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Patent-Secret Mix in Complex Product Firms

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Abstract

Different protection mechanisms may be employed at the same time for a given innovation when the innovation is comprised of separately protectable components. If patents and trade secrets can be mixed in protecting single innovations, a strengthening in patent breadth may induce a lower level of patenting, as innovators are more prone to rely on secrecy.

JEL codes: K00, L49, O34.

Keywords: patents, trade secrets, complex products.

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1. INTRODUCTION

According to Cohen, Nelson and Walsh (2000), for certain purpose the key difference between a complex and a discrete technology is whether a new product or process is comprised of numerous separately patentable elements versus relatively few.[1]

It is then well known that electronic products tend to be comprised of a large number of patentable elements –often hundred– and, hence, may be characterized as complex (Cohen, Nelson and Walsh, 2000). But product complexity is not a sector-specific feature. On the basis of an estimation of the number of patent applications per innovation, conducted on a survey of 1165 U.S. firms realized in the mid-1990s (Cohen, Nelson and Walsh, 2000; Arora and Ceccagnoli, 2005), most innovations appear to be protected by more than one patent. While the number of U.S. patents per innovation is relatively smaller in biotech and pharmaceuticals (around two), it can rise to more than seven in fields such as semiconductors, transportation or rubber products, being on average 5.6 (Lévêque and Ménière, 2006). This suggests that product complexity –in the sense specified above– is pervasive, although with different incidence among sectors.[2]

In the case of complex innovations, firms can rely upon more than one mechanism to protect the same product (Cohen, Nelson and Walsh, 2000; Cohen, Goto, Nagata, Nelson and Walsh, 2002; Jorda, 2004; Denicolò and Franzoni, 2006; Denicolò, 2007).[3] Under some circumstances there is no choice, in that certain components are not patentable, but often the type of protection constitutes an option

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[1] The distinction between complex and discrete, or simple, technologies was drawn by Levin, Kievorick, Nelson and Winter (1987), Merges and Nelson (1990), Kusonaki, Nonaka and Nagata (1998), Kash and Kingston (2000).

[2] In our meaning there is no coincidence between "complex products" and "high technology products". The case of Gillette MACH3Turbo razor quoted in Denicolò (2007) illustrates this.

[3] As stated by Cohen, Nelson and Walsh (2000, pp. 6-7), "…firms at least occasionally rely upon more than one mechanism to protect the same innovation… Different mechanisms may be employed at the same time for a given innovation when an innovation is comprised of separately protectable components or features." Likewise, Denicolò and Franzoni (2006, p. 21) point out that "…an innovation may consist of several components, some of which can be patented while others are kept secret. In this case, secrecy complements patents as a tool for protecting innovators."

for innovators, who can chose the extent patents and trade secrets combine with one another.[4] So, trade secret protection may be important not only during the pendency of a patent application, but also during the term of, or after the expiration of, the patent.[5] As trade secret protection is relinquished to the extent an invention is disclosed in a patent application, there is sometimes motivation to minimize the disclosure made in a patent application in order to obtain broad patent protection and yet retain significant trade secret protection. In software terms, for instance, this can mean a patent disclosure that does not reveal any code.

In this paper we present a model where an innovator, who possesses all the complementary pieces of the new technology and uses them directly, can choose the patent-secret mix. Assuming the technology proprietor aims at maximizing the present value of profits flows deriving from the chosen mix, we determine the conditions pertaining to the patent and secret strength and to patent length allowing for an internal solution, that is to say a solution where patents and secrets actually protect a single product. We will see that, perhaps counterintuitively, an increase in the level of patent protection may induce the innovator to rely more on secrecy. Our results are obtained in a simple setting where signalling *à la* Horstmann, MacDonald and Slivinski (1985) or Anton and Yao (2004) plays no role.[6]

Section 2 contains a discussion of some legal aspects about the coexistence of patents and secrets and some historical examples. Section 3 expounds the model. The last section presents some concluding remarks.

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[4] Jorda (2004) forcefully argues that the optimal way to ensure protection of new technologies is a calibrated combination of trade secrets and patents.

[5] Erkal (2004) argues that trade secrets complements patents in earlier stages of the innovation process, while Graham (2004) stresses the strategic use of the U.S. "continuation" procedure. Instead, we will focus on the simultaneous use of patents and secrecy.

