Do Firms Rely on Big Secrets? An Analysis of IP Protection Strategies with the CIS 4 Survey

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Abstract

Uncertainties during the enforcement of intellectual property rights (IPR) have considerably weakened the case for systematic patenting of an innovation, shifting the trade-off between patenting and secrecy choice in favor of the latter. We investigate whether secrecy is used to protect small or large innovations using the French part of the 2004 Community Innovation Survey 4, which contains a large section dedicated to the use of IP protection methods by the surveyed firms. In line with the predictions of Anton and Yao (2004), we show that in one third of innovative industries (7 out of 21) a larger innovation leads to a smaller patent-to-secret ratio. Bivariate probit regressions show that while the size of the innovation always boosts the use of secrecy, the impact on patenting is not straightforward. The magnitude of an innovation increases the probability that this innovation will be patented for innovative firms overall, though this positive effect disappears for very innovative firms. Manufacturing firms are subject to a reversal in protection behavior where self-reported minor innovations are patented more often than large innovations.

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Keyword: Intellectual property, innovation, patenting behavior

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1 Introduction

The enforcement of intellectual property rights (IPR) is a major source of costs and uncertainty. Patent dispute can arise immediately after a patent has been issued in the form of post-grant opposition (Harhoff and Reitzig, 2004) if it is a European patent. In any case the scope and/or the validity of the patent may be questioned later on at the time of enforcement (Lemley and Shapiro, 2005; Crampes and Langinier, 2002), especially for patents starting a chain of cumulative innovation (Lanjouw and Schankerman, 2001). It turns out that nearly half of the challenged patents are eventually found invalid by the courts.

Earlier contributions focusing on imperfect patents regarded the uncertainty of an IP right as technical in nature. Horstmann et al. (1985) consider cases in which a protected innovation can be copied due to the competitors' abilities to work around the existing patent, and show that firms may opt out of patenting. Surveys on appropriability of innovation confirms that firms do not automatically patent when they can (Mansfield, 1986) and consider secrecy as more important than patenting to protect their innovations (Levin et al. 1987, Cohen et al., 2000). Yet, the huge increase in patent applications in the last two decades shows that there remains a stronge motive for patenting, be it related to appropriation or purely strategic. Strategic motives primarily includes preventing competitors to develop a related technology, building defensive or offensive blockade, generating licensing revenues, building bargaining chips for negociations[1], benefiting from the signal and reputation effects associated with having patents pending (Long, 2002) or misleading the rivals about the potentials of the innovation as regard future improvements (Langinier, 2005). The literature has furthermore identified a positive impact on market valuation (Hall, Jaffe and Trajtenberg, 2005).

The main negative aspect of patents for an applicant is the information disclosure requirement. It is thus necessary that patenting provides benefits over secrecy to maintain its incentive power. It has long been considered obvious that patenting would ensure appropriation in a safer manner that secrecy would, as secrecy is an all or nothing, precarious situation – either the firme is successful in maintaining secrecy and it can then enjoy a monopoly without the information disclosure, or the secret

[1] See Blind et al., 2007 for a comprehensive overview of empirical studies related to these motives to patents.

leaks and the firm is left without recourse. Secrecy being such a risky option, the patent system was viewed as offering a more secure option. Uncertainties surrounding the enforcement of IPR directly threatens this conclusion. In this paper, I study how the trade-off between patenting and secrecy is affected by the size of the innovation. In particular, I test whether the difficulty to enforce IPR has shift the firms' choice towards secrecy for major innovations, an idea pushed forward by Anton and Yao (2004).

Firm-level determinants of the propensity to patent identified by the literature are actually few. They include cooperation, as patents is used to help circumvent the respective IPR of the partners; the industry in which the firm operates, as patents are more useful in sectors relying on codified knowledge; and studies usually focus on firm size. The first reason to consider patenting firms according to their size is that the financial constraints is likely to play a role in the decision to patent, and will affect small companies much more than large companies. Secondly, company size also influences strategic motives: reputation building is a major concern for small companies while large firms are motivated by the licensing income and improving their bargaining power in IPR negociation whith the competition (Blind et al., 2006). In the same study, other potential factors influencing strategic patenting include the intensity of the competition, which is found to have a positive effect on the traditional motive of protection and on the strategic motive of blockade; and trademark, as a proxy of marketing effort, also has a positive impact.

