Policy Implications of Weak Patent Rights

by

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1. Introduction

All patents are not created equal. They vary substantially in the degree of protection provided against unauthorized imitation. Thus, patent strength—or the lack thereof—is a major concern for innovators and imitators alike. Patents may lack strength for a number of reasons, including, they have a significant probability of being overturned or they are relatively easy to circumvent. We refer to patents with such characteristics as "weak," though this category also includes patents of middling strength.

Intellectual property policy discussions often adopt a perspective on patents that implicitly assumes the characteristics associated with strong patents. But research suggests that this starting point may be unjustified and potentially misleading because the economic and policy implications of weak patents frequently differ from those of strong patents. For example, weak patents cause firms to rely more heavily on secrecy, which, in turn, creates an environment in which competing firms lack economically important information about the capabilities of their competitors.

This chapter explores the economic and policy implications of weak patents. We begin by exploring the significance of weak patent rights in the presence of private information. The remaining sections then discuss 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 Intellectual Property and Private Information

Weak patent rights and private information interact and, therefore, are best considered together. We briefly discuss each factor in turn and then consider their interaction.

The Ubiquity of Weak Patent Rights

Considerable evidence suggests that for a wide array of technologies (and hence industries) patent protection is not strong. This section reviews some of the evidence regarding variations in the strength of patent protection.

Evidence of Weak Patents

A substantial proportion of patents granted in the United States are at risk for being invalidated or narrowed. Determining the precise percentage of such dubious patents is difficult, but studies of patent overturn rates are suggestive on this count.[1] Along these lines, Allison and Lemley (1998) found that among patents challenged on validity grounds, 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%. Insufficiency of examination resources is an important contributor to the patent quality that results in such reversal rates.[2]

Under the U.S. patent system careful examination of all patent applications would be extremely costly. Because the vast majority of patents have little or no ultimate economic value, a close examination of all patent applications arguably wastes resources. Patents that have economic value and that are legally questionable are natural targets for litigation by competitors or other affected parties. Litigation focuses intense scrutiny on precisely those patents that matter. Many consider patents as "licenses to sue" and it is through the litigation process that the true strength of a particular patent emerges.

In addition to legal soundness, patent strength also depends on the ability to exclude economically "close" substitute technologies. If such a circumventing technology results in a product that has comparable performance and cost characteristics as a product embodying the patented technology, then the private economic value of the patent is lessened.

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 earlier study by Mansfield, Schwartz, and Wagner (1981) examined 48 innovations (of which approximately 70% were patented) and found that about 60% were

[1] Two problems with determining the percentage of dubious patents are that validity challenges are less likely when a patent is obviously strong and, conversely, many questionable patents may be licensed rather than litigated. Also, patents that are not invalidated but are narrowed will not necessarily count as being overturned. See, e.g., Jaffe and Lerner (2004) for an extended discussion of such issues and other estimates of reversal percentages.

[2] 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).

imitated within 4 years. This finding also suggests that the patents were not strong enough to deter infringement or avoid close circumvention.

Uncertain Patents

Many patents may also be perceived as weak when issued, in part because they involve issues of first impression. Later, some of these patents may be viewed as strong. In technical fields that involve a new class of technology, considerable uncertainty may exist regarding patent scope, or even the availability of protection at all. It was initially unclear, for example, whether a genetically altered living organism could be patented and some patents in biotechnology have been criticized as overexpansive, while others seem to conflict with existing patents. Business methods, which had historically been hard to patent, have found new patent life via *State Street*.[3]

The Ubiquity of Private Information

Because knowledge is easy to expropriate once it is known, firms typically attempt to keep their innovative know-how secret. Firms, therefore, frequently make critical investment and pricing decisions without knowledge of other firms' decisions and with quite limited knowledge of what others already have discovered. Sometimes firms may even be unable to identify whether others are working on the same problems.

A partial picture of the broader knowledge portfolio of a competitor can be gleaned from the competitor's patent portfolio (Rivette and Kline 2000). While such competitor scanning is of significant value and may suggest the overall foci of a competitor's research efforts, it constitutes only a lower bound on the competitors' actual knowledge. Moreover, even if all inventions were patented, patent know-how disclosures typically lag patent applications by eighteen months or more.

