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Probabilistic Patents

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Probabilistic Patents[1]

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Abstract

Economists often assume that a patent gives its owner a well-defined legal right to exclude others from practicing the invention described in the patent. In practice, however, the rights afforded to patent holders are highly uncertain. Under patent law, a patent is no guarantee of exclusion but more precisely a legal right to try *to exclude. Since only 0.1% of all patents are litigated to trial, and since nearly half of fully litigated patents are declared invalid, this distinction is critical to understanding the economic impact of patents. The growing recognition among economists and legal scholars that patents are probabilistic property rights has significant implications for our understanding of patents in four important areas: (1) reform of the system by which patents are granted; (2) the legal treatment of patents in litigation; (3) the incentives of patent holders and alleged infringers to settle their disputes through licensing or cross-licensing agreements rather than litigate them to completion; and (4) the antitrust limits on agreements between rivals that settle actual or threatened patent litigation.*

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For many years economists typically conceptualized patents as well-defined property rights giving their owners either a monopoly over some market or at least a significant competitive advantage in that market, e.g., due to control over a product improvement or a low-cost method of production (Nordhaus, 1969; Reinganum 1989).[4] Once a patent was issued, these models tended to assume that the patent was valid, that it granted a right of definite scope, and that competitors respected that right or were forced by courts to do so.

Viewing patents as grants of monopoly power has proven to be a highly flexible and informative framework. Treating patents as well-defined rights to exclude rivals has permitted economists to focus on the important and complex relationships among patents, innovation, competition, and diffusion of technology. This framework has informed research on a wide range of topics, including patent races, technology transfer through licensing, and research joint ventures (Lee and Wilde, 1980; Reinganum, 1989; Katz and Shapiro, 1985; Katz, 1986). This same basic approach to modeling patents has also been used to explore the thorny problem of how to apportion patent rights between initial inventors and subsequent improvers (Merges and Nelson, 1990; Scotchmer, 1991; Green and Scotchmer, 1995; Scotchmer, 1996; O'Donoghue et al., 1998). Due to the complex nature of these relationships, and since patents are frequently not the main method by which industrial firms appropriate returns from their R&D, the link between the stronger patent protection and more rapid innovation is both theoretically and empirically ambiguous (Levin, et al. 1997; Cohen, et al. 2000; Gallini, 2002).

More recently, however, economic and legal scholars as well as policymakers have begun to look more closely at the empirical evidence regarding the issuance of patents and patent litigation. We now know that the vast majority of patents that are issued are never litigated, and roughly half of those patents that are fully litigated are found to be invalid. At the same time, scholars and policymakers have begun to peek inside the "black boxes" of both patent prosecution and patent litigation. With nearly 200,000 patents issued each year in the U.S., many of questionable validity, economists have increasingly recognized that a patent does not

[4] Even those who focused on variability or uncertainty in the patent system tended to identify only a single axis on which the nature of the right could vary, most commonly the duration of patent protection. (Kaplow, 1984).

confer upon its owner the right to exclude but rather a right to *try* to exclude by asserting the patent in court. (Shapiro, 2003a).

Put differently, most patents represent highly uncertain or probabilistic property rights. By this we mean that patents are a mixture of a property right and a lottery. When a patent holder asserts its patent against an alleged infringer, the patent holder is rolling the dice. If the patent is found valid, the patent will indeed give its owner the right to prevent the infringer, and others, from practicing the patented invention. However, if the patent is found invalid, the property right will have evaporated entirely.

Of course, virtually all property rights have some element of uncertainty attached to them. The owner of real property may find that the title to that property is flawed; hence we have title insurance. The (careless) owner of a trademark may find that its mark has been used so widely as to become a generic term without trademark protection. However, we believe that the uncertainty associated with patents is especially striking and fundamental to an understanding of the effects of patents on innovation and competition.

This article explores the economics of probabilistic patents. As background for our analysis, we begin by giving a brief description of the system by which patents are issued and litigated in the U.S. This includes a review of the empirical data on patent prosecution and litigation. These data establish clearly that uncertainty is at the heart of today's patent system. The key observation is that a huge number of patents are issued after a very limited examination process, many of which will likely be found invalid if actually litigated. The objective validity of those patents is uncertain, or probabilistic, unless and until they are litigated. This uncertainty about patent rights is central to many important issues surrounding the patent system.

In Part II, we discuss the uncertainty of patent value, and the ways in which patents resemble lottery tickets. Part II also discusses the ways – both socially beneficial and socially harmful – in which patent applicants and competitors seek to hedge against that uncertainty.

In Part III, we then turn to the design of the system by which patents are granted and proposals to reform that system. Most of the attention paid to patent reform in the last few years has surrounded efforts to strengthen patent examination, weeding out bad patents and reducing

the uncertainty associated with patent validity. Scholars have posed the normative question of how much uncertainty is optimal in the issuance of patents, and its relationship to proposals to reform the patent system as a whole. It is far from clear that the most efficient overall system involves devoting greater resources *ex ante* to determining just which of the vast number of patent applications truly describe inventions that qualify for patent protection, since most issued patents turn out to have little or no commercial significance.

In Part IV, we evaluate uncertainty in the patent litigation process, and how proposed reforms would affect this uncertainty. Enforcing a patent right is an exercise fraught with uncertainty. Nearly half of all litigated patents are invalidated, and still other valid patents are of indeterminate scope. Proposed litigation reforms have moved in two different directions, some trying to modify the law to recognize this inherent uncertainty and others trying to reduce or eliminate the uncertainty associated with litigation.

In Part V, we explore the incentives of patent holders and alleged infringers to settle their disputes rather than litigate them to completion. Settlement is far more common than litigation. Indeed, virtually every patent licensing and cross-licensing agreement can be seen as the settlement of a patent dispute, even if the parties agree to licensing terms prior to engaging in formal litigation. We emphasize here the fact that carrying patent litigation to its completion produces information about the patent's validity and thus generates positive externalities. In particular, establishing that a patent is invalid can greatly reduce entry barriers and thus benefit other producers and ultimately consumers. Because patent settlements affect competition and generate substantial externalities, there is no reason to expect the frequency or form of private settlements to serve the public interest. Because litigating patent disputes to completion tends to generate positive externalities, we should expect to see too many settlements.

We develop this point further in Part VI by considering the antitrust limits on settlements of patent disputes between rivals. Quite naturally, patent owners often seek to hedge against the risk of invalidity by settling patent disputes. However, what the patent holder sees as a "risk of invalidity" is equally a chance for consumers to avoid bearing the costs of a monopoly that was improperly granted. While settlements of patent litigation between actual or potential rivals are normal and generally desirable, they also are agreements between competitors that can limit

competition. Drawing the line between pro-competitive settlements, which properly reward innovators and promote the diffusion of technology, and anti-competitive settlements, which harm consumers, is far from straightforward. For this reason, there has been a recent flurry of antitrust cases scrutinizing patent settlements under uncertainty. Here we identify the underlying economic issues and provide a basic framework for the antitrust analysis of patent settlements.

I. Patent Prosecution and Patent Litigation in the U.S.

Most economists are unfamiliar with the inner workings of the U.S. patent system. We begin by giving a quick overview of the elements of that system that are most pertinent to our analysis, starting with some basic statistics to put the patent system in perspective.[5]

Patenting is big business in the United States, and indeed throughout the world. Inventors file over 350,000 patent applications a year with the U.S. Patent and Trademark Office ("PTO"), a number that is growing steadily even in the face of an economic downturn (U.S. PTO Annual Report, 2003), and spend over $5 billion a year to obtain those patents (Lemley, 2001). The PTO grants nearly 200,000 new patents a year, a number that is also growing. (U.S. PTO Annual Report, 2003). John Barton has noted that this growth cannot be traced to increases in GNP, R&D expenditures, or productivity. Indeed, he finds that the growth in patenting is strongly correlated only with the growth in the number of patent lawyers. (Barton, 2000).