The straigthforward question of the impact of the size of the innovation on the propensity to patent has not been given much consideration in the empirical literature. Yet it has been well documented that even if few patents are actually litigated, they are the most valuable ones (Lemley and Shapiro, 2005). Will this lead firms to decide not to patent major innovations and consider keeping them secret instead? Is it already the case?

Recent economic models have taken into account the uncertainty surrounding a patent by introducing patent strength. A patent is said to be strong if it likely be challenged and declared invalid by a court. That a patent can be declared invalid is indeed a major risk for firms, as illustrated by the invalidation of Eli Lilly's patent on Prozac by a U.S. court which led to a 31 percent decrease of Lilly's stock in one day. The recent literature now views patents as a *probabilistic right*, whose validity (and value) is known with certainty only after it has been tested in court. Anton and Yao's *"Little Patents, Big Secrets"* paper (2004) models this uncertainty and establishes that the optimal disclosure of information through patenting is decreasing with the size of the innovation.

The model introduces several sources of uncertainty within the protection of intellectual property.

(i) Monitoring costs. Once the owner of a patent, a firm must monitor that no other firm (including a competitor) infringes on it. The firm alone is in charge of detecting infringers. To enforce the patent, the firm can as a first step threaten the alleged infringer to bring the case to court; the more patents the firm can claim, the more time and legal and financial resources it has, then the more credible the threat will be. That is not in favor of a small company, owning a few patents necessary to its operations, without dedicated legal services and operating in a fast moving innovative industry.

(ii) The legal process itself is by nature uncertain, because the alleged infringer can challenge the validity of the patents upon which the case is built. Far from being a mere formal step, this is a real test for the patent. The under-funded Patent Office reviews the patent application for an average of a dozen hours before to decide whether or not to grant the patent, in matters that are by nature very technical and involve cutting-edge technology. That is why the literature now refers to patents as a *probabilistic right* (Lemley and Shapiro, 2005). A patent is actually a right to ask for a full trial, where the exact nature of the innovation and of the alleged infringement are subject to a deep and timely review.

(iii) Finally, information disclosure after the patent has been granted makes imitation easier. A patent application must in principle disclose every information necessary to reproduce the innovation *"without undue experimentation"*, and only the legal protection granted by the patent prevents imitation. Yet, this protection, as we just saw, is very uncertain. It turns out that whereas the filing costs (registering and monitoring costs as well as easier imitation due to information disclosure), the gains (the ability to bring an infringer to court) are uncertain.

The rest of the paper is organized as follows. First I recall the theoretical framework on patenting behavior and the main predictions for which I seek empirical support. Second I describe the CIS data regarding IP protection methods. Third I present the results related to the patent/secrecy ratio, and fourth I present the results of the probit estimations.

2 Existing Predictions and Implications

Usual View When the patent is seen as ironclad the patenting decision is determined by the comparison between the income gap provided by the innovation and the cost. If the extra profit generated by the patent, as opposed to practicing an unpatented innovation, is larger than the monetary cost then patenting is worthwhile. That is, the firm will patent if:

$$\underbrace{\Pi^P - \Pi^c}_{\text{patent premium}} > c$$

where Π^P is the profit driven by the patented innovation, Π^c the profit of the non-patented, competitively-provided innovation[2] and c the cost of patent filing.

Whenever the extra profit from the innovation is larger than the average patent-filing cost, *i.e.* 32 000 euros[3], then one should file a patent. If, on the other hand, the extra profit is smaller than this amount then a patent should not be filed. The filing cost c is not, strictly speaking, independant from Π^P because the attorney costs to interact with the patent office are increasing with the technical complexity of the application[4]. Yet the patenting decision is a threshold-based decision rule, and increasing the magnitude of the innovation can only increase the likelihood that the income gap upon which the decision to patent is based will indeed excess the threshold. Secrecy is used when the cost of patent filing exceeds the patent premium.

