Patent licensing under financial structure with limited liability

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ABSTRACT

In a seminal paper, Kamien and Tauman (1986) show that fixedfee licensing is always superior to royalty licensing for the outsider licensor under Cournot competition. However, empirical studies demonstrate that royalty licensing is much more popular than fixed-fee licensing. We attempt to reconcile this controversy by taking into account the financial structure of firms with limited liability. We show that the optimal licensing contract under Cournot competition is royalty licensing if the mean-preserving variance of demand is large, while it is non-exclusive fixed-fee licensing otherwise. Moreover, this result is robust under mixed licensing contract and an oligopolistic market.

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1. Introduction

In a seminal paper on patent licensing, Kamien and Tauman (1986) show that fixed-fee licensing is *always* superior to royalty licensing for the outsider licensor who owns a cost-reducing innovation, when firms produce a homogeneous good and engage in Cournot competition in the commodity market. Subsequently, Kamien, Oren, and Tauman (1992) confirm the same result by using a generalized demand function. Nevertheless, the empirical literature, such as Rostoker (1984), shows that royalties alone account for 39%, fixed fees alone for 13%, and royalties plus fixed fees for 46% of licensing contracts. In addition, Macho-Stadler, Martinez-Giralt, and Perez-Castrillo (1996) and Jensen and Thursby (2001) also consistently point to the prevalence of royalty licensing. Thus, the findings of empirical studies demonstrate that royalty licensing is much more popular than fixed-fee licensing. This creates significant interest in explaining the rationale for choosing royalty licensing in licensing contracts.

The superiority of royalty over fixed-fee licensing for the outsider licensor has been derived in the literature. In relation to this, Beggs (1992) emphasizes the role of asymmetric information; Muto (1993) points out the influence of product

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differentiation under Bertrand competition; Bousquet, Cremer, Ivaldi, and Wolkowicz (1998) highlight risk sharing; Macho-Stadler et al. (1996) and Jensen and Thursby (2001) focus on moral hazard; Saracho (2002) shows that a sales delegation game is crucial; and Poddar and Sinha (2004) refer to the influence of spatial competition in a Hotelling linear city model. Amir, Encaoua, and Lefouili (2014) prove that patent holders may prefer royalties to fixed-fee contracts by taking into account patents whose validity is uncertain.[1] Wang, Tseng, and Liang (In press) consider trade barriers in a two-country model with Bertrand competition. Unfortunately, the existing literature completely ignores an important feature of the modern corporation, namely, the financial structure of firms with limited liability. It is well recognized that firms usually issue debt to finance their production in a modern economy. Thus, it is interesting to examine the optimal licensing contract in a framework where the financial structure of firms with limited liability is involved.

Limited liability is an important feature of modern corporations. By appealing to limited liability, shareholders will not need to provide anything when corporations go into bankruptcy. Thus, shareholders will care about raising returns in good states only, while ignoring reductions in returns in bankrupt states. In their pioneering papers, Brander and Lewis (1986, 1988) indicate that by referring to the limited liability effect, a rise in debt financing will influence firms' output strategies. When the cost of bankruptcy is zero, a higher level of debt financing will increase firms' outputs.[2] The key point of this result is that an increase in debt financing raises the probability of bankruptcy and the shareholders take limited responsibility for their shares only under bankruptcy, so that firms will increase their outputs to raise returns in good states and lower returns in bad states.

Based on the above analysis and assuming that the leveraged firms produce a homogeneous good and engage in Cournot competition, this paper attempts to take into account the financial structure and limited liability of firms in a model with an outsider licensor in order to examine the optimal licensing contract in terms of fixed-fee and royalty licensing. To the best of our knowledge, a study on this issue has not yet been touched upon. This paper aims to fill this gap.

By using fixed-fee licensing, an outsider licensor can decrease the licensees' marginal production cost and increase their outputs. The conventional wisdom indicates that as the degree of competition in Cournot competition becomes less severe, the outsider licensor can earn a higher profit by choosing fixed-fee licensing as opposed to royalty licensing. Kamien and Tauman (1986) and Kamien et al. (1992) support this result. However, by taking into account the debt financing of the leveraged firms with limited liability, the main result derived in this paper is that the optimal licensing contract for the outsider licensor is royalty licensing in a model where firms produce a homogeneous product and engage in Cournot competition when the mean-preserving variance of demand is large, while it is non-exclusive fixed-fee licensing otherwise. The reason for this result is that choosing fixed-fee licensing by an outsider licensor will cause the licensees to raise their debt financing and then their outputs. This demonstrates that choosing fixed-fee licensing enhances the degree of competition in the industry when debt financing and limited liability are involved. From the viewpoint of an outsider licensor, the superiority of fixed-fee licensing over royalty licensing will decline in order to decrease the degree of competition, if choosing fixed-fee licensing will result in excessive competition in the industry. In this paper, we show that the larger the variance of demand (represented by a larger upper bound of the demand shock), the more intense will be the competition in the industry. As a result, the optimal licensing contract is royalty licensing when the mean-preserving variance of demand is large. Moreover, since the intensity of competition increases as the variance of demand rises, this paper reaches the main finding by relying on an *endogenous* way of varying the intensity of competition under Cournot competition. By contrast, Muto (1993) obtains a similar result under Bertrand competition by imposing an exogenous assumption on the competitive environment (i.e., that firms compete in Bertrand fashion with differentiated products). Therefore, this paper provides a new explanation for the previous literature to justify the superiority of a royalty to a fixed-fee licensing contract through an endogenous approach of varying the intensity of competition.

The remainder of the paper is organized as follows. Section 2 sets up a basic model to analyze the case where patent licensing is absent. Section 3 and Section 4 examine the optimal number of licenses under fixed-fee licensing and the optimal royalty rate under royalty licensing, respectively. Section 5 explores the outsider licensor's optimal licensing contracts in terms of fixed-fee and royalty licensing. Section 6 acquires the robustness of the main result derived in this paper by using the mixed licensing contract and an oligopolistic market. The final section concludes the paper.

2. The basic model

Consider two leveraged firms denoted as 1 and 2 in an industry that sells a homogeneous product. The firms can issue debt to the public and to financial institutions, and engage in Cournot competition in the commodity market. In addition, there is a patent holder standing outside the market and having a process innovation, which can reduce the production cost of the licensee by (εq_i) where ε denotes the innovation size. In order to ensure an interior solution for the optimal debt level, we assume that the cost function is quadratic in output denoted as $C_i = cq_i + q_i^2$, $i = 1, 2$, where q_i is firm i's output, and c is a

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[1] Sen and Tauman (2007) consider the incentive for cost-reducing R&D conducted by an outsider licensor, and show that a pure royalty can never be an optimal licensing contract under Cournot competition. For the case where the licensor is an insider competing with the licensees in the industry, the typical result is that royalty licensing is superior to fixed-fee licensing. This result can be found in Katz and Shapiro (1985) and Wang (1998).

[2] When the cost of bankruptcy is greater than zero, the effect of debt financing on the output depends upon the amount of debt and the cost of bankruptcy.