E C O N O M I C S   B U L L E T I N

On the Optimality of Patent Licensing with Maximum Production Volume

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Abstract

This paper compares alternative licensing schemes of a patentor, that is, at the same time, a producer within an industry. The licensing scheme can assume the form of a royalty per unit of output, a fixed fee, or a fixed fee with maximum authorized production. We show that, when the innovation is non-drastic, in a duopolistic Cournot competition, the third method dominates the others. As the patentor has strong incentives to limit the output of the opponent, this practice must be carefully monitored by the antitrust authority.

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1 Introduction

A patent gives a firm the exclusive right to directly exploit an innovation or to license it to other firms. Licensing agreements are quite widespread practices in business as they are the main source of income for an outside patent holder and an important source of additional income to a patent holder participating in the production. The literature on licensing has distinguished between two main cases depending on whether the patent holder is involved in production or not (see, for example, Kamien, 1992).

When the innovator is not participating in the production, Kamien and Schwartz (1982), Kamien and Tauman (1984, 1986) and Kamien, Oren and Tauman (1992) show that licensing by means of a fixed fee is superior to licensing by means of a royalty (for the outside patent holder). In fact, a royalty scheme generates lower patenting revenue with respect to a fixed fee scheme, as royalties raise the marginal costs of production of the licensees and hence such a scheme reduces the advantage of innovation (and the returns to the patent holder).

A second stream of research has analysed the case of a patent holder that is involved in production. Wang (1998) shows that, in a Cournot duopoly, a royalty scheme can outperform a fixed fee scheme when the cost-reducing innovation is non-drastic. Kamien and Tauman (2002) have generalized this result in an oligopolistic context. In both cases, a royalty is superior to a fixed fee as the innovator cares not only about the licensing revenue but also about the returns of its direct sales. When a patenting-holder firm chooses to license by means of a royalty, it reduces the output of the opponent with respect to a fixed fee and it increases its market share. The dominance of a royalty scheme rests on the fact that the increase in profits due to a larger market share is higher than the reduction in licensing revenue associated with the distortionary royalty payment.

Licensing agreements are often more complex than previously described. OECD (1989) indicates that licensing agreements usually include territorial agreements, limitations on the licensee's quantity, quality controls, and many other restraints. Anand and Khanna (2000) provide a recent analysis of the agreement contracts. Bessy et al. (2002) report that fixed-fee agreements are often linked to maximum authorized production capacities. In Anderson and Gallini (1998), there are many contributions describing exclusivity restrictions and other licensing agreements in Europe and the US.

Although licensing restrictions are notorious, especially in the literature on patent licensing and competition policy, there are few contributions which analyse the optimal licensing scheme in complex environments. Some exceptions are Rey and Winter (1998) who study the case of exclusivity restrictions, Rockett (1990) who studies the impact of quality restraints, and Gilbert and Shapiro (1997) who propose an analysis of vertical licensing restraints.

In this paper we investigate the optimality of the licensing schemes when a patent holder can choose among three different licensing agreements: a royalty per unit of output; a fixed fee; or a fixed fee with a maximum authorized production.

We will show that the third licensing method dominates the previous ones. The explanation of this result is straightforward. Licensing agreements produce a trade-off to the patent-holding firm which is participating in the production. The licensor gains from the licensing payments but it loses profits as a result of increased competition.

The proposed licensing method makes this trade-off clear. When firm 1 sets the maximum production level low, it can only ask for a small licensing payment, while, when it sets the maximum production level high, it can ask for a large licensing payment. However, we will show that the gains in profits due to a reduction of the competitive pressure always dominate the reduction in the licensing payment. As licensing by means of a fixed-fee with maximum production allows firm 1 to reduce the output of the opponent more than with other methods, this method maximizes the payoff of the patent holder. In this context, the patent holder has a strong incentive to limit the output of the opponent, and therefore these practices must be carefully monitored by the antitrust authority[1].

