The Policy Implications of Weak Patent Rights

by

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1. Introduction

Patents differ substantially by the degree to which they provide protection from unauthorized imitation and, therefore, strength of a patent is a major concern for innovators and imitators alike. Patents may lack strength because they have a significant probability of being overturned or are relatively easy to circumvent. For ease of discussion we call patents with such characteristics "weak," though this category also includes patents of middling strength.

Discussions of intellectual property policy often implicitly adopt a perspective on patent protection most consistent with characteristics associated with strong patents. Recent research suggests that such a starting point can be misleading because the economic and policy implications of weak patents are quite different than those of strong patents. The purpose of this paper is to explore the implications of weak patents.

Weak patents cause firms to rely more heavily on secrecy and this, in turn, creates a situation in which competing firms lack economically important information about the capabilities of their competition as well their directions for future innovative effort. We begin by exploring the significance of weak patent rights in the presence of such private information. The remaining sections are, then, devoted to discussions of the implications of weak patent rights and private information on innovation and disclosure incentives, antitrust policy, and organizational incentives and entrepreneurial activity.

2. The Strategic and Policy Implications of Weak IP and Private Information

Weak patent rights and private information interact and therefore need to be considered together. We begin with a short discussion of each factor and then consider the interaction.

The Ubiquity of Weak Patent Rights

Considerable evidence suggests that for a wide array of technologies (and hence industries) patent protection cannot be characterized as strong. In this section we briefly review some of the evidence on the strength of patent protection.

Evidence of Weak Patents

A substantial proportion of patents granted in the United States stand a good chance of being overturned. While it is difficult to know the precise percentage of likely invalid patents, of patents that have been challenged on validity grounds, Allison and Lemley (1998) found that about 46% of litigated patents were overturned between 1989 and 1996. Prior to the creation of the Federal Circuit in 1982 this percentage was closer to 65%.

Conservation of examination resources is one reason that patents are sometimes overturned or circumscribed.[1] A careful examination of each patent is quite costly. Because the vast majority of patents have little or no ultimate economic value, a close examination of such patents is arguably a waste of resources. Patents that have economic value and are questionable are natural targets for litigation by competitors or buyers of the patent-holder. Through litigation, intense scrutiny is given to precisely the patents that matter. Many have come to view patents as "licenses to sue" and it is often under the stress of litigation that the true strength of a particular patent emerges.[2]

The strength of a patent also depends on its ability to exclude economically "close" substitute technologies. If such a "circumventing" technology results in a product that has nearly identical performance and cost characteristics as a product embodying the patented technology, then the private economic value of the patent is greatly reduced.

The Levin, et. al. (1987) and Cohen, et. al. (2001) surveys of intellectual property appropriability provide evidence suggesting that (1) the strength of property rights varies significantly by types of invention (or industry) and (2) in a large number of industries, trade secrecy is as important, or more important, than patents for appropriating the rents to invention. An early study by Mansfield, Schwartz and Wagner (1981) examines 48 innovations and finds that 60% are imitated within 4 years. This statistic also suggests that the patents were not strong enough to deter infringement or avoid close circumvention.

Uncertain Patents

At the time of issue many patents may also be perceived as weak, in part because such patents involve patent issues of first impression. (Later, some of these patents may be viewed as strong.) In technical fields that involve a new class of technology, there is considerable uncertainty about the ultimate patentability and scope of protection. It was initially unclear, for example, whether a genetically altered living organism could be patented. Some patents in biotechnology have been criticized as overexpansive, while others seem to conflict with existing patents. Business methods, which had historically

[1] The degree to which patent applications face examination scrutiny varies from country to country. Kingston (1984) noted that some countries have issued patents with very little examination (e.g. South Africa) while others examine patent applications with considerably more scrutiny (e.g. Germany).
[2] See Jaffe and Lerner (2004) for a general discussion of the U.S. patent system.

been hard to patent, have recently found new patent life via *State Street*. In some cases uncertainty about patent quality may also result from patent interference problems where two or more patents seem to share the same patent space.

The Ubiquity of Private Information

Firms typically take great pains to keep their innovative know-how secret. The reason for this behavior is straightforward: knowledge is easy to expropriate once it is known. Thus, firms frequently make critical investment and pricing decisions without knowing the choices of others and with quite limited knowledge of what the others already have discovered. Sometimes firms may not be even able to identify whether others are working on the same problems.[3]

A partial picture of the broader knowledge portfolio of a competitor can be gleaned from the patent portfolio of (apparent) competitors (Rivette and Kline 2000). While such competitor scanning is of significant value and may also suggest the overall foci of a competitor's research efforts, it is only a lower bound on what a competitor actually knows. In any event, even if all inventions were patented, disclosure of the knowledge lags that of discovery as patent publication typically lags patent application by eighteen months or more. Further, when a prospective patent is likely to be weak, competitors may choose to rely on trade secret protection rather than on patent protection. In those cases not only is the actual know-how of each competitor private, the extent of the knowledge of the competitor may be private as well. That is, the uninformed party will know neither the extent to which a firm has learned to lower its costs, nor the actual knowledge that allowed it to do so.

An example of this double level of secrecy is the "walking out" process that Intel discovered in the early 1970s that allowed it to achieve high yields in the production of EPROM circuits. Because this process left no trace in the product itself, it could not be reverse engineered and if Intel wished to keep the yield secret, it could have done so (Jackson 1997).

From the perspective of private information, then, the disclosure function of patents is very important. Patents not only reveal know-how information, they also can be read as indicators of the total extent of knowledge that a firm holds in its patent portfolio and as secrets.