Competitors may also rely on trade secret protection rather than on patent protection, especially when a prospective patent is likely to be weak. In those cases not only is the know-how private, the extent of the competitor's know-how may be private as well. 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. This process left no trace in the product itself and could not be reverse engineered. Further, if Intel wished to keep the yield secret, it could have done so (Jackson 1997).

On the other hand, when a firm chooses to patent, it is forced to disclose technical know-how. As we discuss later, the patent may also signal the extent of the firm's total knowledge (patented knowledge and knowledge held secret).

[3] *State Street Bank and Trust Company v. Signature Financial Corp., Inc.* 149 F.3d 1368 (Fed. Cir. 1998).

Strength of Patent Right versus Extent of Private Information

The cost of 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 depth of protection against infringement. While the importance of validity and scope is self-evident, the depth of protection against infringement deserves some comment. Illegal 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] Moreover, even if detection is easy, it is unclear whether the amount of the infringement damages is sufficient to deter infringement in the first place. In the United States, the two primary methods used for awarding damages are determination of lost profits and determination of reasonable royalties. As we discuss below, both methods can be ineffective deterrents to infringement.[5]

When patents are not strong, a firm is more likely to rely on trade secrets 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 settings involving secrecy is that private information exists 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]

Secrecy cannot protect those innovations where the invention is disclosed through the product itself. In such cases, even weak patent protection is preferred to no protection at all. Patents also preempt others from acquiring a patent on the knowledge that a firm could have, instead, held secret. In the U.S. inventors who employ secrecy expose themselves to being excluded by subsequent patenting of their inventions by others. In Europe such subsequent patenting poses fewer problems as the Europeans allow the first inventor to continue to use the invention.

Table 1 examines how various combinations of *secrecy effectiveness* and *patent strength* 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. For example, *patent strength* is the expectation of the firm as to how well patents will protect its intellectual property should the firm choose to patent. *Secrecy effectiveness* represents

[4] *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 generally, Scotchmer and Green (1990), Gallini (1992), and Bessen and Maskin (2000).

the firm's expectation about how much knowledge 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. The secrecy effectiveness dimension separates inventions into three general categories: *naked idea* inventions, *black box* inventions, and *unobserved* inventions. Each category 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 patent protection, naked idea inventions can be imitated easily. 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 still 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. This category includes, for example, process inventions that allow a previously offered product to be manufactured for a greatly-reduced cost. Competitors may not 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 illuminates how a firm might choose its protection strategy given expectations about the invention's characteristics regarding patent strength and secrecy effectiveness. The decision to patent or keep know-how partially or completely secret has implications for a firm's assessment of its competitors' innovation positions which then affect investment, pricing, and entry. Oftentimes, it will benefit the knowledge-

holder to signal its advantageous position to its competitors (while avoiding fully disclosing the underlying know-how responsible for this advantageous position). Thus, the firm with private information may signal its position to competitors.

Table 1: Secrecy Effectiveness Versus Patent Strength

		Patent Strength	
		strong	*Weak*
Secrecy Effectiveness	*None (Naked idea)* key invention is observable in commercial product/service and technology readily imitable	Patent all observable inventions *Clasp locker (zipper)*	Patent but rely on first-mover or complementary asset advantages *Business idea such as a Greek-Chinese fusion restaurant*
	Know-how hidden (Black box inventions) key invention cannot be reverse engineered but performance observable	Patent most, but concern about protecting future generation inventions *Semi-adhesive post-it note*	Rely heavily on secrecy *Coca-Cola formula*
	Know-how and extent hidden (Unobserved inventions) use of invention not directly observable	Patent most and use know-how disclosure as signal of extent of remaining secret know-how *"reflow" process to aid in manufacture of MOS circuits* (Jackson 1997)	Rely on secrecy, but use know-how disclosure as signal of extent of secret know-how *cost-reducing process invention*

3. Implications for Innovation Incentives

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.

Generally, weak property rights reduce the prize available to a patent holder. Within a specific context, however, the impact of weak property rights, depends in part on whether the intellectual property in question can be protected by other means and the incentives of the innovator's competitors to use the innovator's know-how.