A. Patent Applications and Patent Prosecution

A patent application contains claims that describe the legal boundaries of the rights that are being sought. PTO patent examiners look at each application to see if the invention described in that application meets the statutory requirements for patentability. For our purposes, the required key elements are that the invention be novel and not obvious. The PTO tests for novelty by looking for prior art, typically as described in other patents and in publications and as incorporated into existing products. The applicant is required to disclose relevant prior art of which it is aware, but not to conduct a thorough search for prior art. The PTO is frequently

[5] More detailed descriptions of the operation of the U.S. patent system are available from many sources. See, for example, National Academies of Science (2004), Appendix A, "A Patent Primer," or Schechter and Thomas (2003).

criticized for missing relevant prior art and thus improperly issuing patents, especially in the areas of software and business methods. The PTO also checks that the invention would not have been obvious "to a person of ordinary skill in the art" at the time the application was filed (based on the prior art found by the PTO).

The applicant is required to disclose its invention in the patent application, which will then be made public when the patent is issued (or 18 months after the application is filed if the applicant also seeks patents outside the U.S.). The disclosure must be sufficient so that those skilled in the art can practice the patent without undue experimentation.

Inventors regularly file patent applications without any clear idea of whether the invention will be a commercial success, and in some instances whether the category of invention is even patentable at all. In part this dynamic is driven by the strong incentives to file applications early we have built into the patent system. Inventors who commercialize a product, publish a paper, or disclose an idea to the public have only a year in the United States to get a patent application on file. (35 U.S.C. § 102(b)). Those who wish protection abroad have even stronger incentives to file early, both because Europe lacks this one-year grace period and because if more than one inventor claims the same invention, every country but the United States will give the patent to the first person to file an application.[6] These policies encourage disclosure of ideas and help reduce the risk that a patent will take a mature industry by surprise.[7] But they also mean that in many industries, particularly pharmaceuticals and biotechnology, inventors must file applications on a large number of drugs or therapies of potential interest before they know whether those drugs will in fact be safe and effective.

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[6] If two parties are seeking claims for the same invention, priority in the U.S. is given to the first firm to invent. In the rest of the world, priority is given to the firm that is first to file for a patent. Disputes over priority are known as patent interferences.

[7] Prior to 1999, patent applications were not disclosed prior to the issuance of the patent. Therefore, some patent applications remained hidden from public view for years, even decades, while the PTO considered those applications and while industry participants made significant investments that ultimately required them to make use of the patented invention. These so called "submarine patents" arguably allowed patent holders to engage in significant opportunism, in part by strategically slowing down the PTO process and by amending claims to capture new products introduced into the market well after the patent application was initially filed. Submarine patents are less of a concern since the law changed in 1999.

Inventors also file patent applications in areas of technology that have historically not been patentable at all. The scope of patentable subject matter has been expanding over time (Gallini 2002). The Federal Circuit Court of Appeals added software to the list of patentable inventions in the 1980s and 1990s, and business methods in 1998. Because the consequences of keeping an invention secret can be severe if the invention turns out to be patentable – a first inventor who opted not to file for a patent can lose rights over the invention to a second inventor who did (Lemley et al., 2003) – inventors frequently file patent applications even in areas that are not currently eligible for patent protection, simply to hedge their bets. (Lerner, 2002).

Typically, the patent applicant negotiates with the patent examiner over the claims that will be allowed. This process is called patent prosecution. The burden is on the PTO to provide a reason *not* to issue a patent sought by an applicant. If the applicant is dissatisfied with the claims allowed by the patent examiner, the patent applicant can file a continuation application, even after receiving a patent, and thus continue to seek broader protection (in the form of a patent with broader claims). The applicant can even add new matter to the continuation application and claim the invention with additional, new elements. Applicants are allowed to track market developments and amend their applications to capture products that are appearing in the market, so long as they stay within the bounds of the invention described in the initial applications. Furthermore, applicants who are not content with the examiner's decision have appeal rights.

The nature of the examination process in the PTO is necessarily influenced by the large volume of patent applications. The PTO lacks the time and resources to give each of the 350,000 plus applications it receives each year a thorough and searching examination. Indeed, while the examination process takes nearly three years on average (Allison and Lemley, 2000), a patent examiner spends only 18 hours per patent on average during those three years reading the application, searching for and reading prior art, comparing the prior art to the application, writing one or more provisional rejections, reviewing responses and amendments, often conducting an interview with the applicant's attorney and writing a notice of allowance. (Lemley, 2001; FTC, 2003). Even with this quick look, the PTO currently faces a backlog of nearly 500,000 unexamined applications. Further, legal scholars who have studied the patent prosecution process have pointed to structural problems in the PTO that encourage it to grant patents of

doubtful quality, including high examiner turnover and an incentive system that rewards examiners for allowing but not for rejecting applications. (Merges, 1999; Thomas, 2001). The result is that the overwhelming majority of patent applications in the United States, at least 85%, ultimately result in an issued patent. (Quillen et al., 2003; NAS, 2004).[8]

A patent holder or a third party may request that a patent be re-examined if significant issues involving prior art are identified. *Ex parte* re-examinations involve no third party participation. According to the NAS Report, "Nearly one-half of *ex parte* re-examinations are brought by patent owners seeking to strengthen at least a portion of their own rights with or without a narrowing amendment because some prior art has come to light." (NAS, p. 122) *Inter partes* re-examinations involve third party participation and have been permitted since 1999 but are extremely rare. According to the FTC Report, the *inter partes* reexamination process had been used only four times in the first three and a half years of its operation (FTC 2003, Chapter 1, p. 27).

B. Patent Litigation and Damages

Strictly speaking, a patent holder has the right to sue others to prevent them from using the technology described in the patent's claims. Patent lawsuits take place in the federal courts, usually in front of a jury. Appeals of patent decisions go to the Federal Circuit Court of Appeals, a specialized appeals court for patent cases established in the early 1980s. Many observers believe that the creation of the Federal Circuit has led in general to decisions more favorable to patent holders. (Dreyfuss, 1989; Kortum and Lerner, 1999).

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[8] One cannot simply divide the number of issued patents into the number of applications to obtain the grant rate, for two reasons. First, because the number of applications increases from year to year, and because it takes almost three years on average for the PTO to issue a patent, the proper comparison would be between the number of patents issued in a given year and the number of applications filed three years earlier. Second, over a quarter of all U.S. patent applications are so-called "continuation" applications. (Graham and Mowery, 2002; Lemley and Moore, 2004). These continuation applications represent a patentee's opportunity to get multiple bites at the apple, returning to the PTO in an effort to obtain the same patent that had been denied earlier. Remarkably, there is no limit to the number of times the patentee can do this. (Lemley and Moore, 2004). A proper measure of the grant rate must exclude from consideration applications that are not in fact new filings, but just continued efforts to obtain the same patent. To complicate matters further, continuations can sometimes result in multiple patents, so an accurate count cannot simply eliminate all continuation applications from consideration. Quillen et al. have done a careful study controlling for these variables, and determine that the grant rate is 85% on the most plausible set of assumptions.

When accused of infringement, defendants in patent cases typically claim that the patent is invalid, usually based on the existence of prior art that was not found by the PTO. Therefore, a patent holder who actually litigates a patent is usually running the risk that the patent will be found invalid, either in whole or in part. However, patents are afforded a presumption of validity; to have a patent declared invalid requires "clear and convincing evidence." Defendants also usually claim that they do not infringe the patent, even if it is valid.

A patent holder who wins an infringement suit can obtain an injunction preventing the infringing party from practicing the patent, which may force the infringing party to withdraw its products from the market. (In some cases, the patent holder can even obtain a preliminary injunction, forcing the alleged infringer to cease using the patented technology during the pendency of the patent litigation.) The infringing party might, however, be able to invent around the patent and stay in the market, albeit with higher costs or a less attractive product. A victorious patent holder also can seek damages from past infringement, either in the form of lost profits or reasonable royalties. If the infringement is found to be "willful," the infringing party may be forced to pay three times the actual damages.