Strength of Patent Right vs Extent of Private Information

The cost to disclosing knowledge through a patent depends on the strength of patent rights and the extent of private information.

A strong patent is very likely to be upheld if challenged, gives the patent-holder a broad scope of protection (circumvention is difficult), and considerable protection against

[3] A common criticism of the government antitrust agencies' use of innovation markets is that it is very difficult to determine what firms are working on relevant projects.

infringement. While the importance of validity and broad scope is self-evident, legal protection against infringement deserves some comment. Expropriation of knowledge from a patent may be difficult to detect, especially if the use of the underlying knowledge is not visible in the commercial product embodying the invention. (One firm only learned that its trade secret had been stolen by another firm after it had acquired the other firm!)[4] Further, even given the difficulty of detection, there is the question of whether the size of the infringement damages is sufficient to deter infringement in the first place. In the U.S. the two primary methods used for awarding damages are determination of lost profits and determination of reasonable royalties. As we will see below, both of these methods can be ineffective at deterring infringement.[5]

When patents are not strong, a firm is more likely to employ secrecy or some combination of patents and secrecy. This is perhaps one reason why Cohen, et. al. (2001) found that in most industries firms rated secrecy equal to or above patent protection as a means of appropriating profits. Thus, a defining characteristic of such cases will be private information held by the knowledge-holder over both the extent of the knowledge held and the actual knowledge. Issues relating to private information thus become of increased importance.

The costs and benefits of secrecy depend on several considerations. How effective is secrecy for protecting the innovative knowledge of the firm? Are competitors aware of the extent of the firm's knowledge? Will disclosed knowledge increase the probability that a competitor will invent the next generation product?[6]

Many product innovations cannot be protected by secrecy because the invention is disclosed through the product itself. In such cases even weak patent protection is preferred to no protection at all. A patent also will preclude others from gaining a patent on the knowledge that a firm was holding secret. U.S. law has one feature which makes using secrecy less attractive in that inventors who employ secrecy expose themselves to being excluded by subsequent patenting of their inventions by others. In Europe subsequent patenting is not as big a problem as the Europeans allow the first inventor to continue to use the invention.

In Table 1 we examine how combinations of patent strength and private information lead to different economic settings. The dimensions in the table represent the expected situation facing the innovating firm prior to its choice of protection mechanism. So, for example, the strength of available patent rights is the expectation of the firm as to how well patents will be able to protect its intellectual property should the firm choose to patent. The private information dimension represents the expectation of the firm about how much of the information that is initially private will become known to others once the product or service embodying the invention is sold on the market, i.e. via direct observation or reverse engineering of the product or service itself. The measure does not account for disclosures made through patenting or publishing. Along the private

[4] This incident is recorded in *Northern Petrochemicals Co. v. Tomlinson*, 484 F.2d 1057 (7th Cir. 1973).
[5] One problem is that the damages do not account for the probability that an infringement is not discovered.
[6] See Scotchmer and Green (1990), Gallini (1992), and Bessen and Maskin (2000).

information dimension we separate inventions into three general categories: *naked idea* inventions, *black box* inventions, and *unobserved* inventions. Each of these categories of invention may be associated with strong or weak property rights.

A *naked idea* invention is one where the critical invention is easily observable in the product or service that embodies that invention. Without strong property right protection, naked idea inventions can be easily imitated. In some cases a first-mover advantage may accrue to the innovator. In other cases rents will be earned by those who are best able to exploit the idea (e.g. firms that control relevant complementary assets such as strong marketing or distribution capabilities). And in other cases, all rents will be competed away.

A *black box* invention is an invention for which the added performance is obvious when the product or service is observed, but the means—the magic ingredients-- by which the performance is achieved cannot be readily discerned or reverse engineered. Software often has many of these features (e.g., Windows operating system)

Many inventions will have combinations of these characteristics. For example, a new configuration of lenses in a telescope eyepiece, can be easily observed once the product is available in the market and could not be kept secret short of not selling the product in the first place. However, the lenses of the new eyepiece result in an observable performance improvement but may be ground using a hidden and novel method.

A third category of invention is the *unobserved* invention. Here we have in mind, for example, process inventions that allow a previously offered product to be manufactured for a greatly-reduced cost. Competitors cannot even know that there is an innovation, though they might suspect it if the innovator's price were to change significantly. Such inventions can be kept secret, but being completely secret might sacrifice some strategic advantage that might result if rivals knew that the innovator had substantially lower costs (and thereby competed more passively).

Because the relevant know-how for strategic competition purposes includes knowledge about follow-on innovation, in many naked idea inventions some element of private information may still exist. Then the private information shifts from the basis for the current invention to knowledge the inventor has that allows for the second generation product. That private information affects the likely product lifetime of the current product and will therefore also affect pricing and promotion decisions.

Table 1 also provides some indication of how a firm might choose its protection strategy given the invention's characteristics regarding the strength of available patent rights and the expected degree of private information. For example, in innovation-critical industries, a firm's choice about how much to invest in, what to invest in, how to price, whether to enter a market, and a host of other choices all depend on the firm's assessment of its competitors' innovation positions. Oftentimes, it will benefit the knowledge-holder to signal its advantageous position to its competitors (without, hopefully, fully disclosing the underlying know-how that is the basis for this

advantageous position). Thus, the firm with private information may choose to signal it position to its competitors.

