Economic Modelling 31 (2013) 297–307

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Patent licensing under cost asymmetry among firms ☆

Kuang-Cheng Andy Wang [a], Wen-Jung Liang [b,*], Pin-Shu Chou [c]

[a] Social Science Division, Center for General Education, Chang Gung University, Taiwan, ROC
[b] Department of Economics, National Dong Hwa University, Taiwan, ROC
[c] Institute of Economics, National Sun Yat-sen University, Taiwan, ROC

ARTICLE INFO

Article history:
Accepted 16 November 2012

JEL classification:
D43
D45
L13

Keywords:
Patent licensing
Insider patentee
Cost differential firms
The protection effect
The efficiency effect

ABSTRACT

This paper extends Poddar and Sinha's (2010) duopolistic model to an oligopolistic model consisting of three cost differential firms engaging in Cournot competition. The focus of the paper is on the impact of the differences in efficiency among the three firms on the choices of the patentee's optimal licensing contract. By confining the number of licenses to one license only, the paper derives a more comprehensive result than that in Poddar and Sinha (2010). In addition, it shows that the insider patentee may choose pure fixed-fee, mixed or pure royalty licensing regardless of licensing to one or two licensees. This paper also proves that the optimal licensing contract can be either exclusive or non-exclusive, depending upon the relative cost advantage between the two licensees.

1. Introduction

This paper examines the optimal licensing contract by extending Poddar and Sinha's (2010) duopolistic model to an oligopolistic model consisting of three cost differential firms engaging in Cournot competition. It differs from their paper in two respects. Firstly, the patentee's marginal cost is assumed to be lower than that of the licensees as licensing is absent, but it can be either larger or smaller than that of the licensees after the innovation is licensed. By contrast, the patentee's marginal cost is always larger than that of the licensee in Poddar and Sinha (2010). Secondly, the patentee can choose to license its innovation to one or two licensees in this paper, while there is only one licensee in Poddar and Sinha (2010). Thus, by confining the number of licenses to one license only, we can analyze the case where the licensee can wrest the unlicensed firm's market share and profit, which is unable to be discussed in Poddar and Sinha (2010). Moreover, we can examine the optimal number of licensees to be more than one license.

In the literature on patent licensing, researchers apart from Poddar and Sinha (2010) usually assume that licensing decreases the licensees' marginal cost to the same level as that of the patentee. This strand of the literature includes Kamien and Tauman (1986) and Kamien et al. (1992), who examine the optimal licensing contract by assuming that the patentee is outside the industry, while Wang (1998, 2002), and Fosfuri and Roca (2004) regard it as inside the industry. In addition, Kamien and Tauman (2002), Liao and Sen (2005) and Sen and Tauman (2007) explore the cases where the patentee can be either an insider or an outsider.

Poddar and Sinha (2010) is the first paper to take into account the asymmetry of the production cost between the patentee and the licensee. They use a duopolistic model to examine the nature of the licensing contract if the licensee's marginal cost is lower than that of the patentee after the licensee accepts the license. One of their main contributions is that, under non-drastic innovation, the optimal licensing contract is characterized by pure fixed-fee, mixed (a fixed-fee and a linear royalty per unit of output) or pure royalty licensing, as the licensee's cost advantage relative to the patentee is large, medium or small, respectively. By contrast, this paper derives a more comprehensive result. We show that by confining the number of licenses to one license only, the optimal licensing contract is fixed-fee licensing if the licensee has a production cost advantage relative to the patentee after the innovation is

☆ We are indebted to anonymous referees for inducing us to improve our exposition and for offering several suggestions leading to improvements in the substance of the paper. The first author would like to thank for the financial support from National Science Counsil, Taiwan. (NSC98-2410-H-182-009).

* Corresponding author at: Department of Economics, National Dong Hwa University, Shoufeng, Hualien 97401, Taiwan, ROC. Tel.: +886 3 8635538; fax: +886 3 8635530.
E-mail address: wjliang@mail.ndhu.edu.tw (W.-J. Liang).

0264-9993/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.econmod.2012.11.025

licensed, and is mixed or royalty licensing only when the patentee has a relative production cost advantage. The reason why our result differs from that of Poddar and Sinha (2010) can be stated as follows. We show in this paper that, by using fixed-fee licensing, the patentee can increase its profit in one of two ways. Firstly, fixed-fee licensing can enhance the licensee's efficiency by decreasing its production cost. Secondly, the licensee can wrest the unlicensed firm's market share and profit. Owing to there being no unlicensed firm present in their model, the latter effect is absent in Poddar and Sinha (2010) so that the incentive for the patentee to choose pure fixed-fee (or mixed) licensing is stronger in this paper compared to that in Poddar and Sinha (2010).

Empirical studies show that fixed-fee, royalty and mixed (fixed-fee plus royalty) licensing are popular licensing contracts employed by the patentee. Rostoker (1984) shows that royalties alone account for 39%, fixed fees alone for 13%, and royalties plus fixed fees for 46% of licensing contracts. Macho-Stadler et al. (1996) indicate that royalties alone account for 62.25%, fixed fees alone for 25.3%, and mixed licensing for 12.5%. Moreover, Caballero-Sanz et al. (2005) refer to the survey report published by the Association of University Technology Managers Licensing which states that about half of the licenses are exclusive, while the other half are non-exclusive.[1] These figures demonstrate that, in the real world, not only are fixed-fee, royalty or mixed licensing popularly selected by the patentee, but the patent may also be licensed either exclusively or non-exclusively. Thus, it is crucial to explore the conditions for licensing under which the patentee will choose fixed-fee, royalty or mixed licensing with an exclusive or a non-exclusive license.

