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Patent pools and dynamic R&D incentives

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ABSTRACT

Patent pools are cooperative agreements between two or more firms to license their related patents as a bundle. In a continuous-time model of multistage innovations, we characterize firms' incentives to perform R&D when they anticipate the possibility of starting a pool of complementary patents, which can be essential or nonessential. A coalition formation protocol leads the first innovators to start the pool immediately after they patent the essential technologies. The firms invest more than in the no-pool case and increase the speed of R&D for essential technologies as the number of patents progresses to the anticipated endogenous pool size, to the benefit of consumers. There is overinvestment in R&D compared to a joint profit-maximization benchmark. If firms anticipate the addition of nonessential patents to the pool they reduce their R&D efforts for the essential patents at each point in time, resulting in a slower time to market for the pooled technologies.

1. Introduction

Patent pools are cooperative agreements among several firms to license as a bundle their respective patents to third parties. Although patent pools have long been suspected of facilitating the implementation of anti-competitive behavior, regulatory authorities do recognize the potential virtues of patent pools, including "integrating complementary technologies, reducing transaction costs, clearing blocking positions, decreasing infringement litigation and the uncertainties related to it, and promoting the dissemination of technology" (US Department of Justice and Federal Trade Commission, 2007, pp. 84–85).[1] By allowing one-stop shopping, the pool gives access to more efficient licensing. Thus, the pool can increase the private value of the constitutive patents and also social welfare by facilitating the diffusion of innovations. As a consequence of this more favorable position, patent pools re-emerged in the recent years, mainly in high-technology sectors.[2] Examples include MPEG-2 (1997), MPEG-4 (1998), Bluetooth (1998), DVD-ROM (1998), DVD-Video (1999), 3G-Mobile Communications (2001), One-Blue (2009). Pools have also formed in the pharma/biotech industry. Examples include the POINT (Pool for Open Innovation against Neglected Tropical diseases) and the Medicines Patent Pool, established in 2009 and 2010, respectively.[3]

The objective of this paper is to characterize the dynamic incentives to perform research and development (R&D) when firms anticipate from the outset participation in a patent pool. We construct a continuous-time model where R&D programs are described as a series of successive patent races in which firms interact strategically. The pool size is the outcome of a coalition formation protocol in which only successful innovators can participate. The pooling of complementary patents, which can be technically essential or nonessential, allows firms to coordinate their licensing behavior and thus increases the return on their investment. After the foundation of the pool, a late innovator can benefit from the bundled technologies if the firm contracts as a licensee with the pool initiators.

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[1] One reads a very similar statement in the Antitrust Guidelines for the Licensing of Intellectual Property (US Department of Justice and Federal Trade Commission, 1995, p. 28). For a comparative analysis with guidelines released by the European Commission, see Gilbert (2004).

[2] See Newberg (2000) and Merges (2001) for detailed descriptions of organizational forms and contractual provisions of past and current pooling arrangements.

[3] For a discussion on patent pools as a mechanism for more accessible genetic inventions, see Matthijs, Van Overwalle, Van Zimmeren, and Verbeure (2006). For more information on recent patent pools in the biopharmaceutical industry, see Matthijs, Vanhaverbeke, Vanneste, Van Overwalle, and Van Zimmeren (2011).

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As a result, in this setup the pool is started immediately after all essential technologies have been patented. The perspective of being among the pool initiators works as a prize and enhances the speed of R&D. Specifically, the equilibrium pattern of innovative efforts increases stepwise over time before the formation of the pool and falls to the no-pool level afterwards. The final race to the pool exhibits an overinvestment in R&D compared to a joint profit-maximization benchmark. We also find that firms' incentives to obtain the essential patents are diluted if a distortion occurs in the endogenous determination mechanism of the pool size so that the addition of nonessential patents is anticipated at the outset. The distortion implies strictly lower equilibrium R&D investments and a delayed expected time to market of the pooled technologies.

Most contributions to the economics literature on patent pools adopt an *ex post* perspective which follows antitrust practices for reviewing the impact on welfare of a pool after it was founded. The objective then is to identify what kind of pools should be authorized by the regulator. Shapiro (2001) examines this question in a pioneering contribution, where a simple model lends theoretical support to the idea that welfare is reduced when patents are substitutes (as in the case of goods coordinated by a cartel), and enhanced when patents are complements. In the latter case, royalty rates are reduced because the pool participants internalize the effect of their pricing on the demand for complementary patents. However, when all patents are substitutes, if firms determine the number of licensees in addition to the license Kato (2004) identifies circumstances in which a pool enhances social welfare. When all patents are complements, Aoki and Nagaoka (2005) show that a pool with all complementary technologies does not form when the number of patent holders is large. In an oligopoly model with an upstream patent licensing stage and a downstream production stage, Kim (2004) shows that vertical integration always lowers the price of the final product if there is a pool and all patents are complements. In a more general setup, Schmidt (2009) establishes that although vertical integration partially solves a double marginalization problem, it might also result in higher royalties and less output for the downstream market. Moreover, a merger at the upstream stage implies a reduction in total royalties and an increase in the output of the downstream market. Jeitschko and Zhang (2012) show that welfare can be negatively affected in a model where the pooling of perfectly complementary patents increases spillovers in the development of new products by rival firms.