Therefore, in such a case the impact of increasing the magnitude of the innovation is straightforward: it increases the desirability of patenting.

[2]The difference between Π^c and Π^P corresponds to the patent premium defined by Arora, Ceccagnoli and Cohen (2007)

[3]Estimation by Roland Berger Market Research, for the European Patent Office, regarding a euro-direct application `http://www.european-patent-office.org/epo/new/cost_analysis_2005_study_en.pdf`

[4]Which is why one can not rely solely on the Patent Office 'listing price' to estimage the average cost of a patent application, as the actual tariff faced by the firm is the one set by the attorney in a case-by-case basis.

Probabilistic View Anton and Yao (2004) establishes the existence of an equilibrium with full patenting for a small innovation, with partial patenting for a medium-size innovation, and without patenting but partial information disclosure for a large innovation[5]. predicts that, in case of a cost-reducing innovation protected by probabilistic intellectual property rights, the amount of information disclosed by a firm may be decreasing with the magnitude of this innovation. The amount of information is defined by the authors as either the number of patents or the total number of claims contained in patents applications.

Langinier (2005) models the decision to patent in a duopoly race of product innovation whith asymetric information about the improvabilty of an innovation. In equilibrium the leader always patents a non-improvable innovation and randomizes its decision to patent when the innovation can be improved. Thus, when the follower observes a patent it gains no additional information about the information, while the choice of secrecy always conceals an innovation which can be improved.

The notion of improvability of an innovation in Langinier (2005)'s setting of patent race with cumulative innovation can easily be interpreted as the magnitude, or size, of an innovation.

In this literature, the impact on patenting of increasing the magnitude of the innovation is mixed or *negative*. That is, increasing the size of the innovation, all else being equal, will lead to less patenting.

3 Data

The 2004 Community Innovation Survey 4 covers 6734 firms operating in France. 2270 firms report to be innovative, this will constitutes our main sample. Out of those innovative firms, 1643 report to be innovative in product and 1624 innovative in process. Innovative firms in this survey have a median number of employees of 88 at the end of year 2004. 450 innovative firms have fewer than 30 employees, 1140 have between 30 and 250 employees and 706 have more than 250 employees. Among the firms that declared to have made a product innovation between 2002 and 2004, 542 have developed at least one innovation new for the firm only, 511 at least one innovation new for the market, and 589 at least

[5] Anton and Yao's model allows for separately deciding whether or not to patent and voluntarily disclosure of information, even if the technology is unpatented. The latter action is profitable because in their signal game there is a benefit to appear stronger at the beginning of the competition game.

one innovation new for the firm and one new for the market (see definition and discussion in the next section).

The CIS 4 survey asks the firms which intellectual property protection methods they have used among seven methods. The answers are reported as binary variables for each method. We do not know how many times a firm has used a given protection method, only whether it has used it or not during the period. Data on protection methods are binary variables so that the average is the frequency of this method in the sample. At the individual level, we interpret it as the probability that a firm of the sample uses the protection method. This frequency is thus a propensity to patent, at the firm level[6].

3.1 Measuring the Magnitude of an Innovation Using the Novelty Criterion

CIS 4 classifies product innovations into two categories: innovations that are "new for the firm" or "new for the market". An innovation which is new for the firm but not for the market (i.e., an incremental innovation), is for instance an already-existing product developed by the firm alone, without infringing existing patents. This product can be differentiated enough from existing products on the same market to be patented on its own, but other firms offer products with similar features. A product is new for the market if it is not based on products which are already offered on the market; we consider this type of innovation to be larger.

This measure of the size of the innovation is not perfect. The two dummy variables variables are set at the firm level, not the innovation level. The protection behavior is also reported at the firm level. So for multiproduct firms with multiple protection methods, it is not possible to match exactly the size of one innovation with the protection. Suppose that a firm has innovations that are new for both the firm and the market, and that it reports using both patent and secrecy. We then do not know which innovation has been protected using which method.