2 The Model

There are two firms: namely, 1 and 2, engaged in Cournot quantity competition. They produce an identical product and incur identical, constant unit costs c. The demand is linear and given by $Q = a - p$ for $p \leq a$, and $Q = 0$ for $p > a$, where Q refers to the total quantity of the good demanded at the price p. We assume that firm 1 has created a new process which reduces the marginal costs of a final product by ε, where $0 < \varepsilon \leq c$. The innovation is non-drastic, i.e. the post-invention monopoly price, $p^m = (a + c - \varepsilon)/2$, exceeds the pre-invention marginal costs, c. Firm 1 can license the process to firm 2 by means of one of the following licensing methods: a royalty per unit of output (R); a fixed fee (F); or a fixed fee with maximum authorized production (A). In the first case, firm 1 requires a constant payment rate r for each unit produced by firm 2. In the second case, firm 1 receives a fixed amount independently of the production of firm 2. In the third case,

[1]This paper does not enter the debate on intellectual property rights and competition policy. There is a wide literature investigating the anticompetitive effects of licensing agreements. For example, Fershtman and Kamien (1992) show that cross-licensing may facilitate collusive outcomes. On the link between patent licensing and competition policy in the EU, see for example, Anderman (1998), and for licensing agreements in the US, see U.S. DOJ/FTC Antitrust Guidelines (1995, 2000).

firm 1 receives a fixed payment, but firm 2 is limited in the production to a maximum level denoted by K_2.

Following Kamien (1992), we assume that, once the licensing method is selected, firms 1 and 2 are involved in a three-stage game. In the first stage, the patent holder makes a take-it-or-leave-it offer to the opponent indicating the licensing method and the terms of the contract. In the second stage, the other firm decides whether or not to become a licensee. Being a licensee requires an irreversible change in the production process, i.e. firm 2 can only produce using the new technology. In the third stage, firms engage in Cournot quantity competition. The equilibrium concept is the subgame perfect Nash equilibrium. To solve the model, we work backward from the third stage, first determining the product-market equilibrium, then determining the decision of firm 2, and finally the offer of firm 1.

We briefly review the first two methods that have already been investigated in the literature. Afterwards, we focus on licensing by means of a fixed fee with maximum authorized production.

2.1 Royalty per unit of output licensing game

We assume that firm 1 selects a constant per unit royalty rate r at which it will license the new technology. Let $q_1^R(r)$ and $q_2^R(r)$ be the quantities produced in the third stage of the game by firms 1 and 2, respectively, if firm 2 accepts the offer, and q_1^N and q_2^N these quantities if firm 2 rejects the offer. $\Pi_1^R(r)$, $\Pi_2^R(r)$, Π_1^N, and Π_2^N are the associated profits, which are similarly defined. Following Wang (1998), $q_1^R(r) = (a - c + r + \varepsilon)/3$, $q_2^R(r) = (a - c + r + \varepsilon)/3 - r$, $q_1^N = (a - c - \varepsilon)/3 + \varepsilon$ and $q_2^N = (a - c - \varepsilon)/3$. Profits are: $\Pi_1^R(r) = q_1^R(r)^2 + r \cdot q_2^R(r)$, $\Pi_2^R(r) = q_2^R(r)^2$ and $\Pi_i^N = \left(q_i^N\right)^2$.

In the second stage, firm 2 will accept the offer if $r \leq \varepsilon$ and, in the first stage, firm 1 chooses $r = \varepsilon$ and maximizes its profits. Hence, the highest profit level under a royalty for firm 1 is $\Pi_1^R = (a - c + 2\varepsilon)^2/9 + \varepsilon(a - c - \varepsilon)/3$, and the corresponding profit for firm 2 is $\Pi_2^R = (a - c - \varepsilon)^2/9$, which coincides with its profits when it rejects the contract. The following proposition summarizes the result.

