\bar{T}_1 > 0$.*

Proof. Suppose $T_1 = 0$ which implies that firm 1 licenses its technology freely to firm 2. Then $\Pi_1(0) = \frac{(a-c_1)^2}{9} > \Pi_1^m$, if firm 2 accepts the offer. Further for $T_1 = 0$, if $\Pi_2(0) = \frac{(a-c_1)^2}{9} > \Pi_2^m$ or $F_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$ firm 2 will accept the offer. This implies that given $F_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, if firm 1 licenses its technology freely then firm 2 as well as firm 1 will be better off than under no-licensing. Therefore if $F_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, which satisfies relation "(3)", firm 1 will charge $\bar{T}_1(> 0)$ as high as possible such that firm 2 accepts the offer. It is to be noted that as $\bar{F}_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9} > 0$ and $F_2 \in (0, \bar{F}_2)$, this situation is possible. ■

Most of the licensing literature does not allow for negative fixed fees. As a negative fixed fee may lead to a situation in which the patentee is bribing the licensee to exit the industry. This is likely to be marked as illegal by the competition authorities as argued in Shapiro (1985). It is therefore assumed that due to antitrust law firm 1 cannot pay subsidy such that firm 2 leaves the market and firm 1 becomes the new monopolist.

Lemma 2. *If* $\frac{a^2}{4} - \frac{2(a-c_1)^2}{9} < F_2 \leq \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, *technology is transferred and* $\bar{T}_1 \leq 0$.

Proof. Suppose $\frac{a^2}{4} - \frac{2(a-c_1)^2}{9} < F_2 \leq \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$ instead[7]. Therefore if $T_1 = 0$, $\Pi_2(0) \leq \Pi_2^m$. Hence, firm 2 will accept only if $T_1 \leq 0$ and at $T_1 = 0$, $\Pi_1(0) > \Pi_1^m$. Moreover, if the contract is signed in stage 2 of the game, this will ensure a receipt of T_1 (payment if $T_1 < 0$) by firm 1 if firm 2 uses the licensed technology (technology of firm 1) in the output production stage. Further, if firm 1 is committed to pay (negative fixed-fee, $\bar{T}_1 < 0$) firm 2 after the output production stage, firm 2 will use only the licensed technology. This is because it has no incentive to use its original technology when the output produced by firm 1 is $\frac{a-c_1}{3}$ (individual firm's output if both firms use the licensed technology). As given $q_1 = \frac{a-c_1}{3}$, if firm 2 uses its original technology it gets a profit of $\frac{(2a+c_1)^2}{36} - F_2 (< \Pi_2^m = \Pi_2(\bar{T}_1))$. Therefore given $\bar{T}_1 < 0$, which is agreed in stage 2, firm 2 does not use the traditional (own) technology.

Further, if the contract is signed in stage 2 such that $\bar{T}_1 < 0$, firm 2 could not produce the monopoly output $q_2 = \frac{a-c_1}{2}$ (given $q_1 = 0$) with the licensed technology. Firstly because, this will contradict $\bar{T}_1 < 0$; as in such case firm 1, earning zero profit (as $q_1 = 0$), will be unable to subsidize firm 2. Secondly, as firm 2 will use the licensed technology as discussed before, firm 1 will always compete with firm 2 in the output market and produce $q_1 (> 0)$ as $\Pi_1(\bar{T}_1) > \Pi_1^m = 0$. This therefore ensures that both the firms, engaged in Cournot competition, will produce same output ($\frac{a-c_1}{3}$). Therefore if $\frac{a^2}{4} - \frac{2(a-c_1)^2}{9} < F_2 \leq \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, technology is transferred (see relation "(3)") and $\bar{T}_1 \leq 0$. ■

[7] As $0 < \frac{a^2}{4} - \frac{(a-c_1)^2}{9} < \bar{F}_2$ and $F_2 \in (0, \bar{F}_2)$, this is possible.

Therefore the licensor can subsidize, by paying a lump-sum amount (negative fixed-fee), the licensee in the equilibrium to license its technology even if they compete in the output market in the post-licensing stage.

Therefore we conclude that if

$$\frac{a^2}{4} - \frac{2(a-c_1)^2}{9} < F_2 < \frac{a^2}{4}, \quad given \quad \frac{a}{2} < c_1 < a \tag{4}$$

then even if firm 2 is the monopolist in the pre-licensing stage firm 1 will license its technology to firm 2 and enter the market.

Therefore given relation "(4)", if $F_2 > \frac{a^2}{4} - \frac{(a-c_1)^2}{9}$, then $\bar{T}_1 > 0$ and $\bar{T}_1 \leq 0$ otherwise.

