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Patenting in the shadow of independent discoveries by rivals☆

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ABSTRACT

This paper studies the decision of whether to apply for a patent in a dynamic model in which firms innovate stochastically and independently. In the model, a firm can choose between patenting and maintaining secrecy to protect a successful innovation. I consider a legal environment characterized by imperfect patent protection and no prior user rights. Thus, patenting grants probabilistic protection, and secrecy is effectively maintained until rivals innovate. I show that (1) firms that innovate early are more inclined to choose secrecy, whereas firms that innovate late have a stronger tendency to patent; (2) the incentives to patent increase with the innovation arrival rate; and (3) an increase in the number of firms may cause patenting to occur earlier or later, depending on the strength of patent protection. The socially optimal level of patent protection, which balances the trade-off between the provision of patenting incentives and the avoidance of deadweight loss caused by a monopoly, is lower with a higher innovation arrival rate or a larger number of firms.

1. Introduction

An important strategic decision for a firm is how to protect innovations. The firm can apply for patent protection or keep its innovation for secret use. Evidence indicates that firms often make heterogeneous choices about whether to patent their innovations. In fact, only a small proportion of innovations are patented (Mansfield, 1986; Pakes and Griliches, 1980; Scherer, 1965), and secrecy is increasingly viewed as an important strategy for appropriating innovations (Cohen et al., 2000; Levin et al., 1987). A question that naturally arises is why some firms choose to apply for patents whereas others adopt secrecy to protect their innovations. Moreover, given firms' strategic decisions concerning whether to patent, what is the socially optimal level of patent protection?

This paper attempts to address these questions. The analysis presented herein is motivated by several observed features concerning innovations and patenting. First, in many situations, multiple firms are capable of independently devising similar or even identical innovations. As Varian (2005) and Shapiro (2007) discuss, such duplication can occur because firms often share common knowledge bases or find their research paths restricted by universal standards. Second, patent protection is probabilistic. Many patent applications are not approved,[1] and as Choi (1998) and Lemley and Shapiro (2005) emphasize, even issued patents can be ruled invalid through litigation.[2] Given the requirement for full disclosure of innovation information during the patenting process, the information that is revealed may be utilized to the benefit of rival firms under conditions of imperfect patent protection. Third, a firm that keeps an innovation secret runs the risk of allowing another firm to obtain a patent for that innovation. Under current U.S. patent laws, a later inventor is permitted to obtain a patent for an invention that was abandoned, suppressed or concealed by previous inventors (Merges and Duffy, 2007). In addition, U.S. patent laws grant no prior user rights,[3] which means that a later inventor has the right to exclude previous inventors that rely on secrecy.[4]

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[1] Of the 485,312 applications received in 2008, only 185,224 (less than 40%) patents were granted. Data source: U.S. Patent Statistics Chart.http://www.uspto.gov/go/taf/us_stat.htm.

[2] Allison and Lemley (1998) report that out of the 300 cases of final validity decisions in their data set, patents were declared invalid in 138 cases.

[3] With exceptions for business methods.

[4] As Denicolò and Franzoni (2004a) report in their discussion of *Gore v. Garlock (721F.2d 1540, 1983)*, Garlock Inc. had discovered a process for creating a tape of unsintered polytetrafluorethylene filament, but decided to keep it secret. However, the process was later rediscovered by W.L. Gore & Associates, Inc., which succeeded in patenting it. In another case discussed in Marshall (1991), both New England Biolabs and Bethesda Research Labs produced modified T7 DNA polymerase and offered it for sale, but neither applied for a patent. The patent for it was later granted to Harvard researchers who threatened the two labs with a lawsuit for using it.

To capture these features, this paper develops a dynamic model of innovation in which multiple firms stochastically and sequentially discover a technology that is critical to a cost-reduction process or to the development of a new product. The firms that have discovered the technology are referred to as innovators. When a discovery occurs, the innovator decides whether to seek patent protection or rely on secrecy. Patent protection is imperfect in that it is effective with only some degree of probability. Moreover, the model assumes a legal environment with no prior user rights (e.g. the U.S. patent system). Within this legal environment, a later innovator may be entitled to the exclusive use of the technology if previous innovators rely on secrecy protection.

Taking into account the uncertainty inherent in patent protection and the threat of independent discoveries by rivals, an innovator's choice between patenting and secrecy becomes less than clear. In particular, by applying for a patent, an innovator that initially seeks to exclude its competitors, may provide help to them by disclosing innovation information if the patent protection is ineffective. Cohen et al. (2000) report such information disclosure to be one of the main reasons for innovators not to seek patent protection. By adopting a secrecy strategy, an innovator with the intention to gain an edge over its rivals may fail to do so if these rivals are able to discover the technology independently within a short period of time. As a matter of fact, blocking rivals from obtaining patents on related innovations is often a motive for firms to patent.