Proposition 1 *When firm* 1 *selects a constant per unit royalty, it sets* $r = \varepsilon$. *Profits realized by licensing are higher than profits without licensing.*

2.2 Fixed fee licensing game

When firm 1 selects a fixed fee, the equilibrium quantity of the third stage game is given by $q_1^F = q_2^F = (a - c + \varepsilon)/3$. Profits net of payments are: $\left(q_1^F\right)^2$. The highest fee that firm 1 can choose to induce the participation of firm 2 is given by the difference between firm 2's prepayment profits with innovation and its profits using the old technology: $F\left(q_2^F\right) = 4\varepsilon(a - c)/9$. Note that licensing the innovation is profitable for firm 1 if $a - c > 3\varepsilon/2$.

The following proposition summarizes the result.

Proposition 2 *When firm 1 selects a fixed fee method it sets $F = 4\varepsilon(a-c)/9$. Profits realized by licensing are higher than profits without licensing provided that $a - c > 3\varepsilon/2$.*

The following proposition compares firm 1's returns from the two licensing methods.

Proposition 3 *Licensing a non drastic invention by means of a unit royalty is more profitable for a patentee which is involved in production than licensing by means of a fixed fee.*

Proof. See: Wang (1998), Proposition 3. ■

2.3 Fixed fee with maximum output licensing game

We now assume that in the first stage of the game firm 1 offers a contract to firm 2 which includes a fixed fee F and a maximum authorized production level K_2. We assume that firm 2 by accepting the contract is irrevocably committed to use the new process and cannot produce with the previous technology. Being the competition in a Cournot-like style, the maximum output clause is effective when $K_2 < q_2^F$. If $K_2 \geq q_2^F$, then we are in the previous case (fixed fee without maximum authorized production), where firm 2 produces q_2^F. Therefore, we solve the third stage of the game assuming that firm 2 produces $q_2^A(K_2) = K_2 < q_2^F$. From first-order conditions, firm 1 will choose to produce $q_1^A(K_2) = (a - K_2 - c + \varepsilon)/2$. Prepayment profits of firms 1 and 2, are respectively: $q_1(K_2)^2$ and $q_1(K_2) \cdot K_2$.

The highest fee that firm 1 can charge to induce participation of firm 2 is given by the difference between firm 2's prepayment profits when using the new process and it is committed to produce K_2 and the profits that firm 2 receives competing in a Cournot game with the old technology:

$$F^{\max}(K_2) = (a - K_2 - c + \varepsilon) K_2/2 - (a - c - \varepsilon)^2/9. \tag{1}$$

Thus, the overall profit of firm 1 is given by $\Pi_1^A(K_2) = q_1^A(K_2)^2 + F^{\max}(K_2)$.

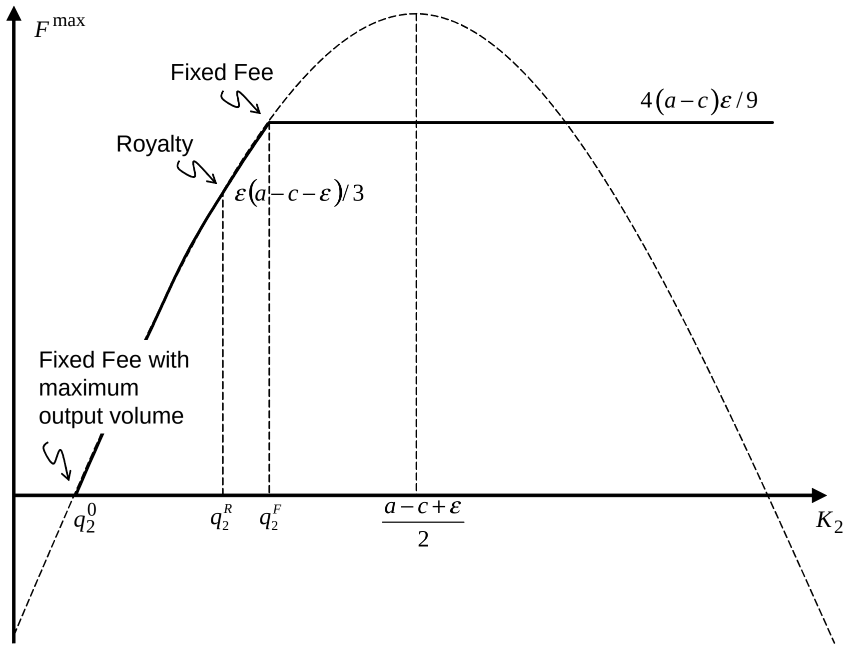

Figure 1: The three licensing scheme: royalty, fixed fee, fixed fee with production constraint.