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

At an extreme, weak property rights approach no property rights, a characteristic typifying early-stage conceptions of many creative ideas. But the absence of property rights does not exclude appropriation. For example, an inventor without property rights can still appropriate rents even when she must fully reveal the know-how of the invention 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."[7] By revealing the invention, the seller removes the buyer's initial skepticism about the value of the previously unseen invention, but now faces the possibility that the now-informed buyer can freely expropriate the invention when there are no property rights. This is, of course, the classic market for ideas problem Arrow identified (1962). The buyer, 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 with no 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 recognize 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 similarly situated with regard to the development and subsequent commercialization of the invention. In many cases, a firm with nonexclusive access to an invention can appropriate the invention's value because of control of complementary assets such as superior marketing or manufacturing capabilities. (See, e.g., Teece 1986). Anand and Galetovic (2004) discuss numerous 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 is arguably less likely to invest in such innovation in the first place. The actual 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. With the exception of 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. Trade secrets provide no legal (except via contract) protection and need not result in disclosure beyond that which is unavoidable through product inspection. In fact, it opens up the innovator to infringement questions should a competitor invent and patent. Because innovations are rarely composed of a monolithic piece of knowledge, a combination of patenting and secrecy is common. An innovator may also preempt imitation by licensing the weakly protected invention to imminent competitors.

An innovation choice regarding the balance of patent and trade secret protection depends on anticipating what the competitors would do, which depends, in part, on the competitor's perceptions of how much innovative knowledge the innovator possesses. For example, how much a potential licensee would be willing to pay for a license depends on what know-how it receives and what additional know-how the licensor retains for the licensor's own advantage.[9] Weak patent rights may induce an innovator to hold some of its know-how secret, thereby leaving the potential licensee with no direct way of learning the full extent of the innovator's knowledge. This critical information asymmetry potentially interferes with the valuation calculation that underlies a licensing negotiation or, alternatively, a cost assessment that impacts competition absent a license.

The message with respect to imitator choice is that in settings with private information (e.g. where secrecy is employed) 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 signals persuade an imitator that the innovator has a significant cost advantage, the imitator will be less aggressive in the ensuing product market competition.

Innovation Investment: Failure Has its Reward Too

[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).

Consider the implications of weak property rights and private information for innovation investment decisions when two or more firms are competitors in innovation, e.g. racing for the patent. Under strong patents, the incentives for firms to invest are strong as the competitors vie for the "monopoly" position.[10] But in the case of weak patents, the reward associated with winning and the "costs" attendant to losing the race are anticipated to be less. The reduction in the cost of losing comes about because the loser under weak patents can more easily circumvent the patentee's invention. This "reward" to failure is a force which acts to decrease the incentive for investment since it decreases the relative difference in competitive positions before and after the innovation race.

Even when a patent provides 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 United States. Consider, for instance, a process innovation within the context of 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's profits to the level that would have been earned 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 incentive to invest in R&D.[12]

The analysis of weak property rights in the presence of private information leads to several results. First, weak patent rights are not fatal to innovation incentives. Second, weak patent rights increase the level of private information. Both of these results 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. In sum, an increased incentive to infringe generally corresponds with lowered incentives for innovation.

4. Implication for Disclosure Incentives (i.e. Patents 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.

In addition to encouraging innovation, another critical purpose of the patent system is to encourage know-how disclosures. Weak patents prompt innovating firms to rely more heavily on secrecy, which, in turn, reduces the amount of knowledge publicly disclosed. Note that if product inspection or reverse-engineering reliably yielded all relevant information then the policy benefit from patent disclosure would be diminished (if not eliminated).

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 corresponding to the case of an *unobserved invention* under weak patent rights (see Table 1) in which greater innovative know-how translates into lower costs. Recall that an *unobserved invention* refers to an invention in which both the extent of know-how and the actual know-how are private knowledge of the innovator. 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 know-how 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