Table 1: Patent Strength and Private Information

		strength of available patent rights	
		strong	*Weak*
Expected degree of private information after commercialization but absent patent	*None (Naked idea inventions)* key invention is observable in commercial product/service and technology readily imitable	Clasp locker (zipper) patent all observable inventions	business idea such as a Greek-Chinese fusion restaurant rely on first-mover or complementary asset advantages
	about know-how (black box inventions) key invention cannot be reverse engineered but performance observable	Semi-adhesive post-it note heavy but not exclusive reliance on patents-- trade secrecy used to extend protection or maintain advantage for future generation inventions	Coca-Cola formula not patentable subject matter, easy to circumvent, or would be off-patent rely heavily on trade secrecy
	about extent and know-how (unobserved inventions) use of invention not directly observable	"reflow" process to aid in manufacture of MOS circuits (Jackson 1997) heavy but not exclusive reliance on patents—may strategically release or hide credible information regarding extent of know-how	cost-reducing process invention not sufficient invention to ensure novelty required for patenting may disclose some know-how via patent to signal extent

3. Implications for Innovation Incentives

A primary driver of innovation investment, especially among firms, is the promise of profits. If firms cannot appropriate the value of their innovation, they will have a limited incentive to invest in innovation.

Legal intellectual property rights such as patents are designed in part to ensure that inventors appropriate the value of their inventions. Obviously, weak property rights

reduce the prize available to a patent holder. The impact of weak property rights, however, depends in part on whether their IP can be protected by other means and the actions of the property right-holder's competitors.

Zero property rights does not mean zero appropriation: protection by other means

The most extreme case of weak property rights is the absence of property rights, a condition common to many circumstances such as early-stage conceptions or many creative ideas. But the absence of property rights not does exclude appropriation. For example, an inventor without property rights can still appropriate rents even when it must fully reveal the know-how of the invention in order to sell it to a firm.

In Anton and Yao (1994), full revelation by an inventor to a buyer prior to a contract still results in a significant payoff for the inventor. The reason is that revelation creates a credible "blackmail threat." By revealing the invention, the seller removes the initial skepticism of a buyer about the value of the previously unseen invention, but now faces the possibility that the now informed buyer can expropriate the invention without penalty when property rights are non-existent. This is, of course, the classic market for ideas problem identified in Arrow (1962). The buyer,[7] however, has a strong incentive to preserve its information monopoly and prevent the seller from going elsewhere. This incentive leads the buyer to offer a contract that provides incentives to the seller not to sell the idea to a third party. The absence of property rights then becomes a two-edged sword and the buyer must pay an (expected) amount that is on the order of duopoly profits to eliminate gains-to-trade between the inventor and a potential second buyer. Thus, even in the complete absence of property rights, the payoff to innovation investments can be significant. The key element is that private information effectively confers an economic property right on an innovator and this information advantage can be leveraged into a significant payoff relative to the market value of the invention. In turn, policy assessments of property rights should take into account the implication that innovation incentives are not necessarily forced to zero by the absence of formal property rights.[8]

Further, not all firms that have access to an invention are on equal footing in the development and subsequent commercialization of the invention. In many cases, a firm with a nonexclusive access to an invention can appropriate the value to the invention because of control of complementary assets such as superior marketing or manufacturing capabilities. See, e.g., Teece (1986). Anand and Galetovic (2004) discuss a number of other means through which innovators can appropriate rents even in settings with limited property right protection.

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[7] A second reason, developed in Anton and Yao (2002), derives from the option of partial revelation by the inventor. By disclosing only a portion of the intellectual property, a seller can induce potential buyers to bid via contract offers to attract the seller and acquire the remaining portion. In these settings, it is the prospect of acquiring additional IP (versus denying it to a rival) that provides an innovation reward when there are no property rights.

[8] The no-property rights setting may reflect complete absence of property rights or a setting in which the transaction is contemplated prior to when property rights can be obtained.

The impact of weak property rights on imitation and infringement

If a firm anticipates that its invention will have only weak intellectual property protection, holding other factors constant, it would appear less likely to invest in innovation in the first place. The impact of weak IP protection, however, ultimately depends on the economic choices made by the innovator and its competitors.

Innovator and Imitator Choices

Consider first some choices an innovator may make given weak property rights. For all but naked idea inventions, the innovator always has the option of protection via secrecy. This option establishes a lower bound on the payoff available to an innovator. Under weak property rights the innovator would disclose its invention to get some modest probability of legal protection against direct imitators. Use of secrecy implies no legal protection—in fact, it opens up the innovator to infringement questions should a competitor invent and patent—but secrecy means no disclosure (beyond that which is inevitable due to product inspection). Because innovations are rarely composed of a monolithic piece of knowledge, a combination of patenting and use of secrecy is frequently employed. Second, an innovator may also attempt to preempt imitation by licensing the weakly protected invention to imminent competitors.

Both of these choices depend on anticipating what the competitors would do given these or alternative choices. A major stumbling block to that analysis is that competitor choice depends in large part on its perceptions of how much innovative knowledge the innovator actually has. This is a serious problem if weak property rights lead to greater use of secrecy and less use of the patent system. For example, how much I would be willing to pay for a license depends on what I am getting and what additional knowledge the licensor is holding back for its own advantage.[9] Because of the weakness of property rights, all of this knowledge is not necessarily contained in the patent and the competitor has no direct way of knowing the full extent of the innovator's knowledge.

The message with respect to imitator choice is that in settings with private information the innovator will often have an incentive to signal its strength on a dimension relevant to either innovative or product market competition. For example, if the innovator's actions persuade an imitator that it has a significant cost advantage, the imitator will be less aggressive in the ensuing product market competition.