Any economic analysis of patent litigation must start from the observation that the vast majority of patents are never actually asserted in litigation. Only 1.5% of all patents are ever litigated, and only 0.1% are litigated to trial (Lanjouw and Schankerman, 2001; Lemley, 2001), though litigation rates vary by industry and reach as high as 6% in biotechnology. (Lerner, 1995). Great care must therefore be taken when interpreting data from any sample of litigated patent cases. The patents involved in litigation are those that are important enough commercially to justify the costs of litigation and for which the parties were unable to reach a mutually attractive settlement prior to litigation.[9]

When patents are litigated, the outcome is far from certain. Of patents litigated to a final determination (appeal, trial, or summary judgment), 46% are held invalid. (Allison and Lemley,

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[9] We do not know what fraction of patents provide commercial benefits to their owners apart from their use in litigation. Clearly, many patents are used in licensing or cross-licensing negotiations and never litigated. Other patents force rivals to alter their products or processes to avoid infringing. The only overall measure we are aware

1998). There is also substantial uncertainty as to whether a patent will be held infringed and whether it will be enforceable. (Moore, 2000). Some of that uncertainty is built into the patent litigation process; the "doctrine of equivalents" permits patentees to expand the reach of a patent beyond its literal scope in order to prevent a patent from being easily evaded. Uncertainty continues through the appeal process. Empirical research has shown that in some areas, particularly the process of determining the meaning of patent claims, so-called "claim construction," the Federal Circuit Court of Appeals reverses district court judgments over one-third of the time (Chu, 2001; Moore, 2002).

II. Patents as Lottery Tickets

Once issued, a patent remains in force until 20 years after the patent application was originally filed. To keep a patent in force, the patent holder must pay certain maintenance fees, ranging from several hundred to a few thousand dollars, at the end of the third, seventh, and eleventh years. Between 55% and 67% of issued U.S. patents lapse for failure to pay maintenance fees before the end of their term; the percentage that lapse increases each time a new fee is due. (Moore, 2004; Lemley, 2001).

The fact that many patents lapse due to non-payment of maintenance fees indicates that many patents are of little value to their owners. Of course, some patents, such as those protecting blockbuster drugs, are extremely valuable. The distribution of value of patents appears to be highly skewed, with the top 1% of patents more than a thousand times as valuable as the median patent. (Allison et al., 2004). Many patents are virtually worthless, either because they cover technology that is not commercially important, because they are impossible enforce effectively, or because they are very unlikely to hold up if litigated and thus cannot be asserted effectively. A small number of patents are of enormous economic significance.

Why do inventors incur the costs to file for many patents that have little or no value? Surely part of the reason is that patent applicants do not know which patents will be valuable and which will be worthless. There is evidence that the value of patents to their owners displays

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of regarding the fraction of patents considered valuable by their owners comes from the data on patent maintenance

considerable *ex ante* uncertainty. (Scherer, 2001; Denton and Heald, 2004). But other explanations have been offered for this phenomenon, ranging from a widespread failure to appreciate the *ex post* value of many patents (Rivette and Kline, 2000), to the use of patents in obtaining financing (Lemley, 2000), to the use of patents as signaling mechanisms (Long, 2002), to the "defensive" use of patents to deter others from suing (Hall and Ziedonis, 2001; Lemley, 2001). Further, even individually weak patents may have value as part of a larger patent portfolio, because the portfolio can be licensed as a block or can serve to deter lawsuits. (Parchomovsky and Wagner, 2004).

Although patent applicants no doubt face a great deal of uncertainty about the value of the patents they seek, there is also evidence that applicants have considerable information at an early stage about the likely value of their patents, at least for those patents at the high end of the value distribution. Allison et al. (2004) find that the most significant predictors of ultimate value are the industry, the number of prior art references, the number of claims, and the time invested in prosecution. This information is either within the control of patentees, who write more claims and cite more prior art, and file more continuation applications, or is at least known to them during the prosecution process. Further, most patent litigation is filed relatively quickly after the patent issues. Allison et al. (2004) conclude that patentees are generally aware *ex ante* which of their patents are most valuable, and take steps during the patent prosecution process (see below) to help insure the validity of those patents. They quote one general counsel at a software company as saying "of the 600 patents we file a year, we pretty much know which 20 we have to have and which 580 it would be nice to have."

Even accounting for the information known to patent applicants, which allows them to distinguish the more promising patents from the many patents that are unlikely to have significant value, it seems clear that many patent applications and indeed patents themselves are much like lottery tickets. Inventors who are uncertain of the value of their ideas *ex ante* file to patent many of them, knowing that most of the resulting patents will turn out to be worthless but hoping that a few of the resulting patents will pay off big time (Scherer, 2001). Plus, the payoffs in the "innovation lottery," patents, are themselves probabilistic property rights.

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payments, which we report below.

Just as people flock to stores to buy lottery tickets when the grand prize grows large, patent applicants have found ways to seek many patents in areas they consider promising. Two of the most common practices used by patentees to maximize the value of their patents and minimize uncertainty are the use of continuations and the proliferation of closely related patents.

Continuation practice stems from the rather remarkable rule in U.S. patent law that makes it impossible for the PTO ever to finally reject a patent application. (Lemley and Moore, 2004). Patentees are free to try again and again to persuade the PTO to grant them a patent they really expect to be valuable. More significantly for our purposes, they can obtain a patent and at the same time continue prosecution on a related application. This permits companies to hedge against the risks that the first-issued patent will not be infringed, that the market will change in a way that renders the first patent obsolete, or even that the first patent is invalid based on prior art not cited to the PTO. The patent owner can modify the claims or submit new prior art to overcome these problems. Continuations are a large and growing part of patent practice, accounting for more than a quarter of all applications filed today. (Graham and Mowery 2003). Indeed, in some industries, notably biotechnology and pharmaceuticals, it is standard practice to keep a continuation application pending during the entire pendency of the original patent as a form of insurance. (Lemley and Moore, 2004).

Patent owners also hedge against the risk of invalid or ineffective patents by filing multiple patents on closely related technologies. The result is a "patent thicket" in which hundreds of patents overlap with each other, creating a barrier that is hard for a competitor to penetrate. (Shapiro, 2001; FTC, 2003). In many industries, particularly semiconductors (Hall and Ziedonis, 2001) and increasingly computer software (Bessen and Hunt, 2004), companies file numerous patent applications on related components that are integrated into a single functional product. One effect of a patent thicket is to hedge against the risk of invalidity; if a patent owner has one hundred patents relevant to a technology, the fact that some of those patents will likely be held invalid does not greatly undermine its proprietary position. Put differently, a company facing claims that it is infringing hundreds of patents is facing a very complex, costly, and risky undertaking by fighting all of those patent infringement claims in court. Simply evaluating the claims in all of the patents that are being asserted and relating those

claims to the defendant company's products, not to mention searching for relevant prior art, can be very complex, costly, and murky.

Both continuation practice and patent thickets have negative consequences on third parties. While continuations can reduce uncertainty for patent owners, they correspondingly increase uncertainty in the marketplace. A competitor who designs around an issued patent – a legal activity that patent policy actively encourages (Conigliaro et al., 2001) – cannot know whether the patentee has a continuation application waiting in the wings with claims that can be drafted specifically to cover the design-around. Indeed, some unscrupulous patentees intentionally delay the issuance of their patents precisely in order to take a mature industry by surprise, increasing their royalty rates once companies operating in the industry have made irreversible investments. (Graham and Mowery, 2003; Lemley and Moore, 2004).[10]

Similarly, patent thickets can have deleterious effects on both competition and innovation. If one company in an industry engages in thicket patenting, others are likely to follow suit defensively to protect their own interests. As a result, many patents owned by different parties can read on a single product. The result is "royalty stacking" in which a manufacturer without its own patent portfolio must pay royalties to a number of separate companies. This is a classic instance of the "Cournot complements" problem (a form of double marginalization), which is known to lead to inefficiently high prices that can even exceed the monopoly level. (Cournot, 1838; Shapiro, 2001) Heller and Eisenberg have termed this problem the "tragedy of the anti-commons." (Heller and Eisenberg, 1998).[11] The problem of the patent thicket can be partially solved if incumbents with extensive patent portfolios can come to terms with each other by signing broad cross-licenses, exchanges of roughly symmetric patent positions, to "clear" the thicket. However, new entrants who lack large patent portfolios may at a major disadvantage in this situation because they have no patents to trade. John Barton

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[10] Indeed, for these reasons courts have adopted doctrines designed to limit the abuse of patent continuations, and patent reformers have suggested limits on the use of continuations. (Federal Trade Commission, 2003).

[11] Based on survey data, Walsh et al question whether the anti-commons problem has actually interfered with production in biomedical research, the area in which Heller and Eisenberg apply their theory. (Walsh et al., 2003). But among the ways they find the industry has avoided anti-commons problems is to invalidate patents and simply to ignore them – approaches that depend heavily on the probabilistic nature of patent rights.

estimated in 1998 that clearing patent rights alone for a new microprocessor would cost $150 million in licensing fees. (Barton, 1998). Patent thickets can therefore require new entrants to pay significant royalties or to obtain their own valuable patents to trade for those owned by incumbents.

