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Per unit vs. ad valorem royalties under asymmetric information

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ABSTRACT

We study an inside patent holder's optimal licensing policy when it has imperfect information about the value of the patent to its rival. The patent holder can choose any two-part licensing fee with either per unit or ad valorem royalties. We demonstrate that the equilibrium will be either a fully separating contract with different per unit royalty rates, or a contract with a single ad valorem royalty that excludes a high cost rival. Fixed fees will not be used. The presence of asymmetric information uniquely drives the per unit royalties that otherwise would not be adopted. Per unit royalties always generate higher social welfare than ad valorem royalties.

1. Introduction

License structure determines the rents earned by patent holders and, as a consequence, the incentive to distribute innovations and to invest in them in the first place (Shapiro, 1985). In choosing a license structure, patent holders face a critical choice between licensing by fixed-fees, by royalties or by a combination of the two (Kamien and Tauman, 1986). Moreover, if patent holders use royalties, they face the option of those being collected ad valorem or per unit. The choices of how to license and to whom to license influence not only the return on patents but also the likelihood of collusion, the success of competition after the patent expires and the antitrust response (see Rockett, 1990 and Eswaran, 1994). As a consequence, it is not surprising that economists have invested substantial effort in understanding how firms license patents.

Typically, an inside patent holder (one that is already producing the product) adopts a royalty in order to put its rivals at a competitive disadvantage. Yet, this finding assumes that the patent holder has full information about how the patent influences its rival's cost (see Sen and Tauman, 2007 and Colombo, 2012 for recent contributions). We argue that this may be unrealistic and, as a consequence, we explore for the first time in the literature an insider's optimal license structure when its Cournot duopoly rival holds private information about its realized marginal cost. At the time of licensing we allow a dichotomous realization of constant marginal cost to be known by the licensee but not the patent holder.

Our setting captures several important aspects of patent licensing. First, patent licensing by insiders to rivals is very common.[1] Second, the realized value of a patent may, indeed, be unknown to the holder when licensing occurs. This value likely depends on intrinsic features of the rival licensee that are not easily observed such as how a rival's management and workforce implement a technological innovation designed elsewhere for a different production facility. Such incomplete information may be especially likely when the patent holder is entering a new market against a largely unknown rival. For example, Fiat began selling and eventually producing tractors in China in the 1980s and

[1] For example, Taylor and Silberston (1973) find that in their sample of 600 UK patent licenses more than three-quarters are between firms whose main operations are in the same industry. Such knowledge sharing can be critical in fostering industrial competitiveness. Streb (2003) finds that the exceptional international competitiveness of the West German plastics industry resulted from an above-average willingness to share innovations with customers and competitors including chemical firms, plastic fabricators and machine makers.

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also decided to license its technology to the previous near monopoly of China First Tractor.[2] It seems unlikely that Fiat would know with precision the consequences of such licensing on the costs of China First Tractor. Far from being an unusual example, it strikes us that such incomplete information may be common and worthy of exploration. Third, instead of examining the performance of fixed fees vs. royalties as in much of the literature, we examine a more general two-part tariff (any combination of fixed fee and royalty). Such two-part tariffs have proven valuable for information revelation in other settings such as supply contracts (Corbett et al., 2004), have been emphasized in general for strategic contracting (Saggi and Vettas, 2002) and are observed in actual patent licensing (Rostocker, 1984; Vishwasrao, 2007). Fourth, we compare the choice of per unit royalties with ad valorem royalties. While per unit royalties drew initial attention by the literature, more recent work emphasizes that ad valorem royalties are both frequent in practice and also typically superior for patent holders in models of complete information (Bousquet et al., 1998; San Martin and Saracho, 2010; San Martin, 2012).

Our exploration of this setting proves valuable as it confirms some existing conclusions in a more general model but also critically modifies other conclusions from the recent literature.

The results show that with either per unit royalties or ad valorem royalties, the optimal contract can be fully separating with the rival choosing a license structure that reveals its hidden cost. Yet, when the difference between the realized marginal costs is substantial, an excluding contract will emerge instead. In this contract only a rival with the larger realized cost savings will be licensed. Surprisingly, the two-part fee emerges as irrelevant and fixed fees are not part of the optimal contract under either type of royalty. In the separating equilibrium the rival simply chooses either a higher or lower royalty rate and in the excluding contract the patent holder presents only a single royalty rate. Thus, our work serves to emphasize the importance of royalties even with asymmetric information and with the possibility of two-part tariffs. The existing empirical evidence seems to broadly match this prediction.[3]

Our comparison of royalty types reverses the prediction from complete information models that ad valorem royalties will be routinely preferred to per unit royalties (see, for example, Bousquet et al., 1998; San Martin and Saracho, 2010; San Martin, 2012). When the rival's probability of having a low cost is small, the innovator adopts a separating contract using per unit royalties. The use of per unit royalties turns uniquely on the incomplete information. When the rival's probability of having a low cost rival is high, it adopts an excluding contract using ad valorem royalties. The complete information outcome emerges as a limit case in our analysis where the probability of the rival having low cost goes to one and so the ad valorem contract is always optimal.