Innovation Investment: Failure Has its Reward Too

Now consider the implications of weak property rights and private information for the innovation investment decisions when two or more firms are investing in innovation, e.g. racing for the patent. Under strong patents, the incentives for firms to invest are strong

[9] For example, BASF has licensed a previous generation process for making the chemical phthalic anhydride while using its own later-generation process (Foster 1986).

as the competitors vie for the "monopoly" position.[10] But in the case of weak patents, the subsequent patented IP is anticipated to be weaker and the "costs" attendant to losing the race to patent are less. Failure has its reward too.

Weak property rights suggest that the loser will be in a good position to successfully circumvent the other's invention. Thus, the costs of losing are less than under strong property rights and this creates a reduced incentive for all innovating parties to invest since part of the incentive involves relative competitive positions before and after the innovation race.

Even where the patent does provide legal protection against expropriation of innovative knowledge, strategic infringement actions can be used to reduce the expected costs of infringement under patent damage rules commonly used in the U.S.

Consider, for instance, a process innovation and a market competition between two firms. The market competition provides the infringer with an opportunity to manipulate the resulting legal damage award via market choices. One form this opportunity can take is that of "passive infringement," which is defined by the infringer taking all of their gains from the process innovation via internal cost reduction with no changes in market behavior.[11] Even when policy is oriented toward protecting the profit of the innovator, as with the lost profits damage award (restoring the innovator to the profit that would have been achieved absent infringement), innovation incentives will be reduced. Passive infringement, by construction, leaves the profit outcome of the innovator unaffected and so the reward to an innovation success is not reduced. However, the reward to an innovation failure is greater (as infringement is profitable) and so each firm has less of an incentive to invest in R&D.[12]

The analysis of weak property rights in the presence of private information thus leads us to a number of observations. First, weak patent rights are not fatal to innovation incentives. Second, weak property rights increase the level of private information, both of which affect the strategic interactions between the innovator and its competitors. The reliance on patenting versus trade secrecy becomes affected by the strategic value associated with appearing "tough" and smaller technical advances are economically better protected than larger advances under weak patent rights. Finally, the incentives for an imitator to risk infringement are increased by the availability of infringement choices that take advantage of the methods by which the courts assess infringement damages. This increased incentive to infringe generally lowers the incentives for innovation.

4. Implication for Disclosure Incentives (i.e. patent vs trade secrets)

[10] For this discussion, we are assuming no market power in the pre-invention status quo. See Gilbert and Newbery (1982) and the subsequent literature on dominant firms and the persistence of monopoly

[11] This discussion is based on Anton and Yao (2005).

[12] Circumvention does not merely mean that a firm can imitate, it also makes it easier for the firm to make better use of whatever knowledge it developed through its own innovation investment.

Another important purpose of the patent system is the encouragement of technology disclosures. As discussed above, weak patents will push an innovating firm to rely more heavily on secrecy, which implies a reduction in the amount of public knowledge disclosure. Note that if product inspection or reverse engineering could reliably yield all relevant information then the policy benefit from patent disclosure would be diminished.

Reliance on secrecy increases the importance of the private information held by the innovator for both subsequent innovation competition and product market competition. Consider, for example, a process innovation setting in which greater innovative know-how translates into lower costs. In the case of product market competition, a firm will be less aggressive if it thinks that the other firm has lower costs. Because the actual cost (through innovation) of the firm is unknown to its competitor, the value of appearing to have low costs creates an incentive for firms to take actions to persuade their competitors that they have low costs. A primary means through which this can be done is to disclose a portion of one's know-how developed through investment in innovation.

The economic rationale for disclosure incentives hinges on a benefit/cost comparison. The cost of disclosing commercially valuable information, whether in a patent or through research papers, conferences and other public methods of dissemination, is that market rivals may be able to improve their own capabilities. The benefit derives from the assessment rivals will make about the true underlying capability of the disclosing firm. This is the familiar notion of market competition in a strategic substitutes setting – a firm would prefer that a rival believe it has a strong capability (such as low costs) rather than weak because this leads the rival to adopt a less aggressive market position (such as reducing output or abstaining from making entry investments). Partial disclosure has the desirable feature of preserving at least some of the advantage for oneself while providing convincing technical evidence for rivals that innovative progress has, in fact, occurred.

The economic forces driving disclosure choices by innovators and reactions of rivals typically lead to an outcome in which an inventing firm is able to appropriate a higher proportion of the value of small versus large inventions. That is, firms with more modest inventions are often led to make full disclosures because the benefit margin swamps the cost margin while those with greater advances rely more heavily on secrecy. Firms with greater advances seek to separate themselves via disclosure from those with lesser advances and this creates an incentive push toward larger disclosures. However, larger disclosures transfer more valuable information to a rival and lead to less appropriation of value by the innovating firm.

