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The equivalence of profit-sharing licensing and per-unit royalty licensing

Shuai Niu *

School of Economics, Australian School of Business, The University of New South Wales, Sydney, NSW 2052, Australia

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ABSTRACT

In a duopoly with symmetric product differentiations, we prove that profit-sharing licensing and per-unit royalty licensing are equivalent to each other regarding both the profitability and the welfare influences.

1. Introduction

In this paper, we compare two licensing forms happening between competitors of different productivity, per-unit royalty licensing and profit-sharing licensing, regarding the profitability and the welfare influences.

Per-unit royalty licensing is a well analyzed topic in the literature, see for example Wang (1998) and Faulí-Oller and Sandonís (2002). Technology sharing between competitors has two opposite effects on joint profit. On the one hand, it raises the production efficiency of the backward firm and realizes cost savings, which helps to increase joint profit (the cost saving effect). On the other hand, it eliminates the initial cost difference and intensifies market competition, which tends to reduce joint profit (the reinforced competition effect). As per-unit royalty payment means a cost disadvantage to the licensee, the introduction of it can help to soften the reinforced competition effect and raise the profitability of technology sharing. That is why per-unit royalty payment is commonly observed when licensing happens between competitors.

In practice, technology transfer between enterprises is sometimes accompanied by equity transactions, for instance[1]

- In August 2005, CSIRO licensed new medical polymer technologies to PolyNovo, a company created by CSIRO and a biotechnology partner, and in return received, as its financial benefit, equity in PolyNovo.
- In 2006, Microsoft and Skinkers signed a technology for equity deal, under which Skinkers was granted the intellectual property rights for the peer-to-peer technology and Microsoft received a minority equity stake in Skinkers.

This phenomenon is usually known as profit-sharing licensing or equity licensing. In the previous literature, the theoretical studies on profit-sharing licensing happening between competitors are quite few. To the best of our knowledge, the only contribution comes from Mukhopadhyay et al. (1999). In that paper, the authors considered a pure profit-sharing licensing contract (profit-sharing licensing without fixed fee payment) and argued that this licensing form can motivate technology transfer when fixed fee licensing is not profitable. The rationale behind this result is that profit-sharing payment creates a positive pecuniary correlation between the licenser's profit and its competitor's and reduces the licenser's incentives to compete, which helps to soften the reinforced competition effect and raise the profitability of technology sharing (a function similar to per-unit royalty payment).

The above analysis tells us that both per-unit royalty payment and profit-sharing payment can help to soften the reinforced competition effect after technology transfer. Given this, it is nature to ask which mechanism is better from the standpoint of involved firms and which one is more socially desirable? To answer this question, in this paper we plan to conduct a formal comparison between these two licensing forms regarding the profitability and the welfare influences.

The remainder of this paper is organized as follows. Section 2.1 introduces the basic model setup. As a benchmark, Section 2.2 discusses the case without licensing. In Section 2.3, we analyze per-unit royalty licensing. The analysis on profit-sharing licensing is

* Corresponding author. Tel.: +61 425841206.
E-mail address: shuai.niu@unsw.edu.au.

[1] Detailed information is available at http://www.csiro.au/Organisation-Structure/Divisions/Materials-Science-Engineering/Biomedical-Materials/Achievements/PolyNovo.aspx and http://www.crunchbase.com/company/skinkers, respectively.

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conducted in Section 2.4. Section 2.5 compares these two licensing forms. In Section 2.6, we explore the consequence of relaxing the symmetry assumption on demands. Section 3 concludes with some remarks.

2. The model

2.1. Basic setup

Consider an industry with two differentiated goods, each produced by one firm. The inverse demand $p_i(q_1,q_2)$ has the following properties

$$p_i(q_1,q_2)=p_j(q_2,q_1),\frac{\partial p_i(q_1,q_2)}{\partial q_i}<0,\frac{\partial p_i(q_1,q_2)}{\partial q_j}<0, \tag{1}$$

where $i,j=1,2$ and $i\neq j$, which mean the own inverse demand function is negatively sloped, these two goods are symmetrically differentiated and are gross substitutes.

There is no fixed cost in production and the marginal variable cost is constant. Initially, there is a cost difference between two firms. Specifically, firm 1 is the advanced firm with marginal cost $c_1=c-x$ and firm 2 is the backward firm with marginal cost $c_2=c$. The initial cost gap is supposed to be non-drastic, which means that under Cournot competition the equilibrium outputs of these two firms are both positive.