With both per unit royalties and ad valorem royalties, the existence of an excluding contract implies that asymmetric information generates inefficiency by creating the chance that socially beneficial licensing will simply not occur.[4] This differs from the otherwise similar complete information setting where an innovator always finds it optimal to license a non-drastic innovation.[5]

Our focus on the optimal license structure of an inside innovator facing asymmetric information combines two strands of literature for the first time. A previous literature focuses on patent licensing by an insider with symmetric information. The licensing choice of an inside innovator typically differs from that of an external innovator.[6] While a fixed fee often allows an external innovator to capture the full willingness to pay, an insider cares not only about fee revenue but the influence of licensing on its position in the product market. As a consequence, an insider typically charges a per unit royalty which becomes part of the licensees' marginal cost. Charging the royalty thus generates fee revenue and simultaneously provides the inside innovator a cost advantage over rivals that allows it to be more aggressive and profitable in the product market. The insider earns greater total profit (the sum of license revenue and profit from production) using per unit royalties rather than a fixed fee — see Wang (1998), Wang and Yang (1999), Kamien and Tauman (2002), Sen and Tauman (2007), Fauli-Oller and Sandonis (2002) and Colombo (2012). We incorporate a realistic aspect of asymmetric information which generates augmented predictions regarding optimal licensing. These include the showing that different types of rivals may obtain the license at different prices and a unique prediction that non-drastic innovations are not always licensed.

Previous research has introduced asymmetric information into models of patent licensing but this literature routinely examines an external innovator (one not producing the product). Gallini and Wright (1990) and Macho-Stadler and Pérez-Castrillo (1991) examine the case in which the innovator holds better information about the quality of the patent. Beggs (1992) focuses on the existence of different types of firms and contracts and explains why a royalty might uniquely emerge under asymmetric information. Sen (2005) considers patent licensing by an external innovator to a monopolist with private cost information. Fan et al. (2013) consider a revelation process in which a finite set of firms reporting the largest cost reductions are awarded fixed fee licenses but all others obtain a license with a royalty. Our analysis differs from these papers by looking at the optimal licensing strategies of an insider. Traditionally inside and external innovators have been shown to face different incentives and to adopt different licensing structures (Kamien and Tauman, 1986), thus we expand the consideration of asymmetric information to the decision of the inside innovator.

Finally, our paper contributes to recent work comparing different types of royalty licensing contracts. San Martin and Saracho (2010) compare ad valorem royalties and per unit royalties when firms compete in Cournot fashion under symmetric information. San Martin (2012) considers the case of a differentiated duopoly. Niu (2013) establishes the equivalence between profit-sharing licensing and per-unit royalty licensing under complete information. Colombo and Filippini (2014) consider firms competing in a Betrand fashion. None of these contributions consider the impact of asymmetric information and this distinguishes our paper.

The remainder of the paper is organized as follows. Section 2 sets out the basic model that is applicable to both per unit and ad valorem royalties. In Section 3 we analyze the optimal two-part licensing fee with a per unit royalty. In Section 4, we analyze the optimal contract with an ad valorem royalty. In Section 5, we compare the profitability and the social welfare of per unit and ad valorem royalties. Section 6 concludes and suggests avenues for further research. All proofs are in Appendices. Those for the critical lemmas and all propositions are in Appendix A to the paper but as the proofs of Lemmas 4–6 are straightforward applications of earlier proofs they are in a Supplementary appendix.[7]

2. The model

An inside innovator (firm 1) licenses a non-drastic process innovation to a rival (firm 2). Prior to licensing, the innovator has a constant marginal cost $c_1 = 0$ and the rival has a constant marginal cost $c_2 = \bar{c}$.

[2] China First Tractor held a share of above 90% in China's crawler tractor market prior to the entry of Fiat Jiao, 2012.

[3] Rostocker (1984) finds that a royalty alone is used in 39% of licenses, that a royalty together with a fixed fee is used in 46% of licenses and that a fixed fee alone is used in only 13% of licenses. Calvert (1964), Taylor and Silberston (1973), and Macho-Stadler et al. (1996) report similar percentages.

[4] Thus, as Hegde and Luo (2013) recognize, frictions such as asymmetric information hinder the smooth functioning of the market and delay, or even block, mutually profitable transactions.

[5] A drastic innovation is one that lowers the innovator's costs so dramatically that it becomes a monopoly and has no incentive to license. Wang (1998) and San Martin and Saracho (2010) show that with perfect information all innovations short of this (non-drastic) will be licensed.

[6] For recent contributions on external innovators see, for example, Giebe and Wolfstetter (2008), Li and Wang (2010) and the references therein.

[7] The supplementary appendix can be found at http://dx.doi.org/10.1016/j.ijindorg.2014.07.005.