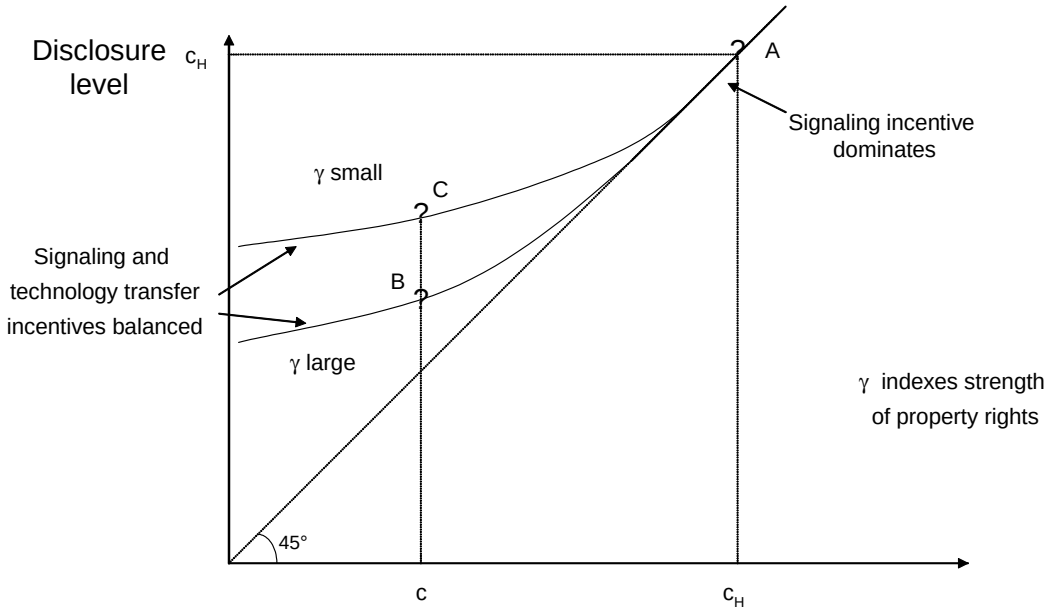
outcome (See Anton and Yao 2003, 2004). Small innovations, which mean high costs in the cases of process innovation, are often fully revealed. With larger innovations, meaning lower costs, disclosure is partial and the firm resorts to secrecy to a greater extent (convex shape).

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 disclosures about the know-how 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 know-how 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 patent rights are strong or weak. The parameter γ is an index for the strength of patent rights, such as the probability of invalidity or compensation via legal damages for infringement. As patent 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 patent 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 patent 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 patent 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 social benefits of disclosure underlie the right to exclude others via a patent (and the creation of monopoly power), 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 inventive steps 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 another firm has invested in innovation (though failed to get the patent), it likely made at least some progress in learning costs reduction. 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 only partial disclosure.

For a specific context, suppose legal damages for infringement take the form of "reasonable royalties" and that the competitor must decide 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 patent right. Intuitively, if a partial disclosure could deter infringement then it would be advantageous for the weaker innovator to mimic the disclosure (which is feasible since it is a partial disclosure). In these cases, the increased market competition provides a cap of sorts on monopoly distortions in the market.

5. Implications for Competition and Antitrust Policy

Antitrust authorities consider the implications of patents on competition in many contexts ranging from proposed mergers to the conduct of standard-setting organizations. [13] One important concern has been with potentially anticompetitive settlements of patent litigation. The resolution of litigation through settlement is typically efficient and should be encouraged. In some cases, however, the settlement process can be hijacked for anticompetitive purposes. The existence of weak patent rights 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 focus on validity issues rather than the related issue of infringement. A primary reason patents are invalidated is that previous patents or publications anticipate the teachings of the patent 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. Such settlements include a wide variety of elements, including, for example, monetary payments, licensing, and/or agreements to discontinue the alleged infringing use.

Antitrust law recognizes that a valid patent grants exclusivity of use to the patent-holder. Therefore, many agreements between horizontally-related parties that would normally constitute law violations are permitted when the agreement involves a valid patent. Whether a patent is valid or not—effectively a crude assessment of patent strength—may determine the range of permissible agreements.

[13] See, e.g., Tom and Gillman (2003) who 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.

Consider the following example: A patent holder sues an alleged infringer who counter-claims that the patent is invalid. A settlement is reached wherein the alleged infringer receives favorable licensing terms. To what extent is or should society's estimation of the settlement reflect the strength of the underlying patent? If the patent is strong, the patent holder is entitled to the market power that the patent's exclusivity conveys.[14] Part and parcel of that is the considerable leeway the patent holder enjoys as it pertains to licensing. Stated alternatively, the patent holder as "monopolist" is permitted to reach a settlement that creates a duopoly involving the patent-holder and the alleged infringer. A comparable outcome given a weak patent would, however, be potentially anticompetitive, if, for example, the result would be prices that are higher than what would have resulted had the patent been invalidated.[15]

Perhaps the most important part of this example is that which is assumed. Distinguishing patents according to strength can be extremely difficult. This is particularly true when the information needed for such an assessment is private and divulgence of that information is not in the interests of those who hold it. Consequently, weak patent rights may increase opportunities for anticompetitive conduct while, at the same time, may decrease the ease with which such conduct can be detected and stopped.