[6] Horstmann, MacDonald and Slivinski (1985) explore the decision of whether to patent with a model in which innovators possess private information about profits available to competitors, and patenting acts as a signal of this profitability. Anton and Yao (2004) focus on the decision of a firm concerning how much of an innovation should be disclosed (with and without legal protection) and how much should be kept secret. In both models signalling is a crucial feature of patenting.

2. COMBINING PATENTS AND TRADE SECRETS

2.1. Legal issues

There is a common misperception of an alternative between patents and trade secrets. As it seems to exist a fundamental conflict between the patent objectives of full disclosure and the protection of commercially valuable technical information implied by a trade secret, are the two forms of IP mutually compatible?

The basis for the Patent Law, Article 1, section 8 of the U.S. Constitution, states: "Congress shall have the power to promote the progress of science and the useful arts, by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries."

Patents are meant to encourage creativity and promote public disclosure. The first goal of the patent system is accomplished by granting exclusive rights for a limited period and providing economic incentives for creative discoveries. As referred to the second one the grant is made in return for public disclosure and ultimate public availability of the fruits of innovation. Patent application procedures and ultimate publication provide documentation of the compositions, methods or designs of the invention, and define the scope of precisely what the patent covers thereby promoting dissemination and creating a permanent repository of scientific and technological data for use and further innovation by others.

In order to obtain a patent the applicant will need to disclose to the public how to make the product, but, here lies the point, only to the minimum extent required by law. An innovator can use both patents and trade secrets to protect different aspects of the same invention, as courts have long held that a published patent does not invalidate those trade secrets that are not disclosed in the patent itself.

The key to leveraging both patents and trade secrets is to first understand precisely what the applicant will need to disclose in order to get a patent. Three legal requirements—written description, enablement, and best mode—set the level of detail that a patent applicant must disclose in order to obtain a valid patent.

The written description step does not require the applicant to describe exactly the subject matter claimed, instead the description must clearly allow persons of ordinary skill in the art to recognize that the inventor invented what is claimed (Fed. Cir. 2005). Thus, trade secrets can still protect the "know how" surrounding the

manufacturing process, so long as persons skilled in the art understand the scope of the patented product. Of course, it goes without saying that technical and commercial information and collateral know-how that can be protected via the trade secret route, cannot include information and know-how, which is generally known, readily ascertainable or constitutes personal skill. But this exclusion still leaves masses of data and tons of know-how which are the grist for trade secrets and often also for additional improvement patents.

Similarly, "enablement" requires that a patent applicant describe how to make and use the invention in such detail as to enable someone skilled in the art to practice the invention without undue experimentation. But this requirement does not imply that patents and trade secrets cannot coexist. The case Hayes Microcomputer Products is an example of a party withholding its trade secrets from a patent disclosure and still satisfying the enablement requirement (Fed. Cir. 1992).[7]

Finally, the "best mode" requirement in patent law is most conducive to withholding later-arising discoveries as trade secrets. The patent applicant must disclose the best mode of carrying out the invention, but only at the time the application was filed. Thus, if a company continues to refine an invention after filing its initial patent application, all subsequent discoveries may be either held as trade secrets or pursued as additional patents.

As it emerges from this discussion, a patent applicant can comply with all legal requirements without giving up its trade secrets.

2.2. Examples

Interesting historical examples of patent-secret mix are reported by Arora (1997). German organic dyestuff in the nineteenth century, one of the earliest of the science based "high tech" sectors, is rather representative.

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[7] The opposing party argued that the patent applicant, who merely provided a flowchart of a software operation, did not describe the claimed "timing means" and thereby kept it as a trade secret. The court relied on the inventor's own assertion that "if you had experience in doing microprocessor programming, you would know how to implement what's in that diagram," and the court further noted that "an inventor is not required to describe every detail of his invention." (Garvey and Baluch , 2007).

Having obtained an early lead in organic dyestuffs, German companies used patents systematically, as a defensive wall to protect whole research areas, to exclude competitors and preserve their market position, both at home and in other countries. Besides German companies skilfully combined patents and secrecy to keep potential imitators at bay in dyestuffs. The result was that these dyes commanded significant price premia, often selling for 40-50% over the standard colors whose composition was known.

The strategic use of patents and secrecy to deter entry into a technological area was not confined to dyestuffs. It was tried in other areas where the German companies were market leaders. The Haber-Bosch process for ammonia, a truly significant process innovation, was protected by more than 200 patents that covered the apparatus, temperatures, and pressures, but avoided particulars about the catalysts employed or their preparation. The catalyst was critical to the successful operation of the process, and keeping it secret significantly increased the expense and time for firms trying to circumvent the Haber-Bosch patent.