This matching issue does not occur for the ideal, mono-product firm. This is the reason why we will distinguish the firms by size classes, and we will focus on small firms, those which can be assumed to offer a limited number of products. However, there are not many firms with fewer than 30 employees

[6]Definitions of the propensity to patent usually retain the frequency of patented *innovations* over the total number of *innovations*, not firms.

in our sample: the first decile of the number of employees for all firms is 15 employees and the median number of employees is 50. Limiting ourselves to small firms dramatically reduces the size of the sample, especially when also considering the industry at the NES 60 level. When we consider small innovative firms below, we only look at 297 firms which represents 4.4 % of the total sample.

3.2 Measuring the Magnitude of an Innovation Using the Innovative Revenue Criterion

Based on the novelty criterion described above, the CIS 4 survey asks the respondent to report the share of its revenue coming from innovative sales. The median share of innovative turnover among innovative firms is 10 %, and it is 25 % among the last (most innovative) quartile.

3.3 Measuring the Magnitude of an Innovation Using the Reported Effects Creterion

The CIS 4 survey asks the innovative respondents to rate from 0 to 3 the effect of their innovation in nine categories as "increases market shares", "improves quality", "lowers the unit cost" or "reduces the inputs necessary to produce the good". By considering the sum of these answers we build an indicator, which takes values from 0 to 24, of the effect of the innovation on the firm's products and processes.

4 Results

4.1 Ranking Protection Methods

The IP protection methods used by innovative firms are, by order of frequency: trade mark (43%), lead time (35.1%), patent (29.8%), secrecy (27.3%), technological complexity (24.4%), drawings and graphics (22.7%), and copyright (11.7 %). These figures have been obtained for firms reporting to be innovative in product or in process.

When considering the product innovating firms, we obtain higher protection levels but the same ranking as Table 1 shows.

Table 1: Rankings of IP protection methods by kind of innovation

in %	Product or Process	Product	Process
Trade Mark	43.0	49.7	40.9
Lead Time	35.1	41.1	36.3
Patent	29.8	35.5	30.1
Secrecy	27.3	31.8	27.9
Complexity	24.4	28.8	25.1
Drawings and Graphics	22.7	26.2	23.1
Copyright	11.7	13.0	12.1
No. of observations	2270	1643	1624

One should also keep in mind that not applying for a patent it not equivalent to secrecy[7], so the two protection methods are not substituable. Evidence that firms consider the choice to apply for a patent and maintain secrecy independantly from each other appear in Table 2 which tabulates the use of patent and secrecy.

Table 2: The use of patent and secrecy among innovative firms

	No Secrecy	Secrecy	Total
No Patent	1272	319	1591
Patent	377	300	677
Total	1649	619	2268

4.2 Relative Use of Patent and Secret

We look for the frequency of use of patent and secrecy in samples of similarly-sized firms. In order to compare the two frequencies we define the patent-to-secrecy ratio $\frac{patent}{secrecy+patent}$, where *patent* and *secret* are the frequencies of use of the protection method in the sample. Note that that this ratio takes values between 0 and 1.

Under the usual view that IPR are effective in enabling firms to appropriate the benefits of their innovation, the size of the innovation should impact positively the frequency of use of patent and has a lesser impact (which may be positive or negative) on the use of secrecy. This should therefore lead

[7] Most trade secret laws require firms to take positive actions to protect an intellectual property, such as limiting the physical access to the intellectual property and having employees sign non-disclosure agreements, for it to be deemed a trade secret.

to an increasing patent-to-secrecy ratio. Otherwise, a decreasing ratio indicates that the impact of the size of the innovation impacts positively the use of secret, and either impacts negatively the use of patent or impact the use of patent to a lesser extent than it does for secrecy.

The following table shows the patent-to-secrecy ratio according to the nature of innovation (product or process innovation) for three firm class sizes: fewer than 30 employees (small firms), between 31 and 249 employees (medium firms), and more than 250 employees (large firms).

Table 3: Ratio of use of patent-to-secrecy for product- and process-innovative firms

	Process	Product
Overall	.51	.52
Small firms	.48	.54
Medium firms	.50	.49
Large firms	.54	.54

For process innovations, the use of patent relative to secrecy is increasing with the size of the firm, which is consistent with the preferences expressed in the CIS 1 survey analyzed by Arundel (2001). Multiple barriers to patent application, be it registering and renewal fees or the need to access specialized lawyers, can explain why small businesses have a proportionally higher use of secrecy than large firms.