Note that this licensing method can replicate the previous cases. In particular, if firm 1 sets $K_2 = q_2^R$ we obtain $\Pi_1^A\left(q_2^R\right) = \Pi_1^R$, and when $K_2 = q_2^F$ we have $\Pi_1^A\left(q_2^F\right) = \Pi_1^F$.

Moreover, it is simple to show that $d\Pi_1^A(K_2)/dK_2 = -K_2/2 < 0$, meaning that firm 1 can increase its profits by reducing the maximum authorized production.

This fact provides a clear interpretation of the result of Proposition 3. In fact, since a royalty scheme reduces the output of the opponent with respect to a fixed fee, i.e. $q_2^R < q_2^F$, the royalty method produces higher profits for firm 1 with respect to the fixed fee method without output restrictions, i.e. $\Pi_1^F < \Pi_1^R$.

Extending this result to a more general case, it is worth noting that firm 1's profits are inversely related to the output of the opponent, i.e. the lower firm 2's output, the higher firm 1's profits. Thus, when firm 1 chooses the maximum authorized quantity such that $K_2 < q_2^R$ and the fixed fee is equal to $F^{\max}(K_2)$, it gains more profits than under a royalty contract.

Figure 1 depicts the optimal licensing fee depending on the maximum output licensed, assuming that firm 1 charges the fixed fee equal to the highest payment that induces the participation of firm 2. The largest licensing revenue corresponds to the fixed fee contract without any production constraint. Reducing the maximum authorized production, the licensing payment which firm 1 can obtain decreases. When $K_2 = q_2^0 = (a-c+\varepsilon)/2 -$

$\left((a-c-\varepsilon)^2/36+(a-c)\,\varepsilon\right)^2$, where $0 < q_2^0 < q_2^R$, the fixed fee is zero, and for smaller values the licensing payment is negative. When $K_2 = 0$, the negative payment corresponds to the profits firm 2 receives if it rejects the contract. Although the licensing payments decrease in K_2, the prepayment profits of the licensor are always sufficient to compensate this reduction. The following proposition compares firm 1's returns from the two licensing methods.

Proposition 4 *Licensing by means of a fixed fee $F \geq 0$ with a maximum authorized production level K_2 dominates licensing by means of a royalty, provided that $q_2^0 < K_2 < q_2^R$ and $F = F^{\max}(K_2)$. In addition, the lower the output of firm 2, the higher the profit of firm 1.*

Proof. Since $\Pi_1^A\left(q_2^R\right) = \Pi_1^R$ and $d\Pi_1^A(K_2)/dK_2 = -K_2/2 < 0$, choosing K_2 such that $q_2^0 < K_2 < q_2^R$ produces higher profits than licensing by means of a royalty. ■

Proposition 4 implies that reducing the output of the opponent increases the profit of firm 1. The maximum profit for firm 1 is when firm 2 produces nothing, i.e. when $F < 0$. Assuming that firm 1 can not choose a negative fee, i.e. $F \geq 0$, it is optimal for firm 1 to choose $F = 0$ and $K_2 = q_2^0$. These simple considerations show that a patent holder which is participating in production has a strong incentive to reduce the opponent's production. This is the reason why this practice must be carefully monitored by the antitrust authority.

3 Conclusions

In this paper we have shown that licensing by means of a fixed fee with maximum authorized production is superior to licensing by means of a royalty per unit when the licensor is a producer within the industry. In a Cournot duopoly model, the reduction of the licensing revenue caused by restricting the maximum production is, in general, outweighted by direct profits earned by the patentor as a result of larger market shares.

The strong incentive to reduce the participation of the rival with the consequence of negative welfare implications raises important questions in terms of antitrust policy.

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