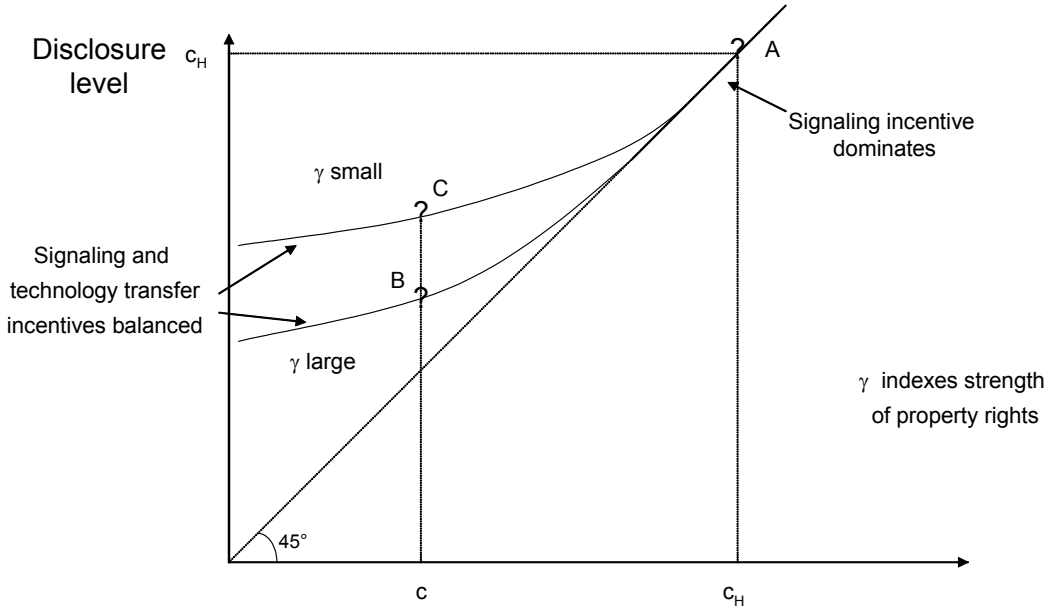
The economic incentive for disclosure with this sort of process innovation is based on the idea that "I would like you to know that I have low costs but I do not want you to know how I do it." Figure 1 provides a graph of the resulting relationship between disclosure and innovation that can arise in equilibrium, with a convex shape being the typical outcome (See Anton and Yao 2003, 2004). Small innovations, which mean high costs in the cases of process innovation, are often fully revealed With larger innovations, meaning lower costs, disclosure is partial and the firm resorts to secrecy to a greater extent (convex shape).

To interpret the structure underlying the graph, imagine that the highest cost level, c_H, corresponds to a patent for a new product with a minimal specification of how it can be produced (point A in Figure 1). Lower values for c correspond to better process innovation outcomes regarding the product and the disclosure levels correspond to revelations about the various techniques involved. The inventing firm can obtain the patent with a minimal disclosure or it can choose to include additional claims (or even separate patent applications). The disclosure curve then shows how, in equilibrium, a firm with privately observed cost c will choose to disclose. As a rough guide, the incentive structure is that any disclosure associated with a small innovation (costs close to c_H) forces an innovator with a more significant innovation to make a larger disclosure as they seek to convince rivals that they are, in fact, stronger competitors in the market.

At point B in Figure 1 we have the situation of an innovator with a significant advance. The true extent of process innovation is given by the production cost on the horizontal axis. The disclosure of this firm regarding its innovation is at the vertical level corresponding to point B. As this point lies above the 45° line, secrecy is being employed. Since the cost level of c_H corresponds to a minimal technical specification, the vertical distance from c_H to point B measures the extent to which disclosure allows a rival to reduce costs. The vertical distance from point B to the 45° line then measures the cost advantage the firm has chosen to maintain, via secrecy, relative to rival firms. Note that as we move to the left in Figure 1 and consider firms that have innovated to a greater extent, both of the vertical gaps increase but the reliance on secrecy is more extensive.

Figure 1 exhibits two different disclosure curves, corresponding to whether property rights are strong or weak. The parameter γ is an index for the strength of property rights, such as the probability of invalidity or compensation via legal damages for infringement. As property rights become perfect and γ goes to 1, we are pushed to the 45 degree line: when the risk of competitor use vanishes, an innovating firm reveals the full extent of innovation. As γ falls the disclosure graph shifts up and secrecy is employed more often. The limiting position when property rights vanish is not, however, a horizontal line at height c_H at which all information beyond a minimal level is withheld. Instead, the limiting position when property rights vanish is one where the tradeoff between signaling and technology transfer to a rival is still operative and the disclosure curve lies between the extremes of minimal and full disclosure.

Figure 1: Disclosure and Private Information



An important observation for policy follows from this last point: an absence of formal property rights does not translate into complete secrecy. As with our above discussion where we argued that rent appropriation and innovation incentives are still possible in the absence of property rights, we see that firms will still have an incentive to make public disclosures about their innovations. To the extent that providing the right to exclude others via a patent (and the creation of monopoly power) is driven by the social benefits of disclosure, it is important to recognize that the benchmark position is not one of complete secrecy.

Depending on the degree of invention (i.e. reduction of costs), the relative cost of disclosing usable technical know-how changes. Firms with smaller inventions face lower costs of revealing this technical know-how for two reasons. First, the cost to infringing is disproportionately greater than the benefits when infringement involves small inventions. Second, if the other firm has been investing in innovation (though did not get the patent), it is likely to have made at least some progress in learning to reduce its costs. Then, the full disclosure of the smaller invention is not so harmful as the competitor is likely to "know" that invention already. This implies that the (marginal) cost of disclosure vanishes at c_H whereas the (marginal) benefit is still positive. Consequently, a firm with a modest invention will disclose fully as the benefit swamps the cost. In both of these cases, however, firms with more significant inventions will face a positive cost margin and the tradeoff comes back into play, leading to a partial disclosure.