There are good reasons doubt the efficiency of a system for granting patents under which (1) patents differ greatly in their commercial significance and value; (2) patent applicants have far superior information to examiners about the likely value of their patents; (3) patent applicants can persist in seeking to have certain claims accepted by patent examiners, thereby raising the chance of acceptance of patents they consider most valuable; (4) the burden of proof falls upon the PTO to explain why a patent application will *not* be granted; and (5) patent examiners are faced with a flood of applications and have little time to devote to each one. These problems are likely to be most pronounced in areas where technology is changing rapidly, making the asymmetry of information between the PTO and the patent applicant greater both with respect to relevant prior art and with respect to likely commercial significance. Overall, the system is skewed toward the grant of patents of dubious objective validity. This bias is especially worrisome in conjunction with the rule that "clear and convincing evidence" must be provided in court for a patent to be declared invalid. The legal system responds to this bias by treating patents not as absolute rights, but rather as contingent ones, subject to proof that the patent is indeed valid and covers what the patentee claims.

Uncertainty, then, is endemic in the patent system. Patent rights are not guarantees of market control, or even rights to exclude competitors from a particular product. They are government grants of an entitlement to enforce a legal right. But those grants are based on a brief, inconclusive *ex parte* process, and they are subject to a much more detailed process of review in the court system. In that review process, accused infringers with focused incentives spend millions of dollars attempting to invalidate a patent or to limit its scope.[12] Further, even valid patents are no guarantee of market success. The fact that most patents turn out not to be

[12] The median patent case with less than $25 million at stake cost $2 million per side in legal fees to litigate to trial in 2003. High-stakes cases involved median legal fees of $4 million per side. (American Intellectual Property Law Association, 2003).

worth licensing or enforcing suggests that at least for routine patented inventions, inventors file their patent applications facing significant uncertainty as to the value of their invention. Accused infringers face a parallel problem – because hundreds of thousands of patents issue each year, they may find it difficult or in many industries impossible to make and sell products without risking a patent infringement lawsuit whose outcome is uncertain.

III. Reform of the System of Granting Patents

The patent system involves a fundamental *quid pro quo*: if you are the first to come up with a genuine invention, i.e., one that is novel and not obvious, and if you are prepared to disclose the workings of that invention to the public, in exchange you can receive exclusive rights to practice that invention for a limited period of time. Put simply, the U.S. government, as provided for in the Constitution, grants exclusive rights in exchange for genuine invention and disclosure. However, when exclusive rights are granted for technologies that are not novel, or are "obvious," i.e., when patents are improperly issued, the fundamental *quid pro quo* is violated. The public suffers harm from the grant of exclusivity, e.g., by paying monopoly prices, without justification.

There is widespread and growing concern that the PTO issues far too many "questionable" patents, i.e., patents unlikely to be found valid based on a thorough review of the sort one sees in patent litigation. We have explained above how the system by which patents are issued in the U.S. is prone to issuing such questionable patents. Of course, we cannot expect the PTO to be perfect; inevitably, some patents will be improperly issued. The policy question is whether the system can be designed to work significantly better at reasonable cost.

A number of scholars and policy-makers have proposed reforming the patent prosecution process to strengthen both examination and the associated validity of the patents that issue.[13] Both the Federal Trade Commission and the National Academy of Sciences have proposed reforms of the patent system that involve expending more money to strengthen patent

[13] It is notable that while prior reforms of the U.S. patent system focused on strengthening the control of patent owners (Gallini, 2002), the current reform proposals are all directed at weakening this control.

examination (FTC, 2003; NAS, 2004). The FTC supports a variety of reforms to the process by which patents are issued, including devoting more resources to the PTO, expanding the PTO's "second set of eyes" review to selected areas, and encouraging examiners to seek more information from applicants. (FTC, 2003, Recommendations 4 and 5) Both the FTC and the NAS also propose creation of a post-grant opposition system in which interested competitors could challenge the validity of an issued patent before an administrative patent board. The FTC also calls for strengthening the legal standard of non-obviousness, making it more difficult for creators of marginal improvements to obtain patent protection.[14] (FTC 2003, Recommendation 3) We now consider some of these proposed reforms.[15]

As a starting point, we can ask what level of certainty one should aspire to from the process by which the PTO grants patents. Even accepting that the PTO is issuing many questionable patents, it cannot be economically efficient to determine the validity of patents with anything approaching certainty during the patent prosecution process. Mark Lemley has argued that the PTO is "rationally ignorant" of the actual validity of a patent because the likelihood that the patent will ever be litigated or even licensed is so small. (Lemley, 2001). So, the practical question is whether more resources should be devoted at the margin to patent examination, or whether different procedures should be used to evaluate patent applications.

At least one analysis indicates that the cost of even a marginal improvement in patent quality significantly outweighs the associated benefits in reduced litigation costs (Lemley, 2001) Central to Lemley's argument is the idea that devoting extra resources to determining the validity of a patent is largely wasted in the 95% of the cases in which the patent is neither litigated nor licensed for a royalty.[16] (Indeed, in the majority of cases in which the patentee lets the patent

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[14] The logical conclusion would seem to be that strengthened examination should result in a patent that was afforded a strong presumption of validity. (Kesan and Banik, 2000). Interestingly, however, the FTC has proposed both the strengthening of patent examination standards and a *weakening* of the presumption of patent validity. (FTC, 2003, Recommendation 2). Shapiro (2004) suggests that effective reform of the patent examination process might make it unnecessary also to weaken the presumption of validity afforded to patents.

[15] For a more complete analysis of the reforms proposed by the FTC and the NAS, see the Special Issue of the *Berkeley Technology Law Journal* devoted to these reforms [Fall 2004?], including Shapiro (2004).

[16] Even if Lemley is correct, it may still be efficient to implement reforms of the patent prosecution process that do not greatly increase costs. For example, implementing better hiring and retention practices and changing the

lapse for failure to pay maintenance fees, even the current cost of examination exceeds the ultimate value of the patent). Lemley also attempts to account for the potential costs of uncertainty, though others have disagreed, arguing that the costs of avoiding unasserted and likely invalid patents are sufficiently great that society should spend the more money to weed out more bad patents. (Gallini, 2002; Kesan and Ghosh, 2004).

Among the variables relevant to deciding how much effort society should put into patent examination are (1) how effective increased examination would be at weeding out objectively bad patents without improperly denying patents for true innovations;[17] (2) the magnitude of costs imposed on third parties by owners of patents that would not be issued with more careful examination, which itself depends in part upon the fraction of patents that are actually licensed or litigated – apparently quite a small percentage; (3) whether competitors are in fact deterred by the existence of patents that have not been brought to their attention by patent owners;[18] and (4) whether venture capitalists and others who rely on patents to assess the value of companies can appropriately discount for the risk of patent invalidity.

Devoting more resources to patent examination is most likely to be efficient if those additional resources can somehow be focused on the patents whose validity will turn out to be commercially significant. Allison et al. identify a number of characteristics of patent applications that are strongly correlated with litigation and ultimate value. (Allison et al., 2004). They suggest that the PTO might use its resources more efficiently by focusing greater attention on those applications. A simpler approach, which the PTO is already following to some degree, is to focus greater resources in areas of new or rapidly changing technology where the PTO has more difficulty identifying prior art, such as software and business methods.

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incentives that currently encourage examiners to grant doubtful patents, as Merges and Thomas suggest, would improve the prosecution process at very little cost. (Merges, 1999; Thomas, 2001).

[17] Lemley assumes that doubling the money spent in examination would double the number of bad patents rejected while not rejecting any good patents, which seems fairly optimistic.

[18] Because of the rules concerning willful infringement, a large number of patent lawyers advise their clients not to read competitors' patents at all. (Lemley and Tangri, 2003). If companies are not reading competitors' patents until threatened with suit or approached to take a license, they are presumably not deterred from making and selling products by the existence of those patents prior to being contacted by the patent owner.