Whether given patents are substitutes or complements is not always obvious, so that an objective for research is to provide the regulator with some means to discriminate among pool candidates. Lerner and Tirole (2004) address this problem in a model that describes the full range between the extreme cases of perfectly substitutable and perfectly complementary patents. Compulsory individual licensing (i.e. the requirement that independent licenses be offered by pool members to third parties) performs as a screening device. The latter is innocuous when patents are complements, but destabilizes a pool of substitutes by reducing its profits. In a related model for the formation mechanism of pools, Brenner (2009) shows that exclusive pool membership (i.e. a firm participates in the startup of a pool only if all other pool initiators agree) must be added to compulsory individual licensing for a pool to be welfare enhancing. However, in another setup where complementary patents can be either essential or nonessential, Quint (2012) finds that a pool containing only nonessential patents can reduce social welfare, although the pool is stable to compulsory individual licensing.

This paper contributes to a stream of literature that adopts an *ex ante* viewpoint to characterize endogenous R&D efforts toward the startup of a pool. As Scotchmer (2004, p. 178) describes, "[p]rospective inventors face different rewards if their intellectual property goes into a patent pool than if they license individually." In this perspective Denicolò (2002) constructs a two-stage model in which a pair of innovations results from two successive patent races with free entry, and the patent pooling is a case of collusion in the pricing of innovations between the first- and second-generation patentees. The author finds that the aggregate R&D investment in the second innovation (and possibly also in the first one) is higher when collusion is permitted.[4] Lerner and Tirole (2008, Appendix B) offer simple theoretical foundations to the conjecture that the possibility to form a pool with independent licensing is preferable to no pool because its lead to more innovation and make users better off. This strengthens the case in favor of pool agreements that allow firms to license their R&D outputs separately. Our starting point is different in that we rule out substitutable patents by assumption in order to eliminate the antitrust concern in patent pooling. This assumption follows a recent paper by Gilbert and Katz (2011), who study formally how alternative reward schemes for two firms impact the choice of R&D levels. Similarly, we also have the specification that technologies are invented sequentially, and are more valuable when used together than separately, although the technologies result from independent and uncertain R&D processes. An important difference is that Gilbert and Katz (2011) identify the properties that an innovation reward scheme must satisfy to support efficient R&D efforts, while we specify the simplest possible reward structure before examining its effect on firms' R&D choices.[5]

A growing empirical literature exists on patent pools. By examining sixty-three such agreements, Lerner, Strojwas, and Tirole (2007) confirm the theoretical prediction that pools of complementary patents are more likely to authorize independent licensing by member firms. Lampe and Moser (2010, 2011) use data on patent grants in the nineteenth century sewing machine industry. They find that the creation of a pool discourages subsequent innovation in complementary technologies, and also strongly encourages innovation in technologically inferior substitutes by outsiders. In another paper, Lampe and Moser (2012) also find evidence of a decline in patenting activity after a pool of substitutes has formed, in a broad range of industries. Layne-Farrar and Lerner (2011) examine nine modern patent pools to identify factors that drive the decision to join an existing pool. The likelihood of joining is shown to be reduced in case of a large group of pool initiators, and if license revenues are shared according to each firm's share of the total number of patents in the pool. The analysis of patents relating to information and telecommunication technologies leads Baron and Delcamp (2010) to suggest that pool initiators have strong bargaining power vis-à-vis other firms, as they are able to introduce lower quality patents than outsiders. Baron and Pohlman (2011) exploit a large data set to show that pools have a positive effect on the number of patent declarations relating to major standards both before and after their startup. Delcamp (2011) finds that pools generally select patents with a higher number of citations – which represent patent value – than other patents with similar characteristics in a control sample.

The paper is organized as follows. Section 2 builds a model of pool formation in the terms of a differential game. Section 3 offers a characterization of the symmetric Markov Perfect Equilibria of the game. Section 4 characterizes the pool size as the outcome of a coalition formation protocol. Section 5 focuses on the pattern of equilibrium R&D efforts toward the pool foundation. Section 6 investigates the effects of firms anticipating the addition

[4] An important difference in our model is that there is no free entry into the patent races; thus the R&D levels cannot be determined by a zero profit condition.

[5] See Gallini (2011) and Schmidt (2010) for thorough discussions on the theoretical economics literature on the efficiencies and potential anti-competitive effects of patent pools.