For a specific context, suppose legal damages for infringement take the form of "reasonable royalties" and that the competitor is deciding between staying with a prior generation technology (cost of c_H) and risking a court finding of infringement by using the disclosed information of the patenting firm. For any disclosure near c_H, the firms are almost symmetric in the market competition and the sizeable market share of the rival implies a large expected royalty damage. Staying with the safe technology is better and because of this, the patenting firm will fully disclose in this range.

Another interesting implication for IP policy is that partial disclosure by the innovator and infringement by a rival go hand-in-hand in equilibrium. That is, the situations in which the inventor chooses to rely on secrecy, at least in part, are also the situations in which the rival will find it profitable to infringe the property right. Intuitively, if a partial disclosure could deter infringement then it would be advantageous for weaker innovator type to mimic the disclosure (which is feasible since it is a partial disclosure). In these cases, the increased market competition is providing a cap of sorts on monopoly distortions in the market.

5. Implications for Competition and Antitrust Policy

Antitrust agencies consider the implications of patents on competition in many contexts ranging from mergers to standard-setting organizations. One important concern has been with potentially anticompetitive settlements of patent litigation.[13] Here, the existence of weak patent rights greatly complicates the analysis of whether a particular patent dispute settlement constitutes an antitrust violation.

Patent litigation typically focuses upon whether the patents at issue are valid and/or infringed. For ease of explication, this section will address validity issues and not the related issue of infringement. A primary reason for a patent to be invalidated is that the teachings of the patent are anticipated by previous patents or publications and, therefore, the claimed invention is not "nonobvious." Patent litigation is typically expensive and unpredictable. Not surprisingly, litigants frequently settle their disputes prior to a judicial ruling on validity. The settlements could entail, for example, licensing, cross-licensing, monetary payments and/or a cessation of the alleged infringing use.

Although settlement is typically efficient, in some cases, the settlement process can be hijacked for nefarious (anticompetitive) purposes. The challenge for society is determining when such settlements constitute antitrust violations but to do so in a manner does not over-deter legitimate settlements.

Antitrust law acknowledges that a valid patent confers exclusivity to the patent-holder and, therefore, that many agreements between horizontal parties with respect to a patent

[13] See, e.g., Schering-Plough Corporation vs. Federal Trade Commission (11th Cir. 2005), Also Tom and Gillman (2003) list more than a dozen non-merger cases in which patent uncertainty has arisen in antitrust cases before the U.S. courts or antitrust agencies.

are permissible where they would be impermissible absent the patent. Whether a patent is valid or not—effectively a coarse assessment of the weakness of the patent--may determine the range of permissible agreements.

Several factors militate against full recognition of patent strength as the critical variable when evaluating settlements for antitrust implications. In particular, under the law patents are not only presumed valid, but also, in effect, presumed strong. Those challenging the patent must demonstrate based on "clear and convincing evidence" that the patent should not have issued. This high standard is imposed despite the fact that when the Patent and Trademark Office (PTO) evaluates a patent application, it determines whether to issue the patent based on the lower "preponderance of the evidence" standard, a practice that has been soundly criticized by many including the FTC.[14] Arguably, this escalation of patent strength contributes to the ability of owners of weak patents to game the system.

We briefly consider two scenarios, one in which the patents are strong on the merits, the other in which they are weak. Collectively, the scenarios suggest that weak patent rights increase the opportunities for parties to act anticompetitively while, at the same time, decreasing the ease with which such conduct can be detected and stopped.

Strong Patent Scenario If patents at issue are strong, then a primary concern would be an anticompetitive settlement of a "sham" litigation.[15] For example, competitors with somewhat related patents could engage in sham patent litigation, which they could then "settle" with a cross-license that effectively enables them to collude by increasing each others' costs through mutual royalty payments (Shapiro 1985). This mutual increase in costs has the potential to reduce output and increase prices.

Weak Patent Scenarios Now suppose that the patents at issue are weak. If two patentees have related patents and each challenges the other's validity, they might well prefer to share monopoly profits than to risk the possibility that both could, for example, have their patents found invalid. (See, e.g., Choi 1998). Or, the patentee could pay the other party "hush" money in order to get them to not divulge prior art or other information that could result in the patent being invalidated. These scenarios are clearly wrapped up in the weakness of the patent. As an aside, note that the antitrust bonafides for many cases are sufficiently clear that the outcome would remain the same regardless of the any clarification of patent strength.

How can or should antitrust agencies address patent strength when they assess the competitive impacts of an IP dispute settlement? Numerous possibilities have been proposed to facilitate treatment of weak patents in antitrust cases. Some are mechanisms designed to directly evaluate patent strength. For example, the antitrust agencies themselves could request PTO reexamination of competitively significant patents. This

[14] FTC Report (2003).
[15] More generally, the antitrust agencies would determine if a license with a horizontal competitor reduces competition.

course of action was something the FTC undertook at least once in the past and about which it has expressed a renewed interest.

Although, the FTC could also undertake evaluation of patent strength themselves, the institutional challenges attendant to such an approach are numerous. As a practical matter, there is the problem of expertise and resources. Evaluating patent validity issues is an extremely resource-intensive enterprise in and of itself. Further, government challenges to settlements encounter the additional obstacle that the antitrust defendants (the parties to what would have been the underlying dispute) are most likely to have the best information regarding patent strength.

But even if those points could be overcome, there is a question of institutional role: should the FTC be engaged in such determinations or should the determinations be left to the PTO and the courts. With these constraints in mind, at least one proposal is that the FTC would engage in a limited assessment of patent strength.[16] Another set of proposals involve "objective indicators of patent validity." That is to say, "antitrust regulators could attempt to identify proxies for patent validity – objective criteria or behavioral conditions that make economic sense only if the patent rights are invalid." The most common indicator or "red flag" includes payments from the patentee to the challenger or "reverse payments." (O'Rourke and Brodley 2003, p. 1784).