An alternative means of focusing attention on particular patents is the adoption of an opposition procedure, whereby competitors can challenge issued patents without resorting to full-blown patent litigation. Europe and Japan already have such a procedure in effect. Both the FTC and the NAS propose creation of such a system in the U.S. (FTC Recommendation 1) Arguably, allowing competitors to identify patents worthy of receiving more intensive scrutiny would take advantage of the superior information of industry participants in comparison with the PTO, thereby focusing resources on the patents that are both questionable and commercially important. Indeed, work by Dietmar Harhoff and others has found that the European patent opposition system is effective in identifying important patents. Patents that survived an opposition proceeding in Germany were more valuable than any other type of patent. (Harhoff et al., 2002). However, any opposition system requiring the active participation by third parties who challenge patents is subject to the general problem that these third parties may lack the incentive vigorously to challenge patents, even ones that are highly questionable. This general problem applies as well to the existing system of patent litigation; see our discussion below.

An alternative approach is to incorporate private information known to the patent applicant itself by letting patent applicants self-select. Under this system, a patent applicant can select the normal, rather brief, examination process, which would lead to a Standard Patent if the application were approved. Alternatively, the patent applicant could select a more rigorous application process, which would lead to Super Patent if the application were approved. For such a system to work, the courts would have to give less weight to a Standard Patent than to a Super Patent. For example, the standard of proof for finding a Standard Patent invalid could be "preponderance of the evidence," whereas the standard of proof for finding a Super Patent invalid could be "clear and convincing evidence." This two-level system is but one of a myriad of possibilities that spring to mind if one thinks of the process of issuing patents in terms of designing a mechanism that can employ the power of self-selection to issue a variety of property rights based on the level of resources devoted to different patent applications.[19]

[19] As an alternative example, the law could require patent applicants to conduct a full search for prior art, on the expectation that they are more likely to be aware of the critical prior art than a PTO Examiner.

It is not clear based on the available data that devoting more resources across the board to patent examination, and then giving the resulting patents a strong presumption of validity, is economically justified. The existing evidence suggests that patent reform designed to strengthen the examination process is most likely to work effectively if the enhanced examination efforts are targeted at areas where the PTO has been most prone to make errors and, crucially, at those patents most likely to be of importance in the marketplace. We doubt that the PTO is well placed to identify these patents. Drawing on the patent applicant's own information about commercial significance thus seems to offer some real advantages. Likewise, relying to some degree on third parties, at least to identify important patents they believe have been issued in error, appears desirable.

Even if many of the reform proposals advocated by the FTC and the NAS relating to the issuance of patents are adopted, the resulting enhanced examination will at best limit the uncertainty associated with patent validity by weeding out some bad patents and giving market participants greater confidence in the PTO's validity decisions. Significant uncertainty will remain as to the scope and validity of patents that are asserted or enter into litigation.

IV. Patent Litigation Uncertainty and Reforms

Uncertainty about the validity and scope of patents entering litigation is likely to persist for the foreseeable future. That uncertainty extends to both validity and infringement. An issued patent is nominally invested with a strong presumption of validity, one that must be overcome by clear and convincing evidence. Nonetheless, as noted above, nearly half of all patents litigated to decision are held invalid.[20] The grounds for invalidating patents vary by industry, but objections related to prior art – obviousness, novelty, and statutory bars – are the most common ground. (Allison and Lemley, 1998). Uncertainty also extends to the scope of patents even when they are

[20] The statistics on patents litigated to judgment are necessarily skewed to some extent by the selection effects of litigation. Priest and Klein emphasize that litigated cases generally are not representative of disputes that are settled, and analyze the factors that affect the observed success rates of plaintiffs and of defendants. (Priest and Klein, 1984). As is now well known and appreciated, litigation typically arises when both parties are relatively optimistic about their chances in litigation, making it impossible for the two parties to find a mutually acceptable settlement. (Cooter and Rubinfeld, 1989) Empirically, we observe patent validity rates that vary widely over time and by court.

held valid. The meaning of patent claim terms – called "claim construction" – is hotly debated in virtually every patent case, and courts have found ambiguity even in such innocuous terms as "a," "or," "to," and "when." Even once the meaning of the patent claims has been determined, the doctrine of equivalents undermines the certainty of patent scope by permitting the patentee to expand its rights beyond the literal protection of the patent in some but not all cases. (Gallini, 2002). A final source of uncertainty is the doctrine of unenforceability. Patents may be rendered unenforceable if the patentee deceived or omitted to state information to the PTO during prosecution. While relatively few patents are held unenforceable for inequitable conduct (Moore, 2000), allegations of unenforceability are ubiquitous, and indeed the Federal Circuit has described the growth of such claims as "an absolute plague." (*Burlington v. Dayco*, 1988).

Reform efforts focused on the patent litigation process have taken two very different approaches. Some reform efforts focus on reducing litigation uncertainty. For example, some reform proposals would strengthen patent examination and correspondingly strengthen the presumption of validity, perhaps even making it conclusive. (Kesan and Banik, 2000). Similarly, the Federal Circuit has been preoccupied over the last several years with reducing the uncertainty associated with the doctrine of equivalents, emphasizing instead the "notice function" of the patent. To accomplish this, the court has expanded the role of prosecution history estoppel, sharply limiting the ability of patentees to claim in litigation to own things they disclaimed during prosecution, and has held that ideas disclosed in the patent but not expressly claimed are dedicated to the public. The NAS proposal to eliminate any evaluation of mental state (intent) in patent law also seeks to make the outcome of litigation more predictable *ex ante*.

Other reform proposals, by contrast, push in the opposite direction – acknowledging that the scope and validity of patent rights are uncertain and ensuring that the law accurately reflects that uncertainty. Thus, the FTC and others have proposed legislation to eliminate the clear and convincing evidence presumption of patent validity in favor of a weaker presumption. (FTC 2003, Recommendation 2; Lemley, 2001). Although it does not support the FTC's recommendation, even the American Intellectual Property Law Association has proposed scaling

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(Allison & Lemley, 1998; Chien and Lemley, 2003; Moore, 2000). The magnitude of the stakes, asymmetry in the stakes, and selection effects all play a role in determining litigation outcomes.

back the application of the presumption of validity through judicial interpretation. (American Intellectual Property Law Association, 2004).

A number of commentators have also proposed eliminating or limiting the doctrine of willful infringement. (FTC, 2003; NAS, 2004; Lemley and Tangri, 2003; Powers and Carlson, 2001). Under that doctrine, an infringer must pay enhanced damages if it intentionally infringed a patent. To intentionally infringe, an infringer must not only be aware of the patent but must believe the patent is valid and that its conduct infringes. Willful infringement has proven unmanageable precisely because a company accused of infringement cannot know *ex ante* whether it is facing a valid and infringed patent. As a result, the law has developed a complex set of rules requiring the company to obtain an attorney's opinion as to the proper scope and validity of the patent; reliance in good faith on that opinion will insulate a defendant from liability for willfulness. Reform proposals relating to willfulness tend to acknowledge that because of uncertainty as to scope and validity, merely being aware of a patent does not make one a willful infringer. Rather than trying to reduce that uncertainty, the proposals instead use the fact of uncertainty to challenge the very idea of willful infringement.

In deciding among these reform models, it is worth keeping in mind that litigation uncertainty is not necessarily a bad thing. One effect of litigation uncertainty is that accused infringers rarely stop selling products merely because they have been charged with infringement. Courts for their part rarely grant preliminary injunctions. Instead, accused infringers take their chances in court, and pay damages if they are later determined to infringe. While patent owners would certainly be better off if the mere threat of an infringement suit caused others to leave the market, consumers and competitors benefit from the competition that occurs during the course of a lawsuit. (Shapiro, 2003a). In considering the economic effects of the uncertainty about patents, and of reforms designed to eliminate that uncertainty, it is important not only to consider the effects of uncertainty on innovation incentives but also the ability of competitors to continue to serve customer demand for products covered by invalid or non-infringed patents. It is worth noting that Congress created an opposition proceeding in 1999, but competitors have refused to use it because the outcome of the opposition is binding in subsequent litigation. (Janis, 2000). This suggests that competitors prefer the uncertainty of litigation to the certainty associated with

opposition outcomes because the opposition process is seen as less favorable than full-blown litigation to those challenging the patent.

V. Private Incentives to Challenge Patents

With the PTO issuing nearly 200,000 patents per year, typically after a very limited examination process, one might hope that commercially significant but questionable patents would be challenged in court. If such court challenges were fast and cheap and common, the many improperly issued patents might have little market impact. They would quickly be challenged and overturned. Unfortunately, the patent litigation process does not work in anything approaching this idealized fashion. To the contrary, there are good reasons to doubt that the litigation process prevents questionable patents from imposing very significant costs on suppliers and ultimately on customers.