How can or should the antitrust agencies address patent strength when they assess the competitive impact of a patent settlement? Numerous mechanisms have been proposed to facilitate treatment of dubious patents in antitrust cases. Some proposals facilitate direct evaluation of patent strength. For example, the antitrust agencies themselves could request PTO reexamination of competitively significant patents. The FTC took this approach at least once in the past and has expressed a renewed interest in it (FTC Report 2003).

The antitrust agencies could, in theory, evaluate patent strength themselves, though the institutional challenges attendant to such an undertaking are numerous. As a threshold matter, there is the problem of expertise and resources. Evaluating patent validity issues is an extremely resource-intensive enterprise. Further, government challenges to settlements encounter the additional obstacle that the antitrust defendants (the parties to what would have been the underlying patent dispute) are most likely to have the best information regarding patent strength as well as an "often strong incentive to submerge or conceal pertinent information..." (Bowman 1973, p. 242).[16]

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[14] That is, the market power depends on how much competition exists from noninfringing substitutes.

[15] See, e.g., Shapiro (1985), (2003) and Choi (1998). There are also examples, of course, in which the antitrust bonafides are sufficiently clear that the outcome would remain the same regardless of any clarification of patent strength.

[16] Evidentiary standards present another obstacle to antitrust cases involving patents. Under the law patents are presumed valid. 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. Arguably, this escalation of patent strength, a practice that has been soundly criticized by many including the FTC, contributes to the ability of owners of weak patents to game the system (FTC Report 2003).

In addition to those practical issues, there is arguably a more fundamental question concerning the proper scope of an antitrust agency's institutional role. Should the agency be engaged in such determinations or should the determinations be left to the PTO and the courts? Given these constraints, at least one proposal has advocated that the antitrust agencies engage in a limited, but direct, assessment of patent strength.[17] Another set of proposals take a less direct approach and involve agency evaluation of "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 decisions. In this section, we 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 choices regarding organizational structure are best understood as "remedying" undesired knowledge flows across division and firm boundaries.

We briefly discuss how organizational and relationship decisions affect (1) potential conflict of interest problems within a firm that provides multiple products or services and (2) incentives to create and exploit inventions and to move intellectual property across firm boundaries.

Organization Structure and Conflicts of Interest

Proprietary information learned during the course of transactions between firms frequently has value in other unauthorized uses. For example, a consulting firm that learns one client's future marketing strategy might find that information valuable in consulting with another client. While the confidentiality of client information is legally protected, under some circumstances that information may be strategically 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 legal protections are typically available to deter breaches of confidentiality, it is difficult to discover and then effectively stop knowledge leakage. Thus, in many circumstances, confidentiality agreements may confer only "weak" property rights to the protected knowledge.

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

Demski, *et.al.* (1999) examined this abuse of confidential information problem and the impact of organizational and ownership structure on the amount of abuse. In their model an employee of a (consulting) firm has an incentive to misuse a client's proprietary information and the client (e.g., a consulting client) cannot monitor the misuse. Misuse is anticipated by the client and is reflected in a lower fee. The firm's choice of an employee incentive structure moderates but does not generally eliminate an employee's incentive to misuse proprietary information. 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 decouple performance from pay. Firms may also find it valuable to make observable investments by erecting "Chinese walls" to increase the costs of information flow (*e.g.*, the firms can locate two divisions in different physical locations), thereby increasing information security and, hence, client fees. As a matter of public policy, the firm also benefits from increased legal liability for proprietary information. This liability assures the client that the firm has incentives to structure 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 must rely on an integrated downstream firm, *e.g.* a launch vehicle supplier, which also owns a rival to the upstream firm. The upstream firm frequently must share proprietary information with the downstream firm to achieve appropriate coordination efficiencies. But the downstream firm may find it in its self-interest to divulge some of this proprietary information with its upstream subsidiary, thereby potentially biasing the upstream competition in favor of the integrated firm.[18]

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

Within a firm, inventions may be either the creations of an individual or a team of individuals. This situation is the source of many potential difficulties. 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.