6. Implications for Organizational Incentives and Entrepreneurial Activity

Weak property rights and private information also affect intra and inter-organizational structure and relationship choices. These choices have a wide range of implications for public policy. Here we briefly discuss how such choices affect (1) potential conflict of interest problems within a firm that provides multiple products or services and (2) incentives to create and to exploit inventions, and move ideas and inventions across firm boundaries.

In this section we will take the perspective that in knowledge-based industries, an important perspective on understanding organizational structure is to view structure as a knowledge management choice. (See, e.g., Teece and Chesbrough 1996, Rajan and Zingales 1998, and Demski, et. al., 1999). From this perspective some organizational structure choices are "remedies" to undesired flows of knowledge across division and firm boundaries.

Organization Structure and Conflicts of Interest

Proprietary information is often learned during the course of transactions between firms and this information may have value in other unauthorized uses. For example, a consulting firm that learns one client's future marketing strategy might find that

[16] Hovencamp, et. al. (2003), argue that the government would consider whether the plaintiff's "ex ante likelihood of prevailing in its infringement lawsuit is significant…. This oversight necessarily requires some inquiry into the merits of the IP suit, but we think it need not be particularly searching." But see O'Rourke and Brodley (2003) for a discussion of what "significant" means as a practical matter.

information valuable in consulting with another client. While the confidentiality of client information is legally protected, under some circumstances that information may be leaked to advantage—or if the same people are involved with both clients, it may be impossible to "forget" the other client's information.

While there are usually legal protections in place for abuse of confidentiality, it is quite challenging to discover effectively and then enforce knowledge leakage, especially when it involves easily remembered ideas or plans. Thus, in many circumstances, confidentiality agreements should be viewed as giving only "weak" property rights to the protected knowledge.

This abuse of confidential information problem is examined in Demski, et.al. (1999). There organization structure and the nature of type of ownership is seen as a means to commit an organization not to engage in unauthorized use of client's information. The context is that of a consulting or accounting firm that necessarily learns private information about its clients and may have a difficult time forgetting such information when it becomes useful in other contexts (e.g. for other clients). In the analysis, a client has a difficult time monitoring the firm for misuse of its proprietary information and misuse is beneficial to the firm. As a result, the client anticipates some level of misuse and reduces the fee it is willing to pay accordingly. The firm would like to commit to no misuse, but has a strong incentive to misuse the information once the client is signed on. In this setting the firm can respond with changes in performance incentives or observable investments in information security. High-powered (strongly performance-based) incentives for employees increase the extent to which proprietary information is (mis)used by employees, so firms that need to reduce misuse of information find it useful to decouple performance from pay. Firms may also choose to erect "Chinese walls" to increase the costs of information flow (e.g., the firms can locate two divisions in different physical locations). As a matter of public policy, the firm also benefits from an increase in the legal liability for breach of proprietary information. This liability assures the client that the firm has incentives to increase its organization and incentive choices to improve information security.

Conflicts of interest also appear in transactions involving an upstream firm, e.g. a satellite manufacturer, that is forced to rely on a downstream firm, e.g. a launch vehicle supplier, which also owns a rival to the upstream firm. It will often be the case that the upstream firm will share proprietary information with the downstream firm in order to achieve appropriate integration efficiencies. But the downstream firm may find it in its self-interest to share some of this proprietary information with its upstream subsidiary, thereby potentially affecting relative competitiveness and possibly reducing innovation activities or even price competition.[17]

Creation and Exploitation of Inventions: Ownership, Control, and the Movement of Ideas and Inventions Across Firm Boundaries

[17] See "Martin Marietta to 'Build Wall' Between Satellite and Launch-Vehicle Divisions to Settle FTC Charges over General Dynamics Acquisition," Federal Trade Commission Press Release March 25, 1994. This general class of problem has been analyzed by Hughes and Kao (2001).

Within a firm, inventions are generally creations of an individual or a team of individuals. This situation creates some potential difficulties for a firm. Consider the case of an individual that discovers an important insight into an invention while working in the firm, but the knowledge is pre-patent or is unpatentable. She could disclose this insight to the firm (after all she is an employee of the firm), but she might worry that once the firm has the information it will not reward her. Alternatively, she can take advantage of the relatively liberal U.S. employment law and either take the idea elsewhere or leave and develop the idea in her own start-up.

The knowledge held by the employee is private information pending disclosure. Weak property rights exist in this setting in three ways. First, no formal property rights (e.g. patents) are established over the invention insight. Second, if the employer owns the property right, it may still be difficult for the employer to effectively enforce it (i.e., firm can't establish that the employee learned the idea prior to departure).[18] Third, while the employee would normally own the property right, say because the insight was developed "after hours," the employer might still be able to exploit the knowledge under the penumbra of its rights as employer, claiming the key conception occurred during company time and with company resources.

A number of recent court cases highlight the tension between inventor-employees and their employers. A prominent example is the case of Shuji Nakamura who in 1990 received a $150 bonus from his employer, Nichia, after revealing his blue light LED invention. In subsequent litigation, Nakamura argued that the company did not support his research and that most of it was done after hours. A Japanese court in 1999 awarded Nakamura $100 million in damages (subsequently reduced in a later settlement to a reported $8 million but still a precedent-setting settlement in Japan for an employee-inventor). Court documents indicate Nichia reported $1.15 billion in profits in 2004 on the sale of products based the Nakamura invention.[19]

Returning to the individual inventor within the firm example, as the employee developed the invention while working for the firm, she has (generally would have) no property rights over it.[20] If the employee anticipates little compensation, the employee might be encouraged not to disclose the conception, but to depart the firm.