In Section 3, I describe the equilibrium of the model and show how innovators' patenting decisions depend on the timing of discovery (whether the discovery occurs early or late), the nature of an innovation (the innovation arrival rate) and the degree of market competition (the number of firms in the market). Early innovators are more inclined to choose secrecy, whereas late innovators have a stronger tendency to opt for patents. In other words, patenting incentives increase as more firms innovate. Consequently, given a certain level of patent protection, in equilibrium, early innovators adopt secrecy and only a sufficiently late innovator chooses to patent. A simple condition is provided to identify the critical innovator that chooses to patent. Moreover, I find that firms' incentives to patent are greater if the innovation arrival rate is higher. This result helps explain why firms in hi-tech industries, which feature by high innovation arrival rates, may choose patenting despite weak industry patent protection. Finally, I show that an increase in the number of firms may cause patenting to occur earlier or later, depending on the strength of patent protection, which suggests that greater competition does not necessarily promote innovation information disclosure.

The analysis in this paper sheds light on the important policy issue of the socially optimal level of patent protection. In the model, the arrivals of innovations are assumed to be exogenously determined. Thus, the issue of ex-ante innovation incentives is not a concern. A patent is viewed as a contract or agreement between society and the innovator in the sense that certain monopoly power is granted in exchange for innovation information disclosure.[5] A social planner faces the following trade-off in choosing the optimal level of patent protection. For a weak patent protection, early innovators are more likely to adopt secrecy. Thus, the society will experience markets in which firms have strong market power until the time that more firms innovate. To speed up the disclosure of innovation information, stronger patent protection is necessary, although it is associated with a greater chance of a monopoly market. I derive the socially optimal level of patent protection and show it to be lower with a higher innovation arrival rate or a larger number of firms.

Section 6 considers a simple model with an endogenous innovation arrival rate. I employ the framework of Loury (1979) and assume that firms incur an up-front R&D investment in the first stage that generates a steady flow of innovation arrivals over time. In the second stage, each firm decides whether to patent when its innovation occurs. I argue that the results from the model with the exogenous innovation arrival rate remain valid in the extended model. Moreover, I explore how the strength of patent protection affects the incentive to innovate. In this model setting, there is a possibility that an increase in patent protection can impede R&D investment.

A small body of literature has studied firms' patenting decisions under imperfect patent protection. However, these studies typically assume away the possibility that firms compete to patent identical or similar innovations (Anton and Yao, 2004; Gallini, 1992; Horstmann et al., 1985). Anton and Yao (2004), for example, present a model in which a firm with private information about the profitability of an innovation chooses between patenting and secrecy and also decides on the amount of innovation information to disclose. In their model, patenting signals low innovation profitability to a potential imitator. The model in this paper involves no asymmetric information issues. Instead, by developing a model with perfect information, I explore firms' patenting decisions under conditions of imperfect patent protection and the possibility of multiple independent discoveries.

Kultti et al. (2006, 2007) consider a situation in which multiple firms that innovate independently choose between patenting and secrecy. However, there are notable differences between this paper and theirs. In their models, firms innovate simultaneously and decide whether to patent based on the level of patent and secrecy protection. This paper complements theirs in that it models independent discoveries that occur stochastically and sequentially. In the present model, an early innovator decides whether to patent by taking into account the strategies of later innovators.

This paper is also related to the literature on multiple patents and the defense of independent inventions (Denicolò and Franzoni, 2004a, 2010; La Manna et al., 1989; Shapiro, 2006). In this literature, the key issue is the optimal allocation of prizes or the mechanisms by which these prizes are awarded in an innovation race. This paper has a different focus, examining innovators' choice between patenting and secrecy decisions in a particular legal environment in which the patent system grants no prior user rights.

Choi (1990) and Erkal (2005) investigate decisions to patent from another interesting and important angle. In a framework of cumulative innovation, they examine two options for an innovator: to patent (and commercialize) the basic version of a product or to keep it secret and work on developing an improved version. They assume perfect patent protection and emphasize the competition among firms in the development of vertically differentiated products. This paper considers the situation of identical innovations (or horizontally similar innovations) and probabilistic patent protection.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 conducts equilibrium analysis. Section 4 performs comparative statics. Section 5 derives the socially optimal level of patent protection. Section 6 considers a simple model with an endogenous innovation arrival rate. Section 7 concludes the paper. All proofs are relegated to the Appendix A.

2. The model

Consider an industry with a fixed number, n, of ex-ante identical firms. These firms are about to discover a technology that is crucial to a cost-reduction process or to the development of a new product.[6] The discovery process for each firm is independent and identical, and is

[5] See Denicolò and Franzoni (2004b) for discussions on the distinction between "reward theory" and "contract theory" of patents.

[6] For convenience, only one technology is considered. Alternatively, the firms could be about to discover different but similar technologies that are likely to be covered by one patent.