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Licensing endogenous cost-reduction in a differentiated Stackelberg model

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ABSTRACT

In this paper we consider a differentiated Stackelberg model, when the leader firm engages in an R&D process that gives an endogenous cost-reducing innovation. The aim is to study the licensing of the cost-reduction by a two-part tariff. By using comparative static analysis, we conclude that the degree of the differentiation of the goods plays an important role in the results. We also do a direct comparison between our model and Cournot duopoly model.

1. Introduction

Technology transfer between firms can be done with many significant methods. One of these methods is *licensing*. Licensing contracts cover a wide range of well-known situations. For example, a production firm might achieve the license for a proprietary production technology from another firm which owns it, in order to gain a competitive edge, rather than expending the time and money trying to develop its own technology. So, a licensing agreement is a legal contract between two parties: the licensor and the licensee. Hence, in a typical licensing agreement, the licensor grants the licensee the right to produce and sell goods, apply a brand name or trademark, or use patented technology owned by the licensor. In exchange, the licensee usually submits to a series of conditions regarding the use of the licensor's property and agrees to make payments under one of the followings forms: (i) a royalty on per-unit of output produced with the patented technology; (ii) a fixed-fee that is independent of the quantity produced with the patented technology; and (iii) a two-part tariff, i.e. a fixed-fee plus royalty.

Literature focused on licensing contracts in a wide variety of situations is vast. We recall the papers [1,2,4,5,8]. Zuniga and Guellec [20] made an interesting and useful study concerning the intensity of licensing to affiliated and non-affiliated companies, its evolution, the characteristics, motivations and obstacles met by companies doing or willing to license, pointing out at the end the fact that patent licensing is widespread. The theoretical literature regarding patent licensing reveals two types of licensors, namely, the outsider licensor (when it is an independent R&D organization and not a competitor of the licensee in the product market; for example, [7,9,11]) and the insider licensor (when competes with the licensee; for example, [10,14,16–19]).

In the present paper, we will analyse the pre-licensing case and licensing by means of a two-part tariff, in a differentiated-good Stackelberg duopoly, when the leader firm engages in an R&D process that gives an endogenous cost-reducing

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innovation. So, in our case the licensor is an insider. Also, we will analyse the social welfare implications. Based on the fact that in a survey of U.S. firms, Rostoker (1984) finds that royalty alone was used 39% of the time, fixed-fee 13% and royalty plus fixed-fee 46%, we analyse just the licensing case by a two-part tariff.

In [12], Li and Ji developed a duopoly model when one of the firms engages in an endogenous cost-reducing innovation and licenses its innovation to its rival firm. The authors consider the licensing in a duopoly market where the decisions on the level of outputs are made simultaneously (Cournot and Bertrand models). Our work differs by considering the duopoly in a Stackelberg model (sequential decisions). Furthermore, we do a comparative static analyses, showing how the results depend on the degree of the differentiation of the goods, a parameter that assumes a great importance in this paper, and, in fact, it plays an important role in some industrial markets. We also compare the results that we obtained in the Stackelberg model with the results for the Cournot model pointed out by Li and Ji [12]. Issues related to the study of this paper have been studied also by Ferreira and Ferreira [3], but the authors considered an international trade under Bertrand model, studying the maximum revenue tariff and assuming that the production costs for both firms are unknown.

The remained of the paper is organized as follows. Section 2 lays down the basic framework and derives our main purposes. Section 3 deals with case of pre-licensing as a benchmark. Section 4 derives the licensing contract. Section 5 yields the main results gained by a direct comparison between our Stackelberg duopoly model and the Cournot duopoly model presented in [12]. Conclusions are drawn in Section 6.

2. The basic framework

We consider a duopoly model where two firms, denoted by F_1 and F_2, produce a differentiated good. The inverse demand functions are given by $p_i = 1 - q_i - dq_j$, where:

- p_i represents the price of the firm $F_i,\ i = 1, 2$;
- q_i and q_j represent the outputs of firms F_i and $F_j,\ i,j = 1, 2, i \neq j$;
- d represents the degree of the differentiation of the goods, $d \in (0, 1)$.

The duopoly market is modeled as a Stackelberg competition: the leader choose its output level and then the follower is free to choose its optimal output taking into account the leader's output. So, the firms do not decide simultaneously the level of their outputs. Initially, both firms have identical unit production cost $c_i = c$, with $i = 1, 2$ and $0 < c < 1$. We consider that only the leader firm F_1 can engage in an R&D process in order to improve its technology. This allows a reduction of its production costs by an amount that we call *innovation size*. The cost-reducing innovation creates a new technology that reduces innovating firm's unit cost by the amount of k, while the amount invested in R&D is $k^2/2$. So, the innovation size is endogenous. There are many papers that use this approach to model process innovations, as [13,15]. However, in other papers the innovation size is exogenous, as [4,6]. So, firm F_1 (the leader) is the licensor and, in case the technology transfer occurs, firm F_2 (the follower) is the licensee.

In case there will be a technology transfer between the two firms, we consider the following five stages game. In the first stage, the innovator firm F_1 decides the value of the innovation size. In the second stage, the innovator firm F_1 decides whether to license the technology or not, because licensing reduces the marginal cost of the follower firm F_2. If decides to license it, then it charges a payment from the licensee (a combination of both royalty and fixed-fee). In the third stage, the firm F_2 decides whether to accept or reject the offer made by the firm F_1. Then, both firms represents the players of a Stackelberg game. So, in the fourth stage the firm F_1 decides its output; and in the last stage, the firm F_2 being aware of the leader's output, chooses the output to produce.

We will also analyse, the consumer surplus CS and the social welfare W, that are, respectively, defined by

$$CS = \frac{q_1^2 + 2dq_1q_2 + q_2^2}{2} \quad \text{and} \quad W = \pi_1 + \pi_2 + CS.$$

3. Benchmark case: pre-licensing

In the pre-licensing situation, firm F_1 owns a cost advantage on the market compared with firm $F_2 : c_1 = c - k$ and $c_2 = c$. Depending on the value of the differentiated parameter d, two cases can occur. Let $d_1,\ 0 < d_1 < 1$, be such that $d_1^2 + 2d_1 - 2 = 0$.[1] Hence, we have the following:

(A) if $0 < d < d_1$, then firm F_2 competes with firm F_1 with its old technology and gets positive profit (non-drastic innovation);

(B) if $d_1 \leqslant d < 1$, then firm F_2 find unprofitable to produce any positive output (drastic innovation). In this case, firm F_1 gains the monopoly.

Throughout the paper, we use the notation subscript nl to refer to the pre-licensing case. The profit functions of firm F_1 and firm F_2 are, respectively, given by

[1] We note that $d_1 \simeq 0.732$.