Alternatively, the employee could reveal the conception to the firm and seek to bargain for payment. But disclosure weakens the bargaining position of the employee as the employer can now develop this conception without paying the employee anything, although the employer may have to contend with competition if the employee chooses to leave and take the knowledge elsewhere (say to a startup). By remaining silent and

[18] It is difficult for an employer to win a suit against an employee who has departed with an idea when the misappropriated idea was in a formative stage and possibly was not even known to the firm. See, e.g., Merges (1999). Almeida and Kogut's (1999) analysis of the knowledge flow in the semiconductor industry finds that employee mobility is a important influence on the local transfer of knowledge between firms.

[19] *Managing Intellectual Property*, March 2004, p.1.

[20] This discussion is based on Anton and Yao (1995).

departing, however, the employee can pursue a start-up under more of a monopolistic scenario as the firm lacks the information to compete. In these settings, the departure option is often more attractive, even when in-house development generates a larger private joint reward.[21]

There are a number of public policy levers that can alter the outcomes of this employee-employer relationship. One set of levers involves changing the strength of the underlying patent and/or trade secret property rights. A second set of levers involves the breadth of rights given to those associated with the invention.[22]

In the employer-employee relationship, the existence of private information can lead to a situation in which property rights remain effectively weak for the employer even while policy shifts toward a stronger property right regime. For instance, if the invention can ultimately be protected via a strong patent, then the outside reward to the employee from remaining silent and leaving the firm to form a start-up can be expected to increase. Similarly, stronger trade secret protection can be expected to improve the bargaining position of the employer, provided that the employer is aware of the invention. But this means that the incentive of the employee to remain silent (rather than reveal the invention to the employer) and depart to form a start-up may rise since the prospect of a reward from the firm is diminished. Thus, because private information impacts the ability to acquire and enforce a property right, the net impact of stronger protection may be a weaker economic property right for the employer.

A similar counterintuitive effect can arise when legal "shop rights" govern the relationship between the firm and employee. Shop rights refer to a distinction in the law concerning the duties of an employee, inventions and company resources. Under a close relationship, inventions belong to the firm; in other cases, the employee is granted ownership while the firm acquires free, non-exclusive use (shop rights) to the invention but is not able to sell the invention to others or prevent the employee (inventor) from doing so. If the firm learns of the invention, for instance after the employee departs to form a start-up, then it may be able to obtain and exercise shop rights. This implies a weaker effective property right for the departing employee/inventor and a smaller start-up reward. In these cases the weaker property right then translates into an increased likelihood that the firm and employee will be able to contract successfully and develop the invention jointly.

7. Conclusion

Weak patents have strong implications for competitive behavior. One important channel through which weak patents work is via their impact on information with which economic decisions are made. The impact of strength of property rights and asymmetry

[21] See Aghion and Tirole (1994) for an analysis of how ownership and control of property rights affects innovation effort and innovation investment under strong property rights.

[22] A third set of levers involves allowing the firm more freedom to write employee contracts that restrict employee mobility.

in information among competitors depends on the nature of the invention. Information asymmetries play an especially prominent role for unobservable inventions (e.g., process inventions), but even naked idea inventions are affected.

Our analysis suggests that very weak property rights does not, by itself, mean that innovation incentives are fully undermined. Thus, attempts to adjust the property right system based on the idea that weak property rights implies little incentive for innovation would underestimate actual innovation incentives and might lead to policies that provide excessive incentives to innovate.

Strategic considerations unfolding from information asymmetry considerations affect choices of how to protect inventions and the possibility and nature of infringement. Weak patents increase the likelihood of imitation and infringement which reduce the incentives to innovate. This, in turn, affects innovation investment, potentially reducing the gain from being a winner in an innovation race, and the amount of knowledge that becomes publicly disclosed.

Innovation incentives can be increased by changing the way courts determine damages. Under the current system, strategies by the firm to minimize damages while gaining net advantages from infringing, make infringement more likely and reduce the general incentives to innovate. A movement toward including some level of disgorgement of profits from the infringer (but not necessarily to the patent holder) would discourage such infringement strategies. Disclosure of know-how that serves to feed overall innovation, will be discouraged with weak patents as well. In such settings one expects firms to rely more heavily on secrecy.

Our discussion also highlights some implications of weak patents for antitrust policy. Firms may engage in (anticompetitive) activities to strengthen an otherwise weak patent right through settlements or patent pools. Weak patent rights increases the likelihood of patent litigation over commercially valuable patents. Such litigation raises, however, the specter of anticompetitive settlements. Greater enforcement activity by the antitrust agencies in the area of intellectual property settlements would help rein in such behavior. However, current antitrust efforts are hampered by lack of patent expertise and general political resistance to an expansion of antitrust agencies role into patent assessments. These problems raise the costs to the agencies of this line of investigation. Allowing the antitrust agencies to refer some patents for reexamination by the patent office would be helpful in lowering the costs to the agency of IP settlement investigations.

Finally, increasing the strength of confidentiality protection reduces the incentive of firms with potential conflicts of interest to take opportunistic advantage of their access to proprietary information. It does this by effectively committing the firm to a credible incentive structure that penalizes confidentiality breaches.

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