Given the initial cost difference, technology sharing via licensing may be mutually profitable. Two licensing forms are to be considered in this paper, per-unit royalty licensing and profit-sharing licensing. Once agreement on per-unit royalty licensing is reached, the backward firm (the licensee) gets the advanced technology (which will reduce its marginal cost to $c-x$) and the advanced firm (the licenser) gets the payment

$$R=rq+F, \tag{2}$$

where r is the per-unit royalty rate, q is the licensee's output after technology transfer and F is the fixed fee. Under profit-sharing licensing, the backward firm gets the advanced technology and the advanced firm gets the payment

$$P=\theta\pi+F, \tag{3}$$

where $\theta\in[0,1]$ is the profit-sharing rate and π is firm 2's profit after technology transfer exclusive of the fixed payment F.

To specify how the licensing contract terms will be determined, by following Faulí-Oller and Sandonís (2002) we model the licensing process like this: the licenser first makes a take-it-or-leave-it offer to the licensee and then the licensee chooses to accept or reject the offer. Under this setting, firm 1 has a complete bargaining power and enjoys all the benefits from licensing, and firm 2 will accept the contract as long as licensing does not make it worse off.

As pointed out in the introduction part, variable payment (per-unit royalty payment or profit-sharing payment) under licensing is likely to damage (or soften) market competition after technology transfer. Therefore, it is reasonable for the government to impose some constraints on the contract terms. In this paper, we adopt a differentiated licensing policy and the specific requirements on each licensing form will be discussed in due course.[2]

Given all the above basic setups, we consider a two-stage game between firm 1 and firm 2. In the first stage, firm 1 decides whether or not to make the licensing offer and firm 2 decides to accept or reject the offer. If agreement on licensing is reached, firm 1 transfers its advanced technology and chooses r or θ to maximize its profit subject to firm 2's participation constraint and the government requirements. If firm 1 does not make the offer or firm 2 rejects it, the initial cost gap persists and there is no licensing payment. In the second stage, two firms compete with each other à la Cournot in the final product market.

2.2. The case without licensing

If at least one firm decides not to engage in licensing, in the second stage game the two firms' profit functions can be expressed as

$$\pi_i=p_i(q_1,q_2)q_i-c_iq_i=R_i-c_iq_i. \tag{4}$$

Each firm chooses output to maximize its own profit and the corresponding first-order conditions are

$$p_i(q_1,q_2)+q_i\frac{\partial p_i(q_1,q_2)}{\partial q_i}-c_i=0. \tag{5}$$

From the first-order conditions, we can get the equilibrium outputs without licensing, q_1^N and q_2^N. Substitute them back into the profit functions, the equilibrium profits without licensing can be derived, π_1^N and π_2^N.

To satisfy the second-order conditions and the stability requirements on reaction functions, by following Brander and Spencer (1983) we assume

$$\frac{\partial^2 R_i}{\partial q_i^2}<\frac{\partial^2 R_i}{\partial q_j\partial q_i}<0. \tag{6}$$

This assumption means that increasing the output of firm i or j will both reduce the marginal revenue of firm i, but own effect exceeds cross effect.

2.3. Per-unit royalty licensing

If agreement on per-unit royalty licensing is reached, in the second stage game the profit functions can be expressed as

$$\pi_1=p_1(q_1,q_2)q_1-c_1q_1+rq_2+F, \tag{7}$$
$$\pi_2=p_2(q_1,q_2)q_2-(c_2-x)q_2-rq_2-F.$$

Each firm chooses output to maximize its own profit and the corresponding first-order conditions are

$$p_1(q_1,q_2)+\frac{\partial p_1(q_1,q_2)}{\partial q_1}q_1-c_1=0, \tag{8}$$
$$p_2(q_1,q_2)+\frac{\partial p_2(q_1,q_2)}{\partial q_2}q_2-c_2+x-r=0.$$

From the first-order conditions, we can derive the equilibrium outputs, $q_1(r)$ and $q_2(r)$. The second-order conditions and the stability requirements on reaction functions are satisfied under Eq. (6).

Before turning to the analysis of the first stage game, we would like to introduce a government constraint on per-unit royalty licensing, $F\geq 0$, which is commonly adopted in the literature. According to Shapiro (1985), this constraint avoids the possibility that the licensing contract be strategically used by involved firms to facilitate colluding. Actually, there is an alternative explanation to it.

Lemma 1. *$F\geq 0$ is equivalent to $r\leq x$.*

Proof. From Eqs. (7) and (8), we can get firm 2's equilibrium profit under per-unit royalty licensing $-\frac{\partial p_2(q_1,q_2)}{\partial q_2}q_2^2-F$. The participation constraint requires that $-\frac{\partial p_2(q_1,q_2)}{\partial q_2}q_2^2-F\geq\pi_2^N$. As firm 1 has a complete

[2] In contrast to the differentiated licensing policy is the uniform licensing policy, under which the same constraint is imposed on different licensing forms. We will briefly talk about the difference between these two licensing policy schemes in the concluding section.