General Electric's (GE) industrial diamond process technology represents another excellent illustration of the synergistic integration of patents and trade secrets to secure invulnerable exclusivity. The artificial manufacture of diamonds for industrial uses, started in the fifties, was very big business for GE, which hold the best proprietary technology. Although some of the patents had already expired, so that much of the technology was in the technical literature and in the public domain, GE maintained her leading position as certain distinct inventions and developments were kept secret.

It is now well established that dual or multiple protection for intellectual property is not only possible but also essential. Such protection exploits the IP overlap and provides a fall back position. Recent decisions such as, *C&F Packing v. IBP and Pizza Hut* (Fed. Cir. 2000) and *Celeritas Technologies v. Rockwell International* (Fed. Cir. 1998) demonstrate this. In the *Pizza Hut* case, for instance, Pizza Hut was made to pay $10.9 million to C&F for misappropriation of trade secrets.

The Pizza Hut case is illustrated by Jorda (2004). After many years of research C&F had developed a process for making and freezing a precooked sausage for pizza toppings obtaining a patent both on the equipment to make the sausage and on the

process itself. It continued to improve the process after submitting its patent applications and kept its new developments as trade secrets.

Pizza Hut agreed to buy C&F's precooked sausage on the condition that C&F divulge its process to several other Pizza Hut suppliers, ostensibly to assure that backup suppliers were available to Pizza Hut. C&F disclosed the process to several Pizza Hut suppliers, entering into confidentiality agreements with them. Subsequently, Pizza Hut's other suppliers learned how to duplicate C&F's results and at that time Pizza Hut told C&F that it would not purchase any more sausage from it without drastic price reductions.

IBP, one of Pizza Hut's largest suppliers of meat products other than sausage, had been entitled to a specification and formulation of the sausage toppings in exchange for a confidentiality agreement with Pizza Hut concerning this information., but it appropriated the secret and started its sausage making process, selling precooked sausages to Pizza Hut. C&F then brought suit against IBP and Pizza Hut for patent infringement and misappropriation of trade secrets and the court found, 1) on summary judgment that the patents of C&F were invalid because the inventions had been on sale more than one year before the filing date and 2) after trial that C&F possessed valuable and enforceable trade secrets, which were indeed misappropriated.

Finally, a long list of lawsuit cases involving both patent infringement and trade secrets misappropriation can be found on the internet, strengthening the claim that these two forms of intellectual property are customarily used by firms together and not in alternative.

3. PATENT-SECRET OPTIMAL MIX

In the preceding section we have seen that exploiting the overlap between patents and trade secrets and utilizing both routes for optimal protection is a common management strategy. But how is the choice of the optimal mix achieved? What are the consequences of a change in the level of patent and trade secret protection on the optimal choice? We try to provide an answer to these questions by means of a simple model where a technology proprietor, who controls all the separate pieces of the innovative knowledge, maximizes the present value of profit flows deriving from the chosen mix.

3.1. The model

Let $\alpha \in [0,1]$ indicate the disclosed and patented fraction of the complex technology. The complementary fraction $1-\alpha$ remains undisclosed, and so protected by trade secrets.

Trade secrets leak out with probability $q^{1-\alpha}$, where $q \in (0,1)$ inversely depends on trade secret breadth granted by law −and other factors. If secrets leak out the innovator earns zero profit. Thus, the innovator's expected flow of profits after the patents expire will be $(1-q^{1-\alpha})\Pi$, where Π is the flow of monopoly profits. Obviously, the probability that trade secrets does not leak out, $1-q^{1-\alpha}$, increases with the undisclosed fraction of the complex technology, $1-\alpha$.

The probability that imitators invent around the patents is p^{α}, where $p \in (0,q)$ inversely depends on patent breadth granted by law. Then, the probability that during the patent life T imitators enter the market is $p^{\alpha}q^{1-\alpha}$. For simplicity we assume that if inventing around the patents has success and secrets leak out the innovator earn zero profit, so that the innovator's expected flow of profits while patents are in force is given by $(1-p^{\alpha}q^{1-\alpha})\Pi$. Since, $p<q$, the probability that during the patent life the innovator earns monopoly profits, $1-p^{\alpha}q^{1-\alpha}$, increases with the patented fraction of the complex technology, α.

Under the above hypotheses, the present value of the innovator's total profits will be given by

$$V = \frac{1-e^{-rT}}{r}\left(1-p^{\alpha}q^{1-\alpha}\right)\Pi + \left(\frac{1}{r} - \frac{1-e^{-rT}}{r}\right)\left(1-q^{1-\alpha}\right)\Pi \,,$$

where r represents the discount rate. That is, by setting $1-e^{-rT} = \tau$,

$$V = \left[\tau\left(1-p^{\alpha}q^{1-\alpha}\right) + (1-\tau)\left(1-q^{1-\alpha}\right)\right]\frac{\Pi}{r} \,. \tag{1}$$

3.2. Optimal mix

Let us now indicate with $\alpha*$ the innovator's optimal choice of α —i.e, $\alpha*$ is solution of the problem $\max_{\alpha} V$. We can write the following proposition.

Proposition 1. Let $0 < p < q < 1$ and $0 < \tau < 1$. Then, if

$$1 > \frac{-(1-\tau)\log q}{\tau(\log q - \log p)} > p \tag{2}$$

the problem $\max_{\alpha} V$ has an internal solution $\alpha* \in (0,1)$.

Proof. Differentiating (1) with respect to α we have

$$\frac{\partial V}{\partial \alpha} = -\tau\frac{\Pi}{r}q^{1-\alpha}p^{\alpha}\log p + \tau\frac{\Pi}{r}p^{\alpha}q^{1-\alpha}\log q + (1-\tau)\frac{\Pi}{r}q^{1-\alpha}\log q .$$

The first order condition $\partial V / \partial \alpha = 0$ implies

$$p^{\alpha} = \frac{-(1-\tau)\log q}{\tau(\log q - \log p)} . \tag{3}$$

Thus, if condition (2) is satisfied we have $1 > p^{\alpha*} > p$, which implies $0 < \alpha* < 1$.[8] ∎

Given τ and q, we have an internal solution, that is an actual patent-secret mix, for some value of p. Let $\tilde{p} < q$ be the value of p such that

$$1 = \frac{-(1-\tau)\log q}{\tau(\log q - \log \tilde{p})} .$$

Then, for $p \geq \tilde{p}$ the innovator's optimal choice is $\alpha* = 0$. In this case, duration and breadth of patent protection, relative to the secret breadth, are not so long and broad to induce the innovator to disclose some piece of knowledge. For $0 < p < \tilde{p}$ the optimal choice may be $0 < \alpha* < 1$ for some values of p and $\alpha* = 1$ for other values. The following proposition holds.

Proposition 2. Let $0 < p < q < 1$, $0 < \tau < 1$, and let $\bar{p}$ be the value of p such that $(\log q - \log p) = 1$. Then

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[8] It is easy to verify that in the relevant interval $\partial^2 V / \partial \alpha^2 < 0$.

(*i*) if $-(1-\tau)\log q/\tau > \bar{p}$ in the interval $(0,\tilde{p})$ the innovator's optimal choice involves $0 < \alpha^* < 1$;

(*ii*) if $-(1-\tau)\log q/\tau < \bar{p}$ in the interval $(0,\tilde{p})$ there exists two levels of p, say $\hat{p}_1$ and $\hat{p}_2$, such that $\alpha^* = 1$ for $\hat{p}_1 < p < \hat{p}_2$ and $0 < \alpha^* < 1$ in the remaining subintervals.

Proof. From equation (3) the condition $p^{\alpha^*} > p$ can be written

$$\frac{-(1-\tau)\log q}{\tau} > p(\log q - \log p) = f(p).$$

Since $f'(p) = (\log q - \log p) - 1$ and $f''(p) = -1/p$, the function $f(p)$ has a maximum at $(\log q - \log p) = 1$, that is at $\bar{p}$. At this point, $f(p) = \bar{p}$. Thus, if $-(1-\tau)\log q/\tau > \bar{p}$ we have $-(1-\tau)\log q/\tau > f(p)$ −that is the condition $p^{\alpha^*} > p$ is respected− for all the relevant values of p. Statement (*ii*) immediately follows.■

Proposition (2) is illustrated in Figure 1.[9] Panel (*i*) shows a case in which in the interval $(0,\tilde{p})$ the innovator's optimal choice involves $0 < \alpha^* < 1$. In the case of panel (*ii*) in the interval $(0,\tilde{p})$ there exists three subintervals: for $0 < p < \hat{p}_1$ and $\hat{p}_2 < p < \tilde{p}$ the innovator's optimal choice again involves $0 < \alpha^* < 1$, while for $\hat{p}_1 \leq p \leq \hat{p}_2$ the innovator will choose $\alpha^* = 1$.
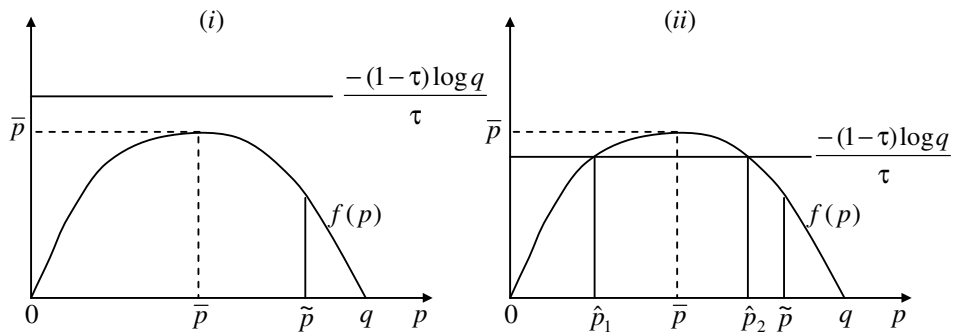

Figure 1

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[9] Note that L'Hospital's rule implies $\lim_{p \to 0} f(p) = 0$.

3.3. Policy implications

We have seen that for some combinations of p, q and τ the complex technology proprietor actually mixes patents and secrets. But how the mix reacts to the authority's choices of patent breadth, trade secret breadth –inversely related with p and q, respectively– and patent length? The answer regarding patent life and trade secret breadth is straightforward.

Proposition 3. Assume an internal solution $\alpha^* \in (0,1)$. Then, an increase in patent length (an increase in τ) or a decrease in trade secret breadth (an increase in q) always leads to an increase in the fraction of the complex technology which is disclosed and patented.

Proof. Differentiating (3) we have

$$\frac{\partial \alpha^*}{\partial \tau} = \frac{1}{-\tau(1-\tau)\log p} \quad \text{and} \quad \frac{\partial \alpha^*}{\partial q} = \frac{1}{-p(\log q - \log p)\log q}.$$

It is immediate to verify that $\partial \alpha^* / \partial \tau > 0$ and $\partial \alpha^* / \partial q > 0$ for any p, q, and τ in the relevant intervals.∎

With regard to patent breadth things are more complex. The following proposition states a result for the case $-(1-\tau)\log q / \tau > \overline{p}$ represented in panel (a) of Figure 1.

Proposition 4. Let $0 < p < q < 1$, $0 < \tau < 1$, and $-(1-\tau)\log q / \tau > \overline{p}$, so that in the interval $(0, \tilde{p})$ we have $\alpha^* \in (0,1)$. Then, if

$$\alpha^* > \frac{1}{\log q - \log p} \tag{4}$$

in the above interval a decrease in p leads to a decrease in α^*, that is an increase in patent breadth leads to a decrease in the fraction of the complex technology which is disclosed and patented.

Proof. Applying the implicit function theorem to (3) we obtain

$$\frac{\partial \alpha^*}{\partial p} = \frac{-\alpha^* p^{\alpha^*-1} - (1-\tau)\log q / p\tau(\log q - \log p)^2}{p^{\alpha^*}\log p}.$$

The denominator is negative. So, if

$$\alpha^* > \frac{-(1-\tau)\log q}{p^{\alpha^*}\tau(\log q - \log p)^2} = \frac{1}{\log q - \log p},$$

we have $\partial \alpha^* / \partial p > 0$.∎

Panel (*i*) of Figure 2 illustrates the result in Proposition 4. We have already seen that $\alpha^* = 0$ for $p \geq \tilde{p}$, while, if $-(1-\tau)\log q / \tau > \bar{p}$, in the interval $(0, \tilde{p})$ we have $0 < \alpha^* < 1$ (Proposition 1 and 2). Proposition 4 tells us that in $(0, \tilde{p})$ there exists a sub-interval $(0, p_o)$, where p_o is the value of p such that $\alpha^* = 1/(\log q - \log p)$, in which α^* decreases with p. The configuration for the case $-(1-\tau)\log q < \bar{p}$, illustrated in panel (*ii*), is similar. The only difference is that there now exists an interval of p in which the innovator relies entirely on patents.
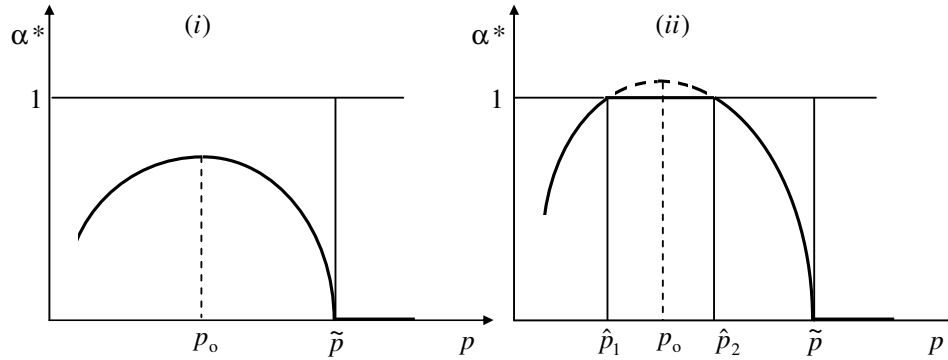

Figure 2

The rationale for the behaviour of α in response to an increase in patent breadth –a decrease in p– rests on a double effect of this policy. First, when patents become broader relative to trade secrets innovators obviously tend to operate a substitution between the two kinds of protection in favour of patents. But, second, an increase in patent breadth implies that innovators can enjoy the same total patent protection as with a lower patent breadth by disclosing a lower fraction of complex technologies. This induces the innovator to rely more on secrets. Our model suggests that, under some condition, when patent protection is wide enough the second effect prevails. In

this case, a patent policy aimed to generate more disclosure by broadening patent protection obtains the opposite result.

The extent to which this argument is valid requires some comments. We have assumed that at the origin a single, profit maximizing subject possesses all the complementary pieces of the new technology. In other words, we avoided a series of problems associated with licensing, patent thicket, patent pooling, and other related issues which arise when complementary pieces of knowledge are owned by different individuals or firms (Scotchmer, 2004, ch. 5; Shapiro, 2001; Lerner and Tirole, 2004; Bessen, 2004). These issues are certainly of great relevance, especially in industries such as semiconductors, biotechnology, computer software, and the Internet. In these industries firms may patent for reasons that extend beyond directly profiting from a patented innovation, that is they may engage in strategic patenting, amassing large portfolios of patents for the purpose of trading them in cross-licensing agreements.

Of course, our result on the effects of patent broadening does not apply to strategic patent portfolios, nor to strategic patent blocking, which is another widespread practice in some industries. This is an obvious limitation of our model. Occasional observations and some empirical evidence nevertheless suggest that there is a large variety of productive realities in which products are complex, the prevention of copying is the primarily reason for patenting, and the alternative between patenting and keeping secret the different components of the products is available. Responses to the survey of Cohen Nelson and Walsh (2000) indicate, after all, that in the aggregate prevention of copying is at the first place among the reasons for patenting, both for product innovations and process innovations. Moreover, there is widespread evidence that firms rely upon more than one mechanism, including trade secret, to protect the same innovation (Cohen, Nelson and Walsh, 2000; Cohen, Goto, Nagata, Nelson, and Walsh, 2002). In such circumstances, we believe, firms choose the patent-secret mix in some manner not too different from that we have modelled.

4. CONCLUDING REMARKS

Trade secrets can be used in lieu of patents but, more importantly, they can be relied upon at the same time and side by side with patents to protect any given invention as well as the volumes of collateral know-how, because far from being irreconcilable, patents and trade secrets in fact make for a happy marriage as equal. With patents and

trade secrets it is clearly possible to cover additional subject matter, strengthen exclusivity, invoke different remedies in litigation and have one standup when the other becomes invalid or unenforceable.

On the other hand, economists and jurists often stress that one of the most relevant functions of 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 threat of duplication by independent inventors –although not against inventing around the patent– while society obtains disclosure of innovations which are then put in the public domain after the patent has expired (see, for example, Kesan and Banik, 2000; Denicolò and Franzoni, 2006). This justification for the patent system complements the reward rationale, according to which patents remunerate successful innovators and so encourage R&D investments.

The conventional wisdom is that by broadening the patent protection society obtains more disclosure, while boosting research effort. Our model suggest that this may not be true. As the overlap between patents and trade secrets means that both routes for optimal protection appear to be a common management strategy utilized by innovators, an increase in the level of patent protection may have a perverse effect on the disclosure levels. If patents and trade secrets can be mixed in protecting single innovations, a broadening in patent scope may induce a lower level of patenting, as it may induce the innovator to rely more on secrecy.

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