An employee's knowledge 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

[18] 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).

that the employee learned the idea prior to departure).[19] 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. One prominent case involves 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 which he pursued primarily after hours. In 1999, a Japanese court awarded Nakamura $100 million in damages.[20] Court documents indicate Nichia reported $1.15 billion in profits in 2004 on the sale of products based on Nakamura's invention.[21]

Returning to the individual employee-inventor example, rather than leaving, the employee could reveal the concept to the firm and seek to bargain for payment.[22] Disclosure weakens the bargaining position of the employee because once the concept is disclosed, the employer can develop this concept without further compensating the employee, though it may then have to compete with a start-up begun by the ex-employee. By remaining silent and departing, however, the employee can pursue a start-up which will encounter less competition from the former employer, who 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.[23]

Numerous public policy levers can alter the outcome 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.[24]

In the employer-employee relationship, the existence of private information can lead to property rights remaining economically weak for the employer notwithstanding policy shifts toward a stronger legal property right regime. If the invention can receive strong patent protection, then the outside reward to the employee from remaining silent and leaving the firm to form a start-up will likely increase. Similarly, stronger trade secret protection can be expected to improve the bargaining position of the employer, provided

[19] It is difficult for an employer to win a suit against an employee who has departed with an idea when the arguably 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.

[20] This award was subsequently reduced in a later settlement to a reported $8 million which was still a precedent-setting settlement in Japan for an employee-inventor.

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

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

[23] 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.

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

that the employer is aware of the invention. Consequently, the incentive of the employee to remain silent (rather than reveal the invention to the employer) and depart may increase since the prospect of a reward from the firm is diminished. Therefore, because private information impacts the ability to acquire and enforce property rights, the net impact of stronger legal 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 allow the employer free nonexclusive use of an employee's invention when that invention was created using the employer's resources. If the firm learns of an invention, for instance after the employee departs to form a start-up, then it may be able to exercise shop rights over that invention. 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 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. By inducing more use of secrecy to protect innovation, weak patents cause key economic decisions to be made under conditions of private information. Private information is especially salient for settings involving black box or unobserved inventions.

Private information considerations affect choices of how to protect inventions and the possibility and nature of infringement. Weak patents increase the likelihood of imitation and infringement and increase the use of secrecy. This, in turn, affects innovation investment, potentially reducing the gain from being a winner in a patent race and the amount of knowledge that becomes publicly disclosed.

Changes in judicial determinations of damages can increase incentives to innovate. Under the current system, firm strategies to minimize damages while gaining net advantages from infringing make infringement more likely and reduce the general incentives to innovate. The inclusion of some level of profit disgorgement from the infringer (but not necessarily to the patent holder) would discourage such infringement strategies.

Our discussion also highlights some implications of weak patents for antitrust policy. Weak patent rights increase the likelihood of patent litigation over commercially valuable patents. Such litigation raises, however, the specter of anticompetitive settlements. Greater oversight by the antitrust agencies in the area of intellectual property settlements would arguably help rein in such behavior. Current antitrust efforts, however, are hampered by a lack of patent expertise and possible political resistance to an expansion of antitrust agencies role into patent assessments. Encouraging the antitrust agencies to

refer some patents for reexamination by the patent office would facilitate agency investigation of potentially anticompetitive settlements.

Weak property rights result not only from limited scope of legal protection but also from the difficulties associated with discovering unauthorized use of intellectual property. Two important settings where discovery is difficult are breaches of confidentiality and loss of intellectual property through employee departure. In the former case, increasing judicial penalties for breach of confidentiality would induce firms to adopt more secure incentive schemes and/or to make more investments in information security. In the latter case, however, an increase in the strength of legal property rights will not necessarily reduce the loss of intellectual property through employee departure. Increases in strength has the direct effect of reducing the loss of intellectual property that the employer knows about, but this effect can be offset because stronger legal property rights also encourage the employee to keep more inventions secret from the employer in anticipation of leaving to launch a start-up.

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