The main problem with the litigation system can easily be demonstrated with a simple example. Suppose that widgets are supplied in a competitive market consisting of ten identical firms, each with constant marginal cost of $40 per unit. Demand for widgets is linear, given by $P = 100 – Q$, where P is price and Q is quantity. Of course, the resulting competitive price of widgets is $40, and 60 widgets are sold.

Now suppose that a new method of producing widgets is developed which lowers the production cost to $30 per unit. If this method is freely available to all producers, we know that the price of widgets will fall to $30 per unit, and quantity will rise to 70. Suppose, however, that a patent is issued covering this new method of production. Let us suppose that the owner of this patent selects the royalty rate, R, in dollars per widget, at which it will license its patent to all widget manufacturers.[21]

Begin with the familiar, standard case in which the patent is unquestionably valid. In this case, widget manufacturers have a simple choice to make: continue producing at $40 per unit or

[21] One might ask why the patent owner would use per-unit royalties rather than lump-sum royalties. However, that discussion is beyond the scope of this paper. Royalties based on units sold, or revenues earned, are certainly more

take a license, produce at $30 per unit, but pay royalties. From the perspective of the patent holder, setting the optimal royalty rate is a simple problem of monopoly pricing. No one will accept a royalty greater than $10 per unit, since that is the cost savings associated with the patented process. For a royalty rate R between zero and ten, the price of widgets will be 30+R, and the quantity produced will be 70-R. The patent owner's licensing revenues will be R*(70-R). In the relevant range, this expression is maximized by setting R*=10. The patent holder receives royalty payments of $10 per unit for 60 units, appropriating the entire cost savings associated with its invention. There is a deadweight loss of $50 resulting from the fact that only 60 units are produced, not 70 which would be socially optimal given the actual (social) cost of production of $30 per widget.[22]

Now change the story to reflect the probabilistic nature of real-world patents. Suppose that the ten widget producers are all aghast that the PTO issued this patent and insist that the patented method was obvious to someone skilled in art at the time of the patent application, based on prior art including recently published research that was in the public domain. Indeed, we may imagine that, following the publication of some basic research, the widget producers soon learned how to apply those research findings to their production methods and thus lower their costs by $10 per unit. Perhaps they even made significant, technology-specific capital investments to do just that. Meanwhile, unknown to them, someone outside the industry had filed for a patent covering this technology and convinced the PTO that its application met the non-obviousness test. For simplicity, let us suppose that the patent at issue is highly questionable: there is only a 20% chance that the patent would be found valid if tested in court. However, litigation involves some costs.

What happens now if the patent holder announces a uniform royalty rate of $10 per widget? Consider the decision by an individual widget manufacturer W: accept this license and pay royalties of $10 per widget or engage in litigation that costs $C. If the patent is upheld, which occurs with 20% chance, widget maker W has spent $C and gained nothing, since it will

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common than fixed-fee royalties. For the purposes of this example, we do not consider non-linear or discriminatory royalties.

[22] In this simple model, more complex licensing contracts are needed to avoid this deadweight loss.

now have to pay $10 per unit in royalties. Regardless of whether the other widget makers accepted the license or not, widget maker W has lost $C by challenging the patent. Alternatively, if the patent is found invalid, which occurs with 80% chance, widget maker W has again spent $C but now can avoid paying royalties. However, the *other* widget makers also will pay no royalties, since the patent has been found invalid.[23] Therefore, the price of widgets will fall to $30. Invalidating the patent was a public good that served to benefit all widget manufacturers. Widget maker W cannot recover the $C litigation costs. Accepting the $10 royalty is a dominant strategy in this simple setting. And this is true even if the patent is very very likely to be found invalid – the analysis here did not rely on the 20% chance of patent validity. In the end, consumers end up paying $10 per widget for to the patent holder even if the patent should never have been issued. Of course, the prospect of this prize, $600 in our example, will encourage various rent-seeking behavior by patent applicants.

What is driving this striking result that even a very weak patent can command royalties approaching those of an ironclad patent covering the same claims? The driving force is that invalidating a patent generates significant positive externalities. As usual, activities that generate positive externalities are under-supplied. When it comes to patent litigation, there are very strong reasons to believe that challenges to patents are under-supplied. (Gilbert, 2004) In practice, this means that companies accused of infringing will tend to settle patent disputes, e.g., by paying royalties, rather than litigating.

We do not mean to suggest that the simple analysis provided above is anything approaching a complete analysis of this problem, or that the royalties commanded by a patent are generally unrelated to the strength of that patent. In the model, competitors have no incentive at all to challenge patents because their position is symmetrical and competition is perfect. In the real world, participants in most industries have various sources of rents stemming from imperfections in competition, oligopoly, product differentiation and brand value, and increasing marginal cost curves. As a result, most accused infringers will have *some* incentive to challenge

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[23] The key case is the Supreme Court's decision in *Blonder-Tongue Lab v. University of Illinois Found.*, 402 U.S. 313 (1971), under which an alleged infringer can prevent an infringement suit if the patent claim asserted against it has been declared invalid in another case.

the validity of a patent, but that incentive will be suboptimal. Whether an accused infringer has *sufficient* incentive to mount an effective challenge will depend on a number of factors: how significant are those rents; how readily they will be dissipated to competitors; how much money is at stake; and what is the relationship between litigation expenditures and success at trial. A company sued for $1 billion in royalties will likely have the incentive to pay $5 or $10 million in legal fees even if competitors will also benefit substantially; a company sued for $10 million in royalties may well not have strong incentives to defend the suit. In short, the simple model just presented is a polar case.[24] But we hope our brief discussion makes it clear that there are serious problems with relying on private parties to challenge questionable patents.

More work is needed to understand the strategies employed by patent holders and alleged infringers, to identify the situations in which questionable patents can have substantial, adverse effects on competition, innovation, and consumers, and to inform policy choices regarding the design of the patent system as a whole. Just starting from the simple model sketched out above, a number of questions quickly spring to mind. How would the outcome change if the ten widget manufacturers could coordinate their decisions to challenge the patent? (Assume in answering this question that they would *not* also be allowed to coordinating their pricing of widgets, i.e., to form a cartel.) How would the analysis change if the widget manufacturers produced differentiated products, or if there were only a few of them who acted as oligopolists? Alternatively, what type of coordination would be required for the downstream consumers, the ultimate beneficiaries of a successful patent challenge in this model, to band together to fight the patent? On the other hand, could the patent holder fight back by credibly threatening to charge a higher royalty to anyone challenging its patent than for those who simply agree to pay royalties without a fight? If so, how does this strategy change the analysis?

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[24] There are cases in which there are no positive externalities associated with invalidating a patent. For example, this occurs in a simple model with a single potential competitor who would capture share from the patent holder without causing any reduction in price. As pointed out by Gilbert (2004), the private return from challenging the patent can, in theory, even exceed the social return: a single customer who invalidates a patent enjoys a transfer of rents from the monopoly supplier. But Gilbert considers such cases "unlikely" due to the public-good problem. He also points out that the incentives to challenge are especially low when multiple blocking patents are involved.

Farrell and Merges (2004) offer insightful further discussion of these issues.[25] They emphasize two basic reasons why individual firms accused of patent infringement have suboptimal incentives to challenge the patents asserted against them: (1) the public good problem – the fact that rivals to the allegedly infringing firm will benefit from a finding that the patent is invalid (or that its claims should be read narrowly); and (2) the pass-through problem – the fact that higher uniform royalty costs are passed through in the form of higher prices, thus muting the incentives of alleged infringers to avoid paying such uniform royalties.[26]

Since invalidating a patent provides a public good, typically to the benefit of competitors and consumers, one can quite naturally consider policies to overcome this particular public good problem. One standard approach for dealing with public goods is to reward or subsidize those who contribute to the public good. John Thomas and Joseph Scott Miller have proposed subsidizing those who successfully challenge patents by instituting some type of bounty system (Thomas, 2001; Miller, 2004). An alternative reward would be to give certain exclusive rights to the party who successfully challenges a patent. The Hatch-Waxman Act, which grants a limited period of exclusivity to the first generic supplier to challenge a pharmaceutical patent, has this flavor. A second standard approach is to get the government involved in supplying the public good, presumably at the prodding of those who stand to benefit. The government can and does challenge some issued patents when the PTO re-examines a patent, perhaps in response to third party complaints or information. Such *sua sponte* reexaminations are rare, however, and tend to occur only in a few high-profile cases.