Proposition 1. *An entrant, having a different technology that forces him to stay out of the market, can license its technology to the incumbent monopolist and thereby enter the market.*

The present model assumes that firm 1 produces its output at a unit cost of c_1 ($F_1 = 0$), while firm 2 only incurs a fixed cost of F_2 ($c_2 = 0$) to produce its output. Hence, when firm 1 licenses its technology to firm 2, the unit cost of firm 2 increases from zero to c_1, which can be called the first effect. However, the fixed cost of firm 2 also falls from F_2 to zero. This is the second effect of licensing. The first effect results in contraction of the industry profit from $\frac{a^2}{4}$ to $\frac{2(a-c_1)^2}{9}$. Contrarily, the second effect is expansionary. It boost up the industry profit. Therefore the industry profit will increase, assuring the possibility of licensing, if the second effect is relatively stronger. This is possible only when c_1 is much lower (slightly above $\frac{a}{2}$) and F_2 much higher. On the other hand if c_1 is much higher than $\frac{a}{2}$ and F_2 much lower, technology is not transferred, from firm 1 to firm 2, as the first effect dominates resulting in fall in industry profit.

Similar analysis can be carried over for royalty licensing in this context. In case of royalty licensing too firm 1 may license its technology to firm 2 and enter the market. The present discussion construes how licensing of technology helps to achieve more competition in the market from the shackles of monopoly which was not emphasized previously in the literature. In contrast to the findings in the literature the present paper highlights how the monopolist becomes a licensee and there by allows an outsider to share the market.

5. Welfare effects

In this section, welfare implications of technology transfer is analysed in two possible situations.

Assume firm 2 to be a foreign firm who sells its output in the home market of firm 1 but repatriates its profit to the foreign country. Therefore the welfare[8] in the pre-licensing stage is only the consumer surplus (as $\Pi_1^m = 0$). Given demand function as defined earlier consumer surplus is $\frac{q^2}{2}$, where q is the industry output. Therefore before transfer welfare is $W = \frac{a^2}{8}$ as the industry output is $q_I = \frac{a}{2}$. [9]

When technology is licensed from firm 1 to firm 2 consumer surplus decreases as the industry output falls, as $q_I > q_I^{T_1}$ where $q_I^{T_1} = \frac{2(a-c_1)}{3}$ is the industry output after transfer[10]. Let the welfare after transfer be $W^{T_1} = \frac{{q_I^{T_1}}^2}{2} + \Pi_1(\bar{T}_1)$, the sum of consumer surplus and firm 1's post-licensing profit. Moreover $W^{T_1} < W$, as $W^{T_1} - W = \frac{4(a-c_1)^2}{9} + F_2 - \frac{3a^2}{8} < 0$ (as relation "(4)" holds), this ensures that welfare will decrease after transfer. Therefore welfare decreases always when technology is transferred from firm 1 to firm 2, if firm 2 is a foreign firm.

Even if firm 2 is of the national origin, the effect of licensing of technology on welfare is same as before. In this case the initial welfare is $W = \frac{q_I^2}{2} + \Pi_2^m$, the sum of consumer surplus and firm 2's pre-licensing profit. The effect of licensing on consumer surplus is same as before. Contrarily in this case the welfare after transfer is $W^{T_1} = \frac{{q_I^{T_1}}^2}{2} + \Pi_1(\bar{T}_1) + \Pi_2(\bar{T}_1)$, the sum of consumer surplus and post-licensing industry profit. Moreover as before $W^{T_1} < W$, the welfare will decrease after transfer (as relation "(4)" holds). Therefore

[8] Welfare is defined as the sum of industry profits and consumer surplus. As firm 2 is a foreign firm we ignore its profit in calculating the welfare, as it is being totally repatriated to the foreign land.

[9] As in the pre-licensing stage firm 1's output is $q_1 = 0$ and firm 2's output is $q_2 = \frac{a}{2}$.

[10] As after transfer both firms produce equal output, hence $q_1 = q_2 = \frac{a-c_1}{3}$.

welfare decreases always when technology is transferred from firm 1 to firm 2.

Proposition 2. *The welfare of the home country always reduces after the transfer of technology, not only when the monopolist is the domestic firm but also when the monopolist is the foreign firm.*

6. Conclusion

This paper studies the problem of the licensing of technology, where the technologies are characterised by a fixed-cost and a constant marginal cost. The monopolist (incumbent) produces output at a lower marginal cost than the entrant (outsider), which has a lower fixed cost. Interestingly it is shown that the entrant, having inferior technology that forces it to stay out of the market, can license its technology to the monopolist and thereby enter the market. It is also shown that at the equilibrium the entrant can subsidize (negative fixed-fee) the monopolist to license its technology. Moreover it is shown that licensing will decrease the welfare of the home country if the monopolist is either a foreign firm, who repatriates its profit, or a domestic firm.

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