Based on the above analysis, the purpose of this paper is to explore the following two issues by taking into account cost asymmetry among three firms under the situation where the licensor serves as an insider patentee, as firms produce a homogeneous product and engage in Cournot competition. Firstly, what is the insider patentee's optimal licensing contract in terms of fixed-fee, royalty and mixed licensing? Secondly, does the insider patentee license the patent exclusively?

The main findings of the paper are as follows. First of all, by confining the number of licenses to one license only, the paper derives a more comprehensive result than that of Poddar and Sinha (2010). Secondly, this paper shows that given that firms exhibit cost asymmetry and that a k non-drastic innovation is satisfied, the insider patentee may still choose fixed-fee or mixed licensing regardless of licensing to one or two licensees. Thirdly, it proves that the optimal number of licenses can be either one or two licenses, depending upon the relative cost advantage between the two licensees.

The remainder of the paper is organized as follows. Section 2 sets up a benchmark model where the patent licensing is absent. Section 3 examines the optimal licensing contract when the patentee licenses its patent either exclusively or non-exclusively and explores the optimal number of licenses. Section 4 presents several further discussions. The final section concludes the paper.

2. The benchmark model

Consider an industry consisting of three cost differential firms. Firm i's cost function is denoted by $TC_i(q_i)=c_iq_i$, $i=1, 2, 3$, where q_i is firm i's output and each firm's marginal cost is assumed to be constant having the following relationship $0\le c_1\le c_2\le c_3$. Firms produce a homogeneous product and engage in Cournot competition in the market. Assume that firm 1 has a patent over an innovation. By accepting this patent, firm n's marginal production cost can be reduced to $c_n-\varepsilon$ for $n=2, 3$. Assume further that the licensee's marginal cost $c_n-\varepsilon$ can be smaller (larger) than the patentee's marginal cost c_1 if firm n is more (less) efficient than firm 1 by accepting the license.

The game employed in the paper involves three stages. In the first stage, firm 1 simultaneously selects the licensed firm, viz., firm 2, firm 3 or both firms, and the optimal licensing contract, viz., a fixed-fee, royalty or mixed contract. In the second stage, the licensed firm chooses to accept or reject the offer provided by firm 1. Finally, the three firms engage in Cournot competition in the market. In order to exclude the possibility of collusion among firms, it is required in this paper that the royalty rate r and the fixed-fee F be non-negative.[2] It is assumed that the inverse demand function takes the following form $p=a-Q$, where p denotes the price level, Q is the quantity of market demand, and a is a constant. In what follows, we first discuss the equilibria under the case where the patent licensing is absent, and concentrate our analysis on the case where innovation is non-drastic.

Given the case where the patent licensing is absent, the Cournot equilibrium output is derivable as:

$$q_i^N=\frac{\left(a-3c_i+c_j+c_k\right)}{4},\quad i,j,k=1,2,3,\quad i\neq j\neq k,$$

where the superscript "N" denotes the variables associated with the case where the patent licensing is absent.

Firm i's profit level can be derived by the above equation as:

$$\pi_i^N=\frac{\left(a-3c_i+c_j+c_k\right)^2}{16},\quad i,j,k=1,2,3, i\neq j\neq k. \tag{1}$$

Since we only analyze the case where innovation is non-drastic in the paper, it is necessary for us to figure out the restriction caused by the non-drastic innovation. Following the definition of Arrow (1962), an innovation is deemed to be non-drastic if the patentee's (firm 1's) monopoly price is higher than the least efficient firm 3's marginal cost before the innovation is licensed, i.e., $c_1>2c_3-a$.[3] Moreover, according to the definition of k non-drastic innovation by Sen (2005) and Sen and Tauman (2007), the duopoly price determined by firms 1 and 2 has to be higher than firm 3's marginal cost when firm 2 accepts the license, i.e., $c_1>3c_3-a-c_2+\varepsilon$.[4] Since the latter restriction is more stringent than the former due to $c_2\le c_3$, the analysis of this paper is subject to the latter restriction being applied throughout the paper.

[1] In this paper, an exclusive license can be referred to as the case where only one or some of the firms acquire the patent license from the patentee, while a non-exclusive license is referred to as the case where all of the firms acquire the license.

[2] Fosfuri and Roca (2004, p. 15) and Liao and Sen (2005, p. 291) indicate that firms may collude if $r<0$ or $F<0$. This will violate the anti-trust law. Thus, we assume that $r\ge 0$ and $F\ge 0$ in this paper.

[3] We can derive the restriction $c_1>2c_2-a$ due to $c_2\le c_3$. This restriction shows that if firm 1 cannot drive firm 3 out of the market by charging a monopoly price, then it cannot force firm 2 out of the market because firm 2 is more efficient than firm 3.

[4] See Sen (2005, p. 143) and Sen and Tauman (2007, p. 169) for the case where $k=2$.