A greater government role might be especially desirable if a new post-grant opposition procedure is instituted, as suggested by the FTC and the NAS and favored by the PTO itself. As with litigation, possible infringers will have insufficient incentives to invoke such a procedure.

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[25] For an impressive, general analysis of contracting in the presence of externalities that has application here and beyond, see Segal (1999).

[26] Farrell and Merges also assert that the outcome of patent litigation tends to be tilted towards the party spending more on litigation, which tends to be the party with the most at stake. Therefore, if the patent holder has much more at stake than does any individual alleged infringer, even if litigation occurs the outcome may be tilted in favor of the patent holder. While this may well be true as a general matter, we strongly suspect that expenditures on litigation are subject to diminishing returns, so such differences may be of little significance in high-stakes cases. A firm

This incentive problem is even worth for post-grant opposition than for litigation. With litigation, the alleged infringer has already been identified by the patent holder, who is seeking royalties. In contrast, a company that observes a patent issue that it believes is invalid and may be used against it does not know that it will ever be found or sued by the patent holder. Worse yet, a company that initiates a post-grant opposition signals to the patent holder that it may well be infringing the patent. In the words of industry participants, a firm that initiates a post-grant opposition effectively "paints a big target on its back." One sensible way around this problem is to empower a government agency to challenge patents based on information provided by interested industry participants, even ones who remain anonymous.[27] We suspect that such an agency, with its consumer-oriented mission, should be distinct from the PTO or at least have a measure of independence. Another way to approach this problem is to encourage public interest organizations to challenge suspect patents. Two such organizations, the Electronic Frontier Foundation and the Public Patent Foundation, have begun efforts to file administrative challenges to patents.

VI. Antitrust Limits on Patent Settlements

Even when patent litigation occurs, it rarely results in a verdict. As noted above, some 95% of patent litigations end in settlements rather than verdicts.[28] So, even before we consider any major policy changes, such as a government agency charged with challenged selected patents, we can ask whether the existing rules governing patent settlements are well crafted. In particular, we can inquire about the *antitrust limits* on settlements of patent disputes. In fact, there have been a flurry of legal cases in this area the law during the past five years which raise some important and complex economic issues. To focus our discussion here, we restrict attention to settlements of patent disputes between actual or potential competitors.

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spending $1 million litigating a patent case will likely do much better than a firm that spends only $100,000, but it does not follow that a firm that spending $20 million will do much better than a firm spending $15 million.

[27] For the reasons we discuss in Part III, simply adding scrutiny to all patents across the board is not an efficient way to deal with this problem.

[28] We reported above that 1.5% of all patents are litigated, with 0.1% litigated to trial.

First, let us explain why some antitrust limits on the settlements of patent disputes between rivals are unquestionably needed. Consider an incumbent monopolist M who faces the threat of entry from a single potential entrant, E. The monopolist owns a patent that it is asserting against the potential entrant. For simplicity, let us assume that both parties agree that if fully litigated, the patent will be found valid with probability P. Suppose that the patent at issue is valuable only in this market, and that there are no other potential entrants, so there is no public-goods problem associated with invalidating this patent. However, consumers are affected by the presence or absence of competition, so there are still externalities associated with the decision to litigate or settle, and consumers are likely to be affected as well by the terms of any settlement. So, there is no reason to assume that efficient bargaining between M and E will lead to a socially optimal settlement.[29]

Indeed, there are compelling reasons to believe that M and E will achieve an anti-competitive settlement in the absence of antitrust rules limiting the manner in which they can resolve their dispute. To see this, denote by π_M the profits earned by M if E does not enter the market. Alternatively, if E wins the litigation and thus enters the market free of any patent challenge or liability for royalties, E will earn profits of π_E and M will earn profits of π_I (for "incumbent") in the resulting duopoly. Let us assume that E is no more efficient than M and that E does not significantly add to variety in the market (either because E's product is very similar to M's product or because M itself can offer multiple products and thus supply variety).[30] Then we know that the monopoly profits are greater than the joint duopoly profits, i.e., $\pi_M > \pi_I + \pi_E$.

Now consider the expected joint profits from litigating vs. settling. Litigating leads to monopoly profits if the patent is found valid, and duopoly profits if the patent is found invalid, less the joint cost of litigation. Expected profits from settlement depend upon the terms of the settlement. But there is an easy way for the parties to settle and achieve full monopoly profits: the incumbent can pay the potential entrant not to enter the market. Of course, E would not agree to stay off the market without a sufficient inducement. How big a payment is needed? By

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[29] By efficient bargaining we mean that the two parties reach an agreement that maximizes their joint profits.

[30] Even if these assumptions are not met, the patent holder would still want to license to the entrant but control competition, so joint profits are still higher from settlement than from litigation.

litigating, E can earn expected profits of $(1\text{-}P)^* \pi_E - C_E$, where C_E represents E's litigation costs. M can induce E to agree not to enter the market by paying E an amount $F > (1\text{-}P)^* \pi_E - C_E$. Is there a mutually agreeable level of F? Yes. Including the payment of F, M earns $\pi_M - F$. In contrast, by litigating, M would earn expected profits of $P^* \pi_M + (1\text{-}P)^* \pi_I - C_M$. Settling is superior to litigating for M if and only if $\pi_M - F > P^* \pi_M + (1\text{-}P)^* \pi_I - C_M$, which can be written as $F < (\pi_M - \pi_I)^*(1\text{-}P) + C_M$. There are mutually attractive levels of F if and only if $(1\text{-}P)^* \pi_E - C_E < (\pi_M - \pi_I)^*(1\text{-}P) + C_M$. Rearranging, this is equivalent to

$$(\pi_M - \pi_I - \pi_E)^*(1\text{-}P) + C_M + C_E > 0.$$

Since $\pi_M > \pi_I + \pi_E$, this inequality must be satisfied.

Intuitively, settlement leads to higher joint profits for two reasons. First, it eliminates the chance that profit-dissipating competition will break out. This would occur if the patent is proven invalid, i.e., with probability (1-P), in which case profits fall from monopoly profits to joint duopoly profits, a decline of $\pi_M - \pi_I - \pi_E$. The expected loss of joint profits due to competition is the first term in the inequality above. Second, settlement avoids litigation costs. The joint saving is $C_M + C_E$, which is the second term in the inequality above. In fact, the left-hand side of that inequality is the expected joint gains from settling rather than litigating.

What started as an inquiry into settlements of patent disputes evolved into a simple payment by an incumbent monopolist to a potential entrant to stay off the market. Without the patent settlement context, such a payment would be blatantly illegal: a monopolist is not allowed to pay its sole potential entrant to stay off the market. A simple payment of this type would be *per se* illegal, an obviously anti-competitive agreement. Nor could such a payment be hidden in the form of an acquisition: under U.S. antitrust law, a monopolist is not allowed to *acquire* its sole potential entrant and thereby insure that its monopoly position persists.

Is this same payment anti-competitive in the context of a patent settlement? The courts have been grappling with this issue, and more generally the antitrust limits on patent settlements, in a series of cases over the past five years. (Hovenkamp et al. 2003; Cotter, 2003; Hovenkamp et al. 2004a). Many of these cases have arisen from settlements between incumbent pharmaceutical manufacturers and potential generic competitors who they have accused of patent

infringement.[31] (Morse, 2002) The courts have devoted most of their attention to settlements involving payments from incumbents to would-be generic suppliers, known as "reverse payments" because they flow from the patent holder to the challenger in contrast to conventional licensing payments which challengers make *to* patent holders. Courts have come to different conclusions on the legality of such reverse or "exclusion payments." For example, Abbott, the maker of Hytrin, a very successful drug used to treat hypertension and enlarged prostate, was faced with potential generic entry by Geneva, which Abbott accused of infringing its patent. Under their 1998 settlement, Abbott agreed to pay Geneva $4.5 million per month for some period of time in exchange for which Geneva agreed not to enter the market. The Eleventh Circuit found that this agreement was not *per se* illegal, instructed the District Court to reconsider the case, and provided standards for that review.[32] A variant of this fact pattern arose in case involving Schering-Plough, the maker of the prescription drug K-Dur 20, which is used to treat low potassium. Schering-Plough entered into an agreement with Upsher-Smith, a potential generic competitor, which involved a payment from Schering-Plough to Upsher-Smith and an agreement by Upsher-Smith not to enter the market before a specified date. The FTC has found this agreement to be anti-competitive.[33] The Courts have yet to establish a clear and uniform approach to these cases.[34]

To see the core economic question raised by these cases, consider an incumbent monopolist M who accuses a potential entrant E of patent infringement. If the patent is found valid, E will not be able to compete without infringing. If the patent is declared invalid, E can

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[31] For a broader look at the role of generic competition, see the FTC Generic Drug Study (FTC 2002).

[32] *Valley Drug Co. v. Geneva Pharmaceuticals, Inc.*, 344 F. 3rd 1294 (11th Cir. 2003). Shapiro has served as an expert witness for Kaiser, a purchaser of Hytrin who claims to be injured by Abbott's agreement with Geneva.

[33] See the decision of the Federal Trade Commission in this case, *In the Matter of Schering-Plough Corporation, et. al*, available at www.ftc.gov.

[34] In contrast to the Abbott-Geneva agreement just noted, the Sixth Circuit found a similar agreement between Hoescht Marion Roussel and Andrx regarding the drug Cardizem CD to be *per se* illegal. (*In re Cardizem Antitrust Litigation*, 3322 F. 3rd 896, Sixth Circuit, 2003). In yet another case, the District Court ruled that a similar agreement involving Cipro was not *per se* illegal because the strength of the patent must be considered as part of the antitrust analysis. (*In re Ciprofloxacin Hydrochloride Antitrust Litigation*, 261 F. Supp. 2nd 188, E.D.N.Y. 2003.)

and will enter the market and drive down prices from monopoly to duopoly levels.[35] If E has already entered, or would enter prior to a ruling on whether the patent is valid, E offers *allegedly infringing competition.* If E would refrain from entering during the pendency of patent litigation and only enter after an invalidity ruling, E offers *potentially infringing competition.* (Shapiro, 2003b) Faced with potential competition from E, suppose that M makes a payment to E in exchange for which E agrees to acknowledge the validity of the patent and stay out of the market until the patent expires. Consumers are thus deprived on the benefits of competition by E, and continue to pay the monopoly price to M. However, M and E defend their agreement by saying that M has the right to exclude E because of M's patent, which is presumed valid under patent law. They stress that infringing competition is no more than theft of the patent holder's property.

In previous work, we have argued that patent settlement involving payments (in excess of avoided litigation costs) from by incumbent patent holders to potential entrants accused of infringing should be presumed to be anti-competitive (Hovenkamp et al. 2003; Shapiro, 2003a; Shapiro 2003b).[36] Why? The likely effect of such payments is to delay entry, either in comparison with litigation or in comparison with a settlement not involving these payments.[37] Such payments are especially worrisome given that so many questionable patents are issued, as we have emphasized above. To see how such "reverse payments" harm consumers and stifle competition, go back to our little model above involving a patent that will be declared valid with probability P. Under litigation, consumers benefit from competition with probability (1-P). If the patent holder can pay off the would-be entrant, consumers are deprived entirely of the benefits of competition until the patent expires. Instead, the patent holder, who had a legitimate right to a monopoly position only with probability P, insured that its monopoly position would remain intact by sharing some of the monopoly rents with the potential entrant. As we explain at

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[35] This basic economic logic still applies if other firms will enter as well after the patent is declared invalid, causing prices to fall even further. As noted above, the Hatch-Waxman Act affords a temporary exclusivity period to the first generic to successfully challenge a pharmaceutical patent.

[36] See also Cotter (2003), and Leffler and Leffler (2002 and 2003).

[37] However, Willig and Bigelow (2004) argue that in cases involving negotiated entry dates, such reverse payments can be pro-competitive. They thus oppose a *per se* rule prohibiting such payments. Under the standard we favor, such payments would be presumptively anti-competitive, giving the settling parties the chance to demonstrate in a given case that justifications such as those offered by Willig and Bigelow – based on risk aversion, imperfect capital markets, and asymmetric information, -- apply with sufficient force to overcome the presumption.

greater length in our papers, neither competition nor innovation are promoted by allowing this type of agreement that harms consumers and enables the owner of a weak patent to pay would-be challengers to drop their claim that the patent is invalid and refrain entirely from competing during the lifetime of the patent.

Defenders of such agreements, and some courts, have argued that infringing competition should not be protected by the antitrust laws, and that the patent at issue might not be weak at all. (Schildkraut, 2004; Crane, 2004). We agree that truly infringing competition does not warrant antitrust protection, but it should be distinguished from allegedly infringing competition and potentially non-infringing competition. (Shapiro, 2003b) Patent owners have the ability to seek preliminary injunctions forcing alleged infringers from the market if they are likely to prevail and would suffer irreparable harm from the allegedly infringing competition, perhaps because the alleged infringer would not be able fully to compensate the patent owner for damages if the patent is found to be valid and infringed. Indeed, in the pharmaceutical context, in which every reverse payment case so far has arisen, the law provides for an *automatic* preliminary injunction for thirty months; reverse payments are an effort to extend the period of exclusion beyond that point without having to litigate the patent. We also show in our previous articles that one often can infer a certain degree of patent weakness from the fact that the patent owner is paying to avoid the risk that its patent will be found invalid, especially if the payment is large.

Patent settlements take many, many forms and can raise a variety of antitrust issues, even when they do not involve simple payments from patent holders to alleged infringers to stay off the market. Virtually every licensing agreement can be seen as the settlement of a patent dispute, even if the dispute never involved formal litigation. In some cases, patent disputes are settled through mergers or acquisitions, or by forming patent pools or engaging in cross-licensing. Some pharmaceutical companies settle with generics by negotiating a date at which the generic firm can enter the market; Hovenkamp et al have argued that such agreements are reasonable so long as they do not include a reverse payment. (Hovenkamp et al., 2003). Patent applicants also settle interference disputes in which each claims to be the first to have come up with an invention; such settlements will necessarily involve a payment from one side to the other because each had a potential affirmative claim to a patent right. (Hovenkamp et al., 2004a).

Thus, we face the rather general question of identifying those few settlements that are anti-competitive in the large universe of all patent settlements. Shapiro has proposed a general framework for establishing the antitrust limits on patent settlements based on the principle that the settlement cannot lead to lower expected consumer surplus than would arise from ongoing litigation (Shapiro, 2003a). This rule respects the rights of patent holders and prevents companies from using the cover of patent settlements to engage in cartel-like agreements. For better or worse, applying this rule typically requires some assessment of the strength of the relevant patent(s). However, inferences about patent strength can reasonably be made in the "reverse payment" cases described above: the presence of a substantial payment from patentee to accused infringer may well imply that the patentee paid for a reduction in competition in comparison with ongoing litigation. Reverse payments, then, will typically fail the "expected consumer surplus" test because they lead to later entry than would happen (on average) were the patent litigation carried to completion. In contrast, this same general framework implies that simple licensing agreements can be presumed pro-competitive: royalties will reflect the underlying strength of the patent and there is no reason for the licensee burden itself with high royalties unless the patent is indeed likely to be found valid and infringed. Shapiro studies a variety of other, more complex types of settlements, including mergers and patent pools as well as negotiated entry dates.

VII. Conclusion

The patent system does not grant a right to exclude competitors, as many economic models assume, but rather gives the patent holder a right to try to exclude others by asserting its patent against them in court. The actual scope of a patent right, and even whether the right will withstand litigation at all, are uncertain and contingent questions, at least until the patent is actually enforced in court. This uncertainty is not an accident or mistake. Rather, it is in inherent part of our patent system, an accommodation to the hundreds of thousands of patent applications filed each year, the inability of competitors to participate effectively in determining whether a patent should issue, and the fact that for the vast majority of these patents, scope and validity are of little or no commercial significance.

The probabilistic nature of patents has important implications for the legal system and economic analysis of that system. Modeling patents as probabilistic rights requires us to rethink

reform of the patent granting process, our approach to patent litigation, the efficacy of litigation as a means of invalidating patents that were improperly issued, and patent antitrust policy towards settlement of patent lawsuits.

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