Yet, the ratio is lower than 0.5 for small firms, which indicates that patenting is more frequent than secrecy, while in the 1993 survey every size class expressed a relative preference for secrecy (and this preference was decreasing with size).

The following table reports the frequency of the use of secrecy and patent filing, as well as the ratio of the two frequencies, in 10 selected industries or groups of industries.

Table 4 shows a frequent use of secrecy, yet less frequent than patent in technological industries like automobile, which corresponds to the traditional view of patents as the preferred appropriation tool. However, the third column confirms that in some innovative industries, like chemicals, secrecy is more frequent than patent filing.

Let us now consider how the ratio evolves with the size of the innovation. The size of the innovation here is measured with each of the three criteria described above: novelty, share of innovative revenues,

Table 4: Frequency of use of patent and secrecy and the ratio of interest, by industry

	Patent (freq.)	*Secrecy (freq.)*	Patent-to-secrecy ratio
Textile	.17	.14	.55
Woodwork	.23	.09	.70
Paper Industry	.30	.34	**.47**
Chemicals	.37	.40	**.49**
Plastic Industry	.39	.30	.55
Metalwork	.37	.31	.54
Automobile	.30	.17	.63
Furniture	.17	.14	.55
Post and Telecommunication	.13	.09	.60

and reported effects, for product innovation unless indicated otherwise.

Table 5: The patent-to-secret ratio by size of the innovation

	Novelty	Innovative Revenue 20% threshold	Innovative Revenue 20% thres., process innovation	Reported Effects
Overall				
very innovative	.53	.52	.50	.53
less innovative	.51	.54	.53	.52
Small firms				
very innovative	.53	.53	.43	.65
less innovative	.54	.54	.56	.49
Medium firms				
very innovative	.50	.50	.49	.49
less innovative	.49	.50	.47	.51
Large firms				
very innovative	.56	.52	.53	.53
less innovative	.51	.57	.57	.56

Reading: small firms engaged in process innovation considered very innovative using the Innovative Revenue criterion defined above have a patent-to-secrecy ratio of .43, and this ratio is .56 for firms of the same size considered less innovative.

The ratio is not always above 0.5 which indicates that secrecy may be more frequent than patent filing. More importantly, the ratio in some cases decreases with the magnitude of the innovation. This result is not consistent with the usual view of IP rights as we saw previously, and suggests that as the size of innovation increases these firms are more willing to consider secrecy to protect their innovations.

The following table reports whether we observe a patent-to-secret ratio decreasing with the size of the innovation, by class size of firms and the criterions used to measure the magnitude of the innovation.

Table 6: Presence of an Anton and Yao effect, by measure of the size of the innovation

	Novelty	Innovative Revenue	Innovative Revenue	Reported Effects
		20% threshold	20% thres., process innovation	
Overall	No	Yes	Yes	No
Small firms	indet.	indet.	Yes	Yes
Medium firms	No	No	No	Yes
Large firms	No	Yes	Yes	Yes

Reading: Using the novelty criterion defined above, small firms considered very innovative have a *lower* patent-to-secrecy than small firms considered less innovative. The opposite is true using the Reported Effects criterion.

Standard deviation of the ratio of interest is computed using bootstrap methods. This allows to test, using a usual two-sample t-test with unequal variances, for the significance of the difference between the two ratios for a given size class; in only a few cases was this difference not significant and is reported as "indet.".

We now proceed with the analysis at the industry level, using the *Nomenclature d'Activité Française* at the 60 divisions level. So as to ensure the significance of the results we remove industries with fewer than 20 innovative firms; we are left with 21 industries (divisions).

Table 7 below reports, for two different measures of the size of an innovation, the number of industries where the patent-to-secret ratio is increasing with the magnitude of the innovation (the standard effect) and the number of industries where this ratio is decreasing:

Table 7: Number of industries exhibiting each behavior of the patent-to-secrecy ratio

	Novelty	Innovative Revenue
Patent-to-secrecy ratio decreasing with the size of the innovation	7	7
Patent-to-secrecy ratio increasing with the size of the innovation	14	12

Out of the 21 innovative industries 14 exhibit a standard behavior of the ratio, while 7 show a use of secrecy increasing faster than the use of patent for larger innovations.

4.3 The Relative Use of Patent and Secrecy: a Bi Variate Probit Model

The previous section looked at the evolution of the relative frequencies of use of patenting and secrecy by firm size at the industry level and could not control for other variables. To see if the effect is robust to the introduction of control variable we need an econometric analysis, namely a probit regression.

First we explain patent and secret by novelty of the innovation (regression 1) and share of innovative revenue (reg. 2) for all innovative firms. This benchmark fits the standard theory: larger and small innovation significantly explain patent, with larger innovations having a stronger effect than smaller ones. Innovative sales strongly explain both patent and secrecy. A large share of innovative sales means that the firm relies very much on its innovative technology and is seeking a legal protection for it, which patents provide. It also explains secrecy because the use of secrecy is largely correlated with patenting and innovativeness.

We then fit a biprobit model to explain the use of patent and of secrecy among very innovative firms (regression 3), on the share of their non-innovative revenue and some controls. To explain patenting only firm size, R&D expenses and industry are significant, and the share of innovative sales is not significant – the point estimator is even negative. To explain secrecy, firm size, research expenses and industry are significant as well as the share of innovative sales. While the share of innovative sales boosts patent filing among innovative firms overall, when considering the very innovative firms, the magnitude of their innovative sales increases secrecy and the impact on patenting is negative and not significant.

Regression 4 considers small innovative firms in the manufacturing sector. Again fitting a biprobit model on the use of patent and the use of secrecy, we focus on the variables capturing the size of the innovation. With respect to patent, a large innovation has no statistical impact while a smaller innovation is strongly significant, in direct contradiction to the standard behavior. Secrecy is explained by innovation both large and small. So here a large innovation increases the probability of use secrecy but not of patent application.

A potential immediate explanation for this is that small firms are more financially-constraint than larger firms and may not be able to apply for patent even though they would like to, or need to be facing a more important innovation to decide patent it than would a large firm. While this is certainly a factor, it remains puzzling that on the same subsample where large innovations do not influence patent applications (coefficient not significant), the smaller innovation is significant and large (coefficient of 1.64).

Regression 5 considers the large firms in the manufacturing sector. Innovative sales are no longer significant for patenting but still are for secrecy. Unlike the previous regression, the financial constraint faced by the firms cannot explain the lesser use of patent, as large firms have typically the means necessary to file patents. Why would large firms no seek the legal protection offered by patents as their business relies more and more on innovative sales, while the use secrecy is significantly impacted by growing share of innovative sales?

We account for correlation in the deviances in each pair of probits by using bivariate probits. Indeed we almost always reject the hypothesis that the coefficient in the co-variances matrix of the two error terms equals to zero, as reported in the regression tables.

5 Conclusion

This paper is concerned by the influence of the size of an innovation on the trade-off between patent and secrecy. The relative use of patent is, in 7 innovation industries out of 21, *decreasing* with the magnitude of the innovation for two usual measures of the size of innovation. In theses cases, a sample of firms with a large innovation use patent less, relatively to secrecy, than similarly-sized firms in another sample in the same industry. The econometric approach also shows that among very innovative firms the innovative sales no longer drive patenting, while it still drives secrecy.

Such behavior is not consistent with the usual view of patents. According to this traditional view, a patent guarantees protection in exchange of information disclosure, as opposed to secrecy, which is a risky protection method since protection is only offered so long as secrecy is maintained. The impact of the size of the innovation on the use of patents is then unambiguously positive. In this context, a reluctance to patent a larger innovation as compared to a smaller innovation cannot be explained. Only models taking into account the uncertainty surrounding the enforcement and/or the validity of a patent can explain this reluctance. Indeed, the fact that the ratio of patent to secrecy decreases with the size of the innovation is the core prediction of Anton and Yao's model with patent strength and is a direct implication of the results from Langinier (2005) on strategic use of patent. The results presented here, though, are empirical results and as such they are merely results *compatible with* the cited theoretical predictions and do not preclude alternative explanations.

Empirical support for the notion that firms may regard patent-filing as in fact no more secure than secrecy is worrisome from a welfare perspective. Patent-filing ensures diffusion of knowledge, which secrecy by definition does not provide. And it is precisely for major innovations than the diffusion of knowledge is the most beneficial to society. The notion that firms tend to prefer secrecy to protect their innovation because of the legal uncertainty surrounding intellectual property rights has been suspected for long and has led to several patent system reform propositions. They mainly consist in creating a two-tier patent system with one kind of patent being the existing one, while creating a 'super-patent' which would be more costlty for the applicant and generate an in-depth ex-ante scrutiny of the validity of the patent sought, which would provide the patent with a stronger presumption of validity before the courts (Encaoua et al., 2006; Lemley et al., 2005).

References

[1] Anton, James J., Greene, Hillary, and Yao, Dennis A. Policy implications of weak patent rights. *working paper*, May 2005.

[2] Anton, James J. and Yao, Dennis A. Little patents and big secrets: Managing intellectual property. *The RAND Journal of Economics*, 35(1):1–22, 2004.

[3] Arora, Ashish, Ceccagnoli, Marco, and Cohen, Wesley M. R&D and the patent premium. *International Journal of Industrial Organization*, 26(5):1153 – 1179, 2008.

[4] Arundel, Anthony. The relative effectiveness of patents and secrecy for appropriation. *Research Policy*, 30:611–624, 2001.

[5] Arundel, Anthony and Kabla, Isabelle. What percentage of innovations are patented? empirical estimates for european firms. *Research Policy*, 27:127–141, 1998.

[6] Bar-Gill, Oren and Parchomovsky, Gideon. The value of giving away secrets. *Virginia Law Review*, 89(8):1857–1895, dec 2003.

[7] Bessen, James. Patents and the diffusion of technical information. *Economics Letters*, 86:121–128, 2005.

[8] Blind, Knut, Edler, Jakob, Frietsch, Rainer, and Schmoch, Ulrich. Motives to patent: Empirical evidence from germany. *Research Policy*, 35(5):655 – 672, 2006.

[9] Crampes, Claude and Langinier, Corinne. Litigation and settlement in patent infringement cases. *The RAND Journal of Economics*, 33(2):258–274, 2002.

[10] Dietmar Harhoff and Markus Reitzig. Determinants of opposition against epo patent grants–the case of biotechnology and pharmaceuticals. *International Journal of Industrial Organization*, 22(4):443 – 480, 2004.

[11] Encaoua, David, Guellec, Dominique, and Martinez, Catalina. Patent systems for encouraging innovation: Lessons from economic analysis. *Research Policy*, 35:1423–1440, 2006.

[12] Friedman, David D., Landes, William M., and Posner, Richard A. Some economics of trade secret law. *The Journal of Economic Perspectives*, 5(1):61–72, 1991.

[13] Hall, Bronwyn H., Jaffe, Adam, and Trajtenberg, Manuel. Market value and patent citations. *The RAND Journal of Economics*, 36(1):16–38, 2005.

[14] Hall, Bronwyn H. and Ziedonis, Rosemarie Ham. The patent paradox revisited: An empirical study of patenting in the u.s. semiconductor industry, 1979-1995. *The RAND Journal of Economics*, 32(1):101–128, 2001.

[15] Henry R. Hertzfeld and Albert N. Link and Nicholas S. Vonortas. Intellectual property protection mechanisms in research partnerships. *Research Policy*, 35(6):825 – 838, 2006. Property and the pursuit of knowledge: IPR issues affecting scientific research.

[16] Horstmann, Ignatius, MacDonald, Glenn M., and Slivinski, Alan. Patents as information transfer mechanisms: To patent or (maybe) not to patent. *The Journal of Political Economy*, 93(5):837–858, oct 1985.

[17] Joseph Farrell and Carl Shapiro, J. How strong are weak patents? *Competition Policy Center. Paper CPC05-54*, 2007.

[18] Langinier, Corinne. Using patents to mislead rivals. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 38(2):520–545, 2005.

[19] Lemley, Mark A., Lichtman, Douglas Gary, and Sampat, Bhaven N. What to do about bad patents. *Regulation*, Vol. 28:pp. 10–13, Winter 2005-2006.

[20] Lemley, Mark A. and Shapiro, Carl. Probabilistic patents. *The Journal of Economic Perspectives*, 19(2):75–98, 2005.

[21] Long, Clarisa. Patent signals. *University of Chicago Law Review*, 69, 2002.

[22] Mansfield, Edwin. Patents and innovation: An empirical study. *Management Science*, 32(2):173–181, feb 1986.

[23] Mansfield, Edwin, Schwartz, Mark, and Wagner, Samuel. Imitation costs and patents: An empirical study. *The Economic Journal*, 91(364):907–918, dec 1981.

[24] Scotchmer, Suzanne. *Innovation and Incentives*. The MIT Press, Cambridge, MA, 2004.

[25] Scotchmer, Suzanne and Green, Jerry. Novelty and disclosure in patent law. *The RAND Journal of Economics*, 21(1):131–146, 1990.

Table 8: Probit explaining the use of patent and secrecy.

	(1) All innovative firms		(2) All innovative firms		(3) Very innovative firms	
	Patent	Secret	Patent	Secret	Patent	Secret
Large innovation	.605***	.435***				
	(.061)	(.060)				
Small innovation	.121**	.135**				
	(.060)	(.060)				
% innovative sales			.438***	.536***	−.152	.302**
			(.122)	(.122)	(.156)	(.154)
Number of employees	.043**	.043 **	.045**	.046**	.128**	.156**
	.020	(.019)	(.019)	(.019)	(.048)	(.05)
Revenue	< .001	< .001	< .001	< .001	< .001	< .001
R&D Expenses	.020***	.006**	.020***	.007***	.026***	.006**
	.004	(.002)	(.004)	(.002)	(.006)	(.002)
Cooperation	.343***	.325***	.425***	.379***	.398***	.315***
	(.061)	(.060)	(.059)	(.059)	(.083)	(.082)
Food Industry	−.535	.342**	−.443**	.412**	.828***	.437**
	(.149)	(.135)	(.147)	(.133)	(.204)	(.185)
Manufacturing Industry	.466***	.438***	.508***	.574***	.493***	.574***
	(.101)	(.103)	(.098)	(.102)	(.142)	(.147)
Transport Industry	−.088	−.199	−.077	−.378	−.175	−.378**
	(.134)	(.141)	(.132)	(.142)	(.184)	(.201)
Commerce Industry	−.020	−.209*	.087	−.134	−.031	−.134
	(.118)	(.126)	(.116)	(.125)	(.178)	(.192)
Services Industry	−.234**	.116	−.543	.088	−.263	.088
	(.111)	(.111)	(.109)	(.110)	(.152)	(.157)
ρ	.271*** (.038)		.307*** (.036)		.182** (.052)	
Observations	2266		2265		1096	

Employees, R&D expenses and revenue are in 10,000. Significance levels: ***1%, **5%, *10%.

Table 9: Probit explaining the use of patent and secrecy in the manufacturing industry

	(4) Small firms		(5) Large firms	
	Patent	Secret	Patent	Secret
Large innovation	.382	1.151***		
	(.493)	(.419)		
Small innovation	1.802***	.747**		
	(.522)	(.363)		
% Innovative sales			−.619	2.225***
			(.766)	(.705)
Number of employees	−.056	.042	−.885	−.187
	(.044)	(.030)	(.662)	(.355)
Revenue	.446***	−.124	<.001	<.001
	.145	(.125)		
R&D Expenses	1.054**	.210	.277**	.015
	.513	(.448)	(.101)	(.014)
Cooperation	−.601	.176	−.091	.074
	(.532)	(.401)	(.328)	(.294)
ρ	n.s.		n.s.	
Observations	72		121	