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Trade Secret vs. Broad Patent: The Role of the Independent Inventor

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Abstract

We present a simple model where patents are inferior to secrecy, meaning that when private returns from innovation under the two regimes are the same, society is better off if the innovator chooses not to patent. In our model, inferiority of patents depends on the lack of an independent invention defence in patent law: thus, although secrecy is superior to patents, it is not superior to other types of formal intellectual property rights where independent invention is allowed (like copyrighted software).

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1. Introduction

One of the most relevant functions commonly ascribed to the patent system is that it makes innovations more widely available in the long run. According to this disclosure rationale, patents can be viewed as a mutually profitable “contract” between innovators and society. By deciding to patent instead of relying on secrecy, innovators are temporarily insured against the risk of leakage and against the threat of independent inventors’ duplications, whereas society obtains the disclosure of the innovations, which are put in the public domain after the patent has expired (Kesan and Banik, 2000; Denicolò and Franzoni, 2004a).

The reasons explaining where the advantage of such a contract lies for society are not so clear, though. Resuming an old argument Boldrin and Levine (2004) point out that patent protection may bear a negative effect on ex post social welfare because innovators will patent only those innovations that might be concealed for a period shorter than patent length.¹ Bessen (2005) claims that diffusion of technical information embodied in inventions is not enhanced by the patent system and may well be delayed.

Denicolò and Franzoni (2004a, 2004b) reach opposite conclusions: when the possibility of duplication is taken into account, it is socially preferable in their model to increase patent life as much as it is necessary to induce first inventor to patent, so that society has not to bear imitation costs. The reasons explaining their result are the same which led Gallini (1992) to claim that a short lived and broad patent is preferable to a long and thin one. In these models the innovator who relies on secrecy or is entitled with a thin patent passively experiences imitators’ entry, perhaps because licensing contracts imply very high transaction costs. On the other hand, showing that patents can be inferior to other forms of intellectual property in which independent invention is a recognised defence to infringement, Maurer and Scotchmer (2002) implicitly supported the superiority of

¹ Certainly, this is an ex post point of view which does not account for the innovator’s need to generate profit. Boldrin and Levine’s arguments only applies to the cases in which trade secret protection is sufficient to ensure that inventors cover their R&D costs. In this paper we adopt the same point of view. (See footnote 2.)

secrets as compared with broad patents, if licenses are possible (see also Scotchmer, 2005, Chapter 4).

In what follows we assume that, although imperfect, a market for the innovations protected by secrecy does exist. Our main finding is that when fixed-fee licensing contracts do not imply very high transaction costs and patent length is set such as to make the innovator indifferent between patenting and not because total profits in the two regimes are equal, ex post social welfare is greater when secrecy is the innovator's choice. Thus, in our model a zero patent length is socially optimal.²

Moreover, we show that when demand is linear and firms compete à la Cournot, superiority of secrecy is maintained as long as transaction costs are not higher than a third of the costs of independent invention. Finally, some extensions are discussed: in particular the alternative of secrecy versus other forms of intellectual property rights such as copyrighted software. Our conclusion is that comparison between trade secret and formal intellectual property rights depends on whether the intellectual property regime under exam envisages or not independent invention.

In Section 2 the assumption of trade secret licensing is justified. In Section 3 the model is outlined. Section 4 is devoted to the welfare analysis, and Section 5 concludes.

2. Trade secret licensing

Although a popular opinion stresses that transaction costs related to secrets licensing are very high because of the confidentiality of information, this does not mean that such contracts are infeasible. To fix ideas, imagine an economy not endowed with a patent system and suppose that an innovator is threatened by the entry of independent inventors. If transaction costs to license the technology are not higher than independent inventors' costs, that is to say if bargaining surplus is not negative, there is room for licensing contracts. If, otherwise, the economy is endowed with a patent system, transaction costs inherent in the licensing of trade secrets will influence the

² This result obviously makes sense only if we assume that relying on secrecy the innovator can cover his or her R&D costs. Otherwise, a zero patent length would be surely not optimal from an ex ante point of view. (See footnote 1.)

innovator's choice between patenting and relying on secrecy. In particular, the higher the transaction costs, the shorter the minimum length required to make patents privately preferable to secrets. But if secrets represent the best choice, positive surplus generating license agreements will be signed.³

There is circumstantial evidence that licensing agreements involving confidential information are not irrelevant in practice. For example, the European Commission has created three categories of license agreements: "pure" patent licensing agreements, "pure" know-how licensing agreements, and "mixed" agreements that, according to the Commission, are playing an increasingly important role in the transfer of technology (European Commission Regulation 240/96; see Harris, 1997). Besides, the inclusion of trade secrets under the TRIPs has been hailed as a major innovation, essentially because in the jurists' view trade secret protection facilitates North-South transfer of non patented technologies through licensing agreements (Dessemontet, 1998). Moreover, it is a widely diffused opinion among professionals that in many cases of mixed licensing agreements the most important object of the transaction is in fact constituted by know-how. In other words many licensing contracts involving patents would, in fact, share the nature of trade secret licensing agreements, where patent would act as an advertisement for the sale of accompanying know-how (Jorda, 2004). Finally, as pointed out by Bessen (2005), there is some empirical evidence that indicates a robust (though perhaps imperfect) market for technology know-how that does not necessarily involve patents (Contractor, 1981; Agarwal and Henderson, 2002).⁴

These indications, together with the preceding theoretical argument, lead us to consider appropriate, in comparing different pure systems of intellectual property, the assumption that pure secret licensing agreements are feasible. Obviously, this does not amount to deny the role of patents

³ Anton and Yao (1994) provide a theoretical model in which firms resort to clever nondisclosure agreements that enable them to license without leaking the secret to unauthorized users. See also Arora (1996).

⁴ Using the 1994 Carnegie Mellon survey on industrial R&D in the United States, Arora e Ceccagnoli (2004) find that firms that do not patent rarely license. However, the authors do not distinguish between "pure" patent agreements and "mixed" know-how and patent agreements.

in facilitating licensing agreements that involve confidential information,⁵ but this role is not the same the “contract” theory assigns to the patent system.

3. The ratio test

The sequence of events in our model is as follows. First, the innovator decides whether or not to patent. Second, if the innovator has not patented, potential independent inventors decide whether or not to enter the market. Third, under the threat of independent invention, the innovator decides to license. Fourth, production takes place and profits are collected.

Consider an innovator who is to choose if patenting an innovation or relying on secrecy.⁶ Patents are assumed to be broad enough to make any non-infringing imitation impossible, so that the intensity of protection can be measured uniquely by patent’s length. By patenting, the innovator reaps the flow of monopoly profits π_m for the duration of patent; after patent’s expiration entry costs and profits are driven to zero. Conversely, by relying on secrecy the innovator must face potential independent innovators who can enter the market at the cost $K < (1/r)\pi_m$, where r is the discount rate.⁷ Thus, in our framework, the difference between patents and secrets lies in the fact that secrets have no expiration date, but allow for independent invention, whereas patents guarantee exclusive exploitation, but have a limited duration.⁸

We first determine the innovator’s payoff under secrecy. Let $H \leq K$ denote transaction costs for each trade secret license, so that surplus generated by a licensing contract will be non negative. Without loss of generality, we assume that these transaction cost are entirely borne by the licensor.

⁵ On this point see, for example, Kitch (1977) and Eisenberg (1989).

⁶ Horstmann, MacDonald, and Slivinski (1985) study the choice between patents and secrecy under asymmetric information, and Anton and Yao (2004) extend the analysis to the strategic choice in the amount of knowledge transfer. These issues are beyond the scope of our paper.

⁷ The introduction of the risk of leakage, as in Gallini (1992) and Denicolò and Franzoni (2004b), wouldn’t affect our results.

⁸ The hypothesis that patent breadth is so wide to guarantee a temporary monopoly implies that the patent holder has not convenience to grant licenses.

Then, by offering to license the secret at a price $F \leq K$ the innovator can prevent independent inventors' entry.⁹ Let n be the number of licenses and $\pi(n)$ the flow of profit accruing to each firm when $n+1$ firms are active in the market, with $\pi'(n) < 0$.¹⁰ Then, assuming a high number of potential independent inventors, so that the innovator can get the reservation price from each of the n licensees, we can write the equilibrium condition

$$(1/r)\pi(n) = F = K . \quad (1)$$

This condition gives us the equilibrium number of licensees. The corresponding innovator's payoff (total profits) under secrecy will be

$$V_S = (1/r)\pi(n) + (F - H)n = (1/r)\pi(n)(n+1) - Hn . \quad (2)$$

On the other hand, if the innovator chooses to patent, the payoff is V_P , given by

$$V_P = T\pi_m , \quad (3)$$

where T is the discounted patent length.¹¹

Whether the innovation is patented or kept secret depends on patent length, independent invention and transaction costs, as implied by a comparison of (2) and (3). By setting $V_S = V_P$ and solving for T , we obtain the patent length which makes the innovator indifferent between patenting and not, given by

⁹ The role of royalties per unit output will be discussed below in Section 4.

¹⁰ For sake of simplicity n is treated as a continuous variable.

¹¹ If τ is the patent duration in "real time", then the discounted duration is $T = (1 - e^{-r\tau})/r$.

$$\bar{T} = [(1/r)\pi(n)(n+1) - Hn] / \pi_m . \quad (4)$$

Without loss of generality, we assume that the innovator chooses to patent when he or she is indifferent between patenting and not. Thus, the innovator will patent if and only if $T \geq \bar{T}$.

Let us now consider social welfare. If the innovator prefers patents, welfare loss as compared with perfect competition is given by $WL_P = TD_m$, where D_m is the monopoly deadweight loss. At \bar{T} , where the total profits collected in the two regimes are the same, the welfare loss associated with patents is

$$WL^P = [(1/r)\pi(n)(n+1) - Hn]D_m / \pi_m . \quad (5)$$

If the innovator chooses secrecy, the loss of social welfare includes the actual value of the deadweight loss and transaction costs, that is

$$WL_S = (1/r)D(n) + Hn , \quad (6)$$

where $D(n)$ is the deadweight loss when there are $n+1$ active firms.

Comparing WL_P and WL_S in equations (5) and (6), it results that at $T = \bar{T}$ welfare loss under patents is not inferior to welfare loss under secrecy, that is to say $WL_P \geq WL_S$, if and only if

$$\frac{D_m}{\pi_m} \geq \frac{D(n) + rHn}{\pi(n)(n+1) - rHn} . \quad (7)$$

Condition (7) is an example of the so-called ratio test, frequently used in the optimal patent design literature (see Scotchmer, 2005, chapter 4). In the following section we concentrate on this condition.

4. Superiority of secrecy

Let price be given by $p(X)$, where X is output and $p(\cdot)$ is a strictly decreasing function on $[0, \bar{X}]$. Moreover, let c be the constant marginal cost.

Proposition 1. If output increases with the number of licensees and demand is not very convex, when transaction costs are null and the patent life is just long enough to render the innovator indifferent between patenting and not, secrecy is socially better than patents. That is, when the total profits collected in the two regimes are the same, social welfare is strictly higher if the innovator chooses trade secrecy.

Proof. As $\pi(0) = \pi_m$ and $D(0) = D_m$, for $n=0$ condition (7) holds as strict equality. Then, it is sufficient to show that for $H=0$ the right-hand side of condition (7) is strictly decreasing in n on the interval $[0, \hat{n})$, where \hat{n} is the number of licensees such that $p=c$. Since $D'(n) = -(p-c)X'(n)$ and $\pi(n)(n+1) = (p-c)X$, differentiating $\phi(n) = D(n)/\pi(n)(n+1)$ we get

$$\phi'(n) = \frac{-(p-c)\pi(n)(n+1)X'(n) - [p-c + p'(X)X]D(n)X'(n)}{[\pi(n)(n+1)]^2}. \quad (8)$$

Monopoly profits are maximized at $p + p'(X)X = c$, so that $\phi'(0) < 0$. Besides, the numerator in (8) approaches zero as n tends to \hat{n} . Thus, monotonicity of the numerator, say $\psi(n)$, is a sufficient condition for $\phi'(n)$ to be negative on the relevant interval. Differentiating $\psi(n)$, we have

$$\psi'(n) = -p'(X)X'(n)\pi(n)(n+1) - [2p'(X) + p''(X)X]X'(n)D(n). \quad (9)$$

If $2p'(X) + p''(X)X < 0$, (i.e., if demand is not very convex),¹² $\psi'(n)$ is positive as long as $n < \hat{n}$, and so $\psi(n) < 0$ on $[0, \hat{n}]$.

The next corollary follows immediately from Proposition 1.

Corollary 1. For any given number of licensees, there exists $\bar{H} > 0$ such that if $0 \leq H \leq \bar{H}$ secrecy is better than patents from society's point of view.

We proved that the fixed-fee licensing contracts between an innovator relying on secrecy and some of the potential independent inventors can make secrecy socially preferable. The reason for this result is that in our model, as in Maurer and Scotchmer's (2002), but unlike in Gallini's (1992) and Denicolò and Franzoni's (2004b), the entry of innovator's competitors doesn't imply wasteful duplication costs. These costs are appropriated by the innovator through licensing fees, and if transaction costs are not too high this improves welfare relative to the patent solution. In what follows we briefly discuss some further issues.

How low transaction costs should be? The result in Proposition 1 holds for quite general conditions about demand function. Nevertheless, with a generic demand function we are not able to establish how low transaction costs should be. Conversely, when demand is linear and firms compete à la Cournot it is straightforward to determine the ratio of transaction costs to independent invention costs below which secrecy is socially better than patents. Since the hypotheses of linearity

¹² The condition $2p'(X) + p''(X)X < 0$ ensures that under Cournot competition reaction curves are negatively sloped.

and Cournot competition imply $D_m / \pi_m = D(n) / \pi(n) = 1/2$, using the equilibrium condition $\pi(n) / r = K$, we can write condition (7) as

$$\frac{1}{2} \geq \frac{K + 2Hn}{2K(n+1) - 2Hn}. \quad (10)$$

It is immediate to verify that for $H \leq (1/3)K$ this condition holds.

Royalties. Allowing licensing agreements to envisage a per-unit royalty ρ , usually makes the analysis much more cumbersome. In fact, royalties create a wedge between licensors and licensees' marginal costs, which implies an additional distortion with respect to the symmetric oligopoly. But we can easily study the case of linear demand and Cournot competition. Some calculations show that when demand has the form $p = a - X$ and firms are Cournot oligopolists, the deadweight loss $D(n, \rho)$ and the industry profits $\Pi(n, \rho)$ are given by

$$D(n, \rho) = \frac{1}{2} \frac{(a - c + \rho)^2}{(n + 2)^2} \quad \text{and} \quad \Pi(n, \rho) = \frac{(a - c + \rho n)[(n + 1)(a - c) - \rho n]}{(n + 2)^2}. \quad (11)$$

Then, $D_m / \pi_m \geq D(n, \rho) / \Pi(n, \rho)$ if and only if $\rho < (a - c) / 2$. But the restriction $\rho < (a - c) / 2$ necessarily holds in equilibrium, because otherwise licensees' output would be zero, and entry by nonlicensees would not be deterred. This means that when demand is linear and firms compete à la Cournot Proposition 1 extends to the royalty contracts. We conjecture that our qualitative result continues to hold under a generic demand function as well.

Bertrand competition. With Bertrand competition, duplication is deterred under secrecy as well as under patents. The threat of a price war after entry reduces to zero the prospective profits of

an independent innovator, who could not cover his duplication costs. In this case our problem vanishes: without risk of leakage, $\bar{T} = 1/r$, and for $T = \bar{T}$ secrecy and patents imply the same welfare loss.

Trade secret vs. copyright. Our analysis rests on the interpretation that patent law does not allow independent invention. However, in this sense, patents are an exception, as in all other formal IP rights, like copyrighted software, independent invention is a defence to infringement.

Let ignore transaction costs and suppose that the independent invention cost is the same under patent and copyright protection. With T_C as the discounted length of copyright, total profits accruing to the innovator getting copyright protection are $T_C \pi(n_C)(n_C + 1)$, where n_C are the licenses granted by the innovator, given by the condition $T_C \pi(n_C) = K$. It is then immediate to verify that the innovator will be indifferent between copyright protection and secrecy if and only if $T_C = 1/r$, implying an infinite length, just as for secrecy.¹³ In such case the two regimes will imply not only equal total profits, but also equal welfare losses, so that the two alternatives will in fact be equivalent: the discriminative feature is not between trade secrecy and formal IP, but among regimes allowing independent invention and patents where it is forbidden.

With independent invention profit is collected more efficiently and when total profits are equal in the different regimes, society is better off if the innovator does not patent.

5. Conclusion

We have shown that, under quite general conditions about demand function, secrecy is socially preferable to a broad patent, if in the market of non patented innovations transaction costs are not too high. That is, when the patent duration is such that the innovator is indifferent between

¹³ If transaction costs and/or independent invention's costs differ in the two regimes, it is then possible that the copyright length making the innovator indifferent between copyright and secrecy is shorter than $1/r$. The same conclusion holds if the probability of leakage is positive.

patenting and not, social welfare is greater when secrecy is selected. The rationale behind this result is that trade secret permits independent invention, and, in turn, independent invention is a threat which induces the first inventor to license his or her innovation. Thus, when the actual values of profits are the same in the two regimes, price, under secrecy, is low enough to offset the longer duration of trade secret protection with respect to patent protection. Although, for the most part, the paper is dedicated to the comparison between patents and trade secret, the result extends to the comparison between patents and other formal IP rights where independent invention is allowed